SiVEST SA (PTY) LTD

PROPOSED CONSTRUCTION OF THE UJEKAMANZI WIND ENERGY FACILITY 1 NEAR AMERSFOORT, MPUMALANGA PROVINCE, SOUTH AFRICA

Avifaunal Specialist Scoping Report

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SiVEST SA (PTY) LTD

PROPOSED CONSTRUCTION OF THE UJEKAMANZI WIND ENERGY FACILITY 1, NEAR AMERSFOORT, MPUMALANGA PROVINCE, SOUTH AFRICA

AVIFAUNAL SPECIALIST SCOPING ASSESSMENT

EXECUTIVE SUMMARY

1. INTRODUCTION

ABO Wind renewable energies (Pty) Ltd (hereafter referred to as “ABO”), has appointed SiVEST SA (Pty) Ltd (hereafter referred to as “SiVEST”) to undertake the required Scoping and Environmental Impact Assessment (S&EIA) process for the proposed development of the renewable energy cluster, located south of Ermelo in the Mpumalanga province. The project will consist of four separate EIA’s, 2 x Wind Energy Facilities (WEF’s), a Main Transmission Substation (MTS) (potentially including 2 x 132kV overhead powerlines) and a Loop-In-Loop-Out (LILO) for the grid connection. Each of the projects will require its own Environmental Authorisation and possibly its own impact assessment report.

Refer to the table below for the project overview:

PROJECTS	DESCRIPTION
2 x Wind Energy Facilities	• Approximate combined capacity: 650 MWac • Approximate properties affected/ Site extent: 20,000 ha • Associated infrastructure include: • Wind Turbine Generators • Substation complex, O&M buildings (workshop etc.), • Battery energy storage systems of 500MW/500MWh, which could • be either lithium-ion or redox flow technology, etc. • Underground cabling (33kV), Overhead powerlines (132kV), • Temporary site compound, Laydown areas, Access roads,
1 x Main Transmission Substation	The proposed development of a 400/132 kV MTS, including associated infrastructure at the MTS (potentially including 2 x 132kV OHL)
1 x Loop-In-Loop-Out grid connection	The proposed development of a 400 kV Loop-In-Loop-Out (LILO) from the existing 400 kV Overhead Power Line to the proposed MTS

None of the projects fall within a Renewable Energy Development Zone (REDZ) or a strategic power corridor.

In terms of the Environmental Impact Assessment (EIA) Regulations, which were published on 04 December 2014 [GNR 982, 983, 984 and 985) and amended on 07 April 2017 [promulgated in Government Gazette 40772 and Government Notice (GN) R326, R327, R325 and R324 on 7 April 2017], various aspects of the proposed development are considered listed activities under GNR 327 and GNR

324 which may have an impact on the environment and therefore require authorisation from the National Competent Authority (CA), namely the Department of Environment, Forestry and Fisheries (DEFF), prior to the commencement of such activities. Specialist studies have been commissioned to assess and verify the project under the new Gazetted specialist protocols.

This scoping level report deals with the potential impact of the **Ujekamanzi WEF 1** on avifauna.

It is estimated that a total of 263 bird species could potentially occur in the Broader Area. Please refer to Appendix 5 which provides a comprehensive list of all the species recorded in the Broader Area. Of the 263 species, 45 species are classified as priority species for wind developments. Of the priority species in the broader area, 37 were recorded during the 12 months of pre-construction monitoring.

2. CONCLUSION AND SUMMARY

2.1 Summary of Findings

2.1.1 Wind Energy Facility

The proposed Ujekamanzi WEF 1 will have several potential impacts on priority avifauna. These impacts are the following:

- Displacement of priority species due to disturbance associated with the construction of the wind turbines and associated infrastructure.
- Displacement due to habitat transformation in the construction phase.
- Mortality due to collisions with the wind turbines in the operational phase.
- Electrocution on the 33kV MV overhead lines (if any) linking the turbines in the operational phase.
- Collisions with the 33kV MV overhead lines (if any) linking the turbines in the operational phase.
- Displacement of priority species due to disturbance linked to dismantling activities in the decommissioning phase.

2.1.1.1 Displacement of priority species due to disturbance associated with the construction of the wind turbines and associated infrastructure.

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species in the remaining high-quality grassland, wetlands and wetland fringes the most, as well as Southern Bald Ibis roosting and breeding in the PAOI, as this could temporarily disrupt their reproductive cycle. Some species might be able to recolonise the area after the completion of the construction phase, but for some species, this might only be partially the case, resulting in lower densities than before once the WEF is operational, due to the disturbance factor of the operational turbines, and the habitat fragmentation. In summary, the following species could be impacted by disturbance during the construction phase: African Fish Eagle, African Grass Owl, African Harrier-Hawk, African Marsh Harrier, Black Sparrowhawk, Black-rumped Buttonquail, Black-winged Kite, Blue Crane, Blue Korhaan, Buff-streaked Chat, Denham's Bustard, Greater Kestrel, Grey Crowned Crane, Grey-winged Francolin, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Rudd's Lark, Rufous-breasted Sparrowhawk, Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White-bellied Bustard and Yellow-breasted Pipit. The impact is rated as **Medium** but could be mitigated to **Low** levels.

2.1.1.2 Displacement due to habitat transformation in the construction phase.

The construction of additional roads is likely to result in further habitat fragmentation, although the site already has a large number of access roads, most of which will be upgraded and utilised for the wind farm development. This, together with the disturbance factor of the operating turbines, could have an effect on the density of several species, particularly larger terrestrial species which would utilise the remaining natural grassland, wetlands and wetland fringes as breeding habitat. It is not expected that any priority species will be permanently displaced from the development site, but densities may be reduced. In summary, the following terrestrial species and raptors are likely to be most affected by habitat transformation: African Grass Owl, Black-rumped Buttonquail, Black-winged Lapwing, Blue Crane, Blue Korhaan, Buff-streaked Chat, Denham's Bustard, Grey Crowned Crane, Grey-winged Francolin, Marsh Owl, Rudd's Lark, Secretarybird, White-bellied Bustard and Yellow-breasted Pipit. The impact is rated as **Medium** pre- mitigation and **Low** post-mitigation.

2.1.1.3 Collision mortality caused by the wind turbines in the operational phase.

The proposed WEF will pose a collision risk to several priority species which could occur regularly at the site. Species exposed to this risk are large terrestrial species and occasional long-distance fliers i.e., bustards, cranes, storks, Southern Bald Ibis and Secretarybird, although bustards and cranes generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species, i.e., species such as Cape Vulture and a variety of raptors, including several species of eagles, are highly vulnerable to the risk of collisions. The regularly occurring priority species could be at risk of collisions with the turbines are the following: African Fish Eagle, African Grass Owl, African Harrier-Hawk
African Marsh Harrier, Amur Falcon, Black Sparrowhawk, Black-winged Kite, Black-winged Lapwing, Black-winged Pratincole, Blue Crane, Blue Korhaan, Common Buzzard, Denham's Bustard, Greater Kestrel, Grey Crowned Crane, Grey-winged Francolin, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Montagu's Harrier, Pallid Harrier, Red-footed Falcon, Rudd's Lark, Rufous-breasted Sparrowhawk, Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White Stork, White-bellied Bustard, Yellow-billed Stork and Yellow-breasted Pipit. The impact is rated as **Medium** pre-mitigation and **Low** post-mitigation.

2.1.1.4 Electrocution on the 33kV MV overhead lines (if any) in the operational phase.

The following priority species are potentially vulnerable to electrocution on the 33kV overhead lines: African Fish Eagle, African Grass Owl, African Harrier-Hawk, African Marsh Harrier, Amur Falcon, Black Sparrowhawk, Black-winged Kite, Common Buzzard, Greater Kestrel, Grey Crowned Crane, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Montagu's Harrier, Pallid Harrier, Red-footed Falcon, Rufous-breasted Sparrowhawk, Southern Bald Ibis and Spotted Eagle-Owl. The impact is rated as **Medium** pre-mitigation and L**ow** post-mitigation.

2.1.1.5 Collisions with the 33kV MV overhead lines (if any) in the operational phase.

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. These spans could pose a collision risk to priority avifauna, depending on where those spans are located. Priority species potentially at risk are African Grass Owl, Blue Crane, Blue Korhaan, Denham's Bustard, Grey Crowned Crane, Marsh Owl
Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White Stork, White-bellied Bustard and Yellow-billed Stork. The impact is rated as **Medium** pre-mitigation and **Low** post-mitigation.

2.1.1.6 Displacement of priority species due to disturbance linked to dismantling activities in the decommissioning phase.

The impact is likely to be similar in nature to the construction phase.

Table 1 summarises the expected impacts of the proposed WEF and proposed mitigation measures per impact.

Table 1: Overall Impact Significance for the WEF (Pre- and Post-Mitigation)

Nature of impact and Phase	Overall Impact Significance (Pre -Mitigation)	Proposed mitigation	Overall Impact Significance (Post - Mitigation)
Construction: Displacement due to disturbance	Medium	(1) Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species. (2) Measures to control noise and dust should be applied according to current best practice in the industry. (3) No construction should take place in all infrastructure exclusion zones as indicated in Section 6.3.	Low
Construction: Displacement due to habitat transformation	Medium	(1) Removal of vegetation must be restricted to a minimum and must be rehabilitated to its former state where possible after construction. (2) Construction of new roads should only be considered if existing roads cannot be upgraded. (3) The recommendations of biodiversity specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned to limit the impact of habitat transformation on priority species. (4) No construction should take place in all infrastructure exclusion zones as indicated in Section 6.3.	Low
Operational: Collisions with the turbines	Medium	(1) No turbines (including the rotor swept area) should be located in turbine exclusion zones as indicated in Section 6.3. (2) Pro-active mitigation in the form of Shutdown on Demand (SDoD) or automated curtailment must be implemented in the medium risk zones as indicated in Section 6.3. (3) Live-bird monitoring and carcass searches should be implemented in the operational phase, as per the most recent edition of the Best Practice	Low

Nature of impact and Phase	Overall Impact Significance (Pre -Mitigation)	Proposed mitigation	Overall Impact Significance (Post -Mitigation)
		Guidelines at the time (Jenkins et al. 2015) to assess collision rates. (4) All wind turbines must have one blade painted according to a CAA approved pattern to reduce the risk of raptor collisions. It is acknowledged that blade painting as a mitigation strategy is still in an experimental phase in South Africa, but research indicates that it has a very good chance of reducing raptor mortality, based on research conducted in Norway (see Simmons et al. 2021 (Appendix 8) for an explanation of the science and research behind this mitigation method). (5) If at any time estimated collision rates indicate unacceptable mortality levels of priority species, i.e., if it exceeds the mortality threshold determined by the avifaunal specialist after consultation with other avifaunal specialists and BirdLife South Africa, additional measures will have to be implemented.	
Operational: Electrocutions on the 33kV MV network	Medium	(1) Underground cabling should be used as much as is practically possible. (2) If the use of overhead lines is unavoidable due to technical reasons, the Avifaunal Specialist must be consulted timeously to ensure that a raptor friendly pole design is used, and that appropriate mitigation is implemented pro-actively for complicated pole structures e.g., insulation of live components to prevent electrocutions on terminal structures and pole transformers. (3) Regular inspections of the overhead sections of the internal reticulation network must be conducted during the operational phase to look for carcasses, as per the most recent edition of the Best Practice Guidelines at the time (Jenkins *et al.* 2015).	Low
Operational: Collisions with the 33kV MV network	Medium	Bird flight diverters should be installed on all the overhead line sections for the full span length according to the applicable Eskom standard at the time.	Low

Nature of impact and Phase	Overall Impact Significance (Pre -Mitigation)	Proposed mitigation	Overall Impact Significance (Post - Mitigation)
Decommissioning: Displacement due to disturbance	Medium	(1) Dismantling activity should be restricted to the immediate footprint of the infrastructure as far as possible. Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species. (2) Measures to control noise and dust should be applied according to current best practice in the industry.	Low

3.2 The identification of preliminary environmental sensitivities: Wind Energy facility

The following preliminary environmental sensitivities were identified from an avifaunal perspective for the proposed wind energy facility:

3.2.1 Very High sensitivity: All infrastructure exclusion zones.

Included in this category are the following areas:

- Medium and high sensitivity buffers as defined by the aquatic specialist around drainage lines, dams and wetlands. This is to prevent the disturbance of priority species breeding and roosting in these areas and to reduce the risk of turbine collisions. Priority species in this category include African Fish Eagle, African Grass Owl, African Marsh Harrier, Black-winged Pratincole, Blue Crane, Grey Crowned Crane, Long-crested Eagle, Marsh Owl and Yellow-billed Stork.
- 1km buffers around Southern Bald Ibis roosts and colonies to prevent displacement of birds due to disturbance and to reduce the risk of turbine collisions.
- 500m buffers around Secretarybird nests to prevent displacement of birds due to disturbance and to reduce the risk of turbine collisions.
- 500m buffers around Grey Crowned Crane roosts and potential breeding areas to prevent displacement of birds due to disturbance and to reduce the risk of turbine collisions.
- All the modelled Rudd's Lark habitat.
- All the modelled Yellow-breasted Pipit habitat.

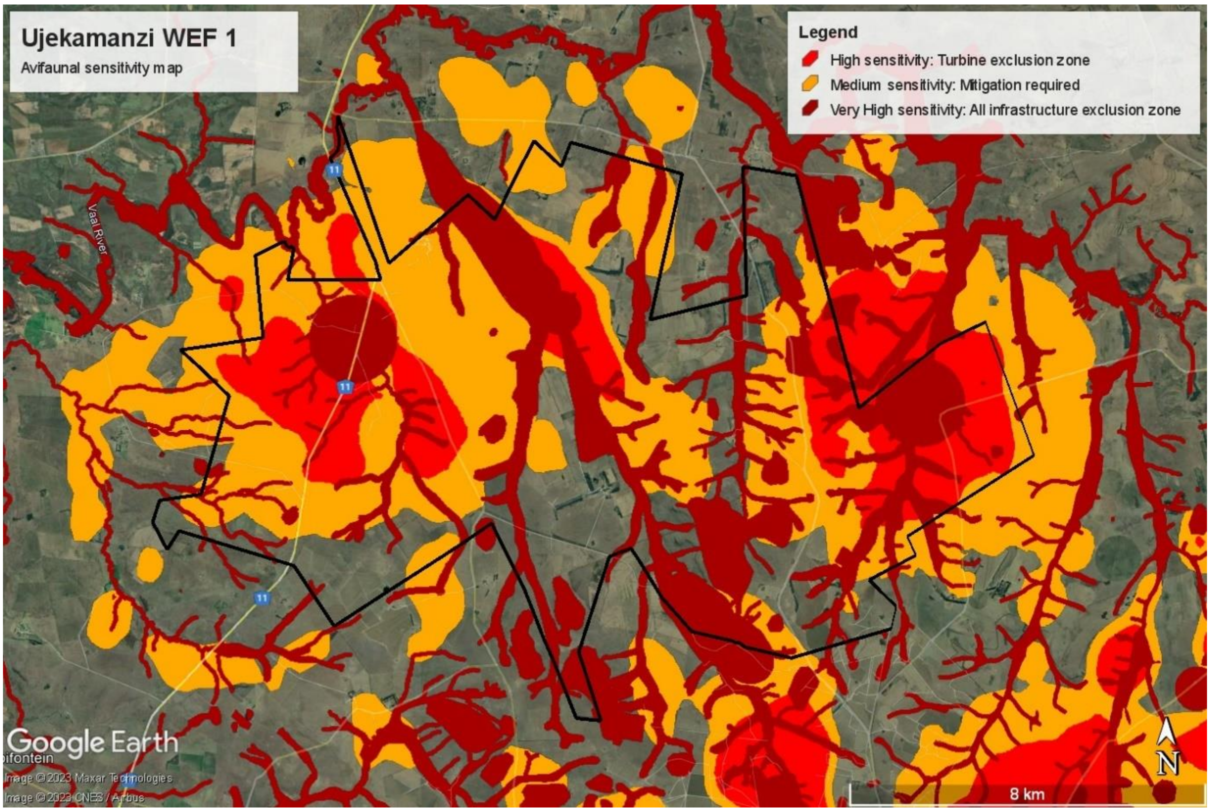
3.2.2 High sensitivity: Turbine exclusion zones

- A 5km turbine exclusion zone around the Martial Eagle nest (FP12)
- A shaped turbine exclusion zone based on the modelled flight activity of the Southern Bald Ibis recorded during the pre-construction monitoring.
- A shaped turbine exclusion zone based on the modelled flight activity of the Secretarybird recorded during the pre-construction monitoring.

3.2.3 Medium sensitivity: Pro-active mitigation zones (shutdown on demand)

- All medium sensitivity flight risk zones modelled for Grey Crowned Crane
- All medium sensitivity flight risk zones modelled for Secretarybird

See **Figure** 11**(i)** for a map indicating the preliminary avifaunal sensitivities and No-turbine buffers.



Figure(i): Avifaunal sensitivities for Ujekamanzi WEF 1

3.3 Conclusion and Impact Statement

3.3.1 Wind Energy Facility

The proposed Ujekamanzi WEF 1 will have a moderate impact on avifauna which, in all instances, could be reduced to a low impact through appropriate mitigation. No fatal flaws were discovered during the onsite investigations. **The development is therefore supported, provided the mitigation measures listed in this report are strictly implemented**.

4. ASSESSMENT OF ALTERNATIVES

4.1 Wind Energy Facility

Table 10 10 provides a summary of the proposed alternatives relating to the WEF and associated infrastructure, namely the four onsite substation options.

Key

PREFERRED	The alternative will result in a low impact / reduce the impact / result in a positive impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Table *2*: Comparative assessment of WEF components

Alternative	Preference	Reasons
SUBSTATION SITE ALTERNATIVES		
Substation Option 1	Favourable. The impact will be relatively insignificant	This option is located in an agricultural field where the natural grassland has already been transformed.
Substation Option 2	The alternative will increase the impact.	This alternative is located in natural grassland and is therefore least preferred as it will lead to further transformation and fragmentation of the natural grassland.
Substation Option 3	The alternative will increase the impact.	This alternative is located in natural grassland and is therefore least preferred as it will lead to further transformation and fragmentation of the natural grassland.
Substation Option 4	Favourable. The impact will be relatively insignificant	This option is located in an agricultural field where the natural grassland has already been transformed.

4.2 No-Go Alternative

4.2.1 Wind Energy Facility

The no-go alternative will result in the current *status quo* being maintained as far as the avifauna is concerned. The low human population in the area is definitely advantageous to sensitive avifauna, especially Red Data species. The no-go option would eliminate any additional impact on the ecological integrity of the proposed PAOI as far as avifauna is concerned.

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6)

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	Section of 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;	Appendix 2
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page 10
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 2
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 7
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Appendix 7
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2
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 7
g) an identification of any areas to be avoided, including buffers;	Section 7
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 7
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 3
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 9

k) any mitigation measures for inclusion in the EMPr;	To be included in EIA Report
l) any conditions for inclusion in the environmental authorisation;	To be included in EIA Report
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	To be included in EIA Report
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 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;	Section 9
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable
q) any other information requested by the competent authority.	Not applicable
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.	All sections

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Glossary of Terms

Definitions	
Broader area	A consolidated data set for a total of 20 pentads where the application sites are located.
Project Area of Impact (PAOI)	An area comprising the proposed Project Site and a 4km buffer around the site which has an extent of approximately 44 000 hectares.
Project Site	The area where the proposed wind farm will be constructed which has an extent of approximately 13 494 hectares.
Wind priority species	Priority species for wind development were identified from the most recent (November 2014) list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012).

List of Abbreviations

BA	Basic Assessment
BGIS	Biodiversity Geographic Information System
BLSA	BirdLife South Africa
DFFE	Department of Forestry, Fisheries and the Environment
EGI	Electricity Grid Infrastructure
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
HV	High voltage
IBA	Important Bird Area
IKA	Index of Kilometric Abundance
IUCN	International Union for Conservation of Nature
kV	Kilovolt
MTS	Main Transmission Substation
LILO	Line-in-line-out
MV	Medium voltage
NEMA	National Environmental Management Act (Act 107 of 1998, as amended)
OHL	Overhead line
PAOI	Project Area of Impact
REDZ	Renewable Energy Development Zone
SABAP 1	South African Bird Atlas 1
SABAP 2	South African Bird Atlas 2
SACNASP	South African Council for Natural and Scientific Professions
SANBI	South African Biodiversity Institute
SAPAD	South Africa Protected Areas Database
WEF	Wind Energy Facility

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None of the projects fall within a Renewable Energy Development Zone (REDZ) or a strategic power corridor.

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This scoping level report deals with the potential impact of the **Ujekamanzi WEF 1** on avifauna.

1.1 Terms of Reference

The terms of reference for this scoping report are the following:

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts;
- Assess and evaluate the potential impacts;
- Give a considered opinion whether the project is fatally flawed from an avifaunal perspective; and
- If not fatally flawed, recommend mitigation measures to reduce the expected impacts.

For the general Terms of Reference for all specialist report, please see Appendix 1

1.2 Specialist Credentials

Please see Appendix 2 Specialist CVs

1.3 Assessment Methodology

The following methods and sources were used to compile this report:

- The **Project Area of Impact (PAOI)** of the proposed WEF was defined as an area comprising the proposed **Project Site** and a 4km buffer around the site which has an extent of approximately 44 000 hectares.

Bird distribution data of the Southern African Bird Atlas Project 2 (SABAP2) was obtained from the University of Cape Town (https://sabap2.birdmap.africa/), as a means to ascertain which species occur within the **Broader Area** i.e. within a block consisting of 20 pentads (see

- Table 1). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2007 to date, a total of 261 full protocol lists (i.e. surveys lasting a minimum of two hours each) have been completed for this area. In addition, 329 ad hoc protocol lists (i.e. surveys lasting less than two hours but still yielding valuable data) have been completed.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the (2022.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the vegetation in the WEF application site was obtained from the Atlas of Southern African Birds 1 (SABAP 1) (Harrison *et al.* 1997) and the National Vegetation Map (2018 beta2) from the South African National Biodiversity Institute website (Mucina & Rutherford 2006 & http://bgisviewer.sanbi.org).
- The Important Bird Areas of Southern Africa (Marnewick *et al.* 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery (Google Earth ©2023) was used to view the broader area on a landscape level and to help identify sensitive bird habitat.
- Priority species for wind development were identified from the most recent (November 2014) list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012).
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the proposed site relative to National Protected Areas.
- The DFFE National Screening Tool was used to determine the assigned avian sensitivity of the PAOI.
- The primary source of information on avifaunal diversity, abundance, and flight patterns at the site were the results of a pre-construction programme currently conducted over four seasons at the two proposed Ujekamanzi WEF application sites. The primary methods of data capturing are walk transect counts, drive transect counts, focal point monitoring, vantage point counts and incidental sightings (see Appendix 3 for a detailed explanation of the monitoring methods).

Table 1: The number of SABAP2 lists completed for the Broader Area

Pentad	Number of full protocol lists	Ad hoc protocol lists
2640_2950	3	**0**
2640_2955	9	**13**
2640_3000	19	**4**
2640_3005	26	**14**
2645_2950	2	**2**
2645_2955	8	**33**
2645_3000	9	**9**
2645_3005	7	**8**
2650_2950	4	**18**
2650_2955	28	**10**
2650_3000	18	**15**
2650_3005	14	**5**
2655_2950	4	**18**
2655_2955	17	**12**
2700_3000	16	**7**
2655_3005	29	**19**
2700_2950	11	**40**
2700_2955	4	**20**
2700_3000	17	**58**
2700_3005	16	**24**
Total	**261**	**329**

2. ASSUMPTIONS AND LIMITATIONS

This study made the basic assumption that the sources of information used are reliable and accurate. The following must be noted:

- The SABAP2 dataset for the Broader Area is a relatively comprehensive but not complete dataset and provides a reasonable snapshot of the avifauna which could occur at the proposed site. For purposes of completeness, the list of species that could be encountered was therefore supplemented with personal observations, general knowledge of the area, and the results of the pre-construction monitoring.
- Conclusions in this study are based on experience of these and similar species at wind farm developments in different parts of South Africa. However, bird behaviour can never be predicted with absolute certainty.
- To date, only one peer-reviewed scientific paper has been published on the impacts wind farms have on birds in South Africa (Perold *et al*. 2020). The precautionary principle was therefore applied throughout. The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle. The principle was implemented in an

international treaty as early as the 1987 Montreal Protocol and, among other international treaties and declarations, is reflected in the 1992 Rio Declaration on Environment and Development. Principle 15 of the 1992 Rio Declaration states that: “in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation.”

- According to the specifications received from the applicant, the 33kV medium-voltage lines will be buried next to the roads where practically feasible. It was therefore assumed that there could be 33kV overhead lines which could pose an electrocution risk to priority species.

3. TECHNICAL DESCRIPTION

3.1 Project Location

The proposed project is located south of Ermelo in the Dr. Pixley Ka Isaka Seme Local Municipality within the Mpumalanga Province (**Error! Reference source not found. and 2**).

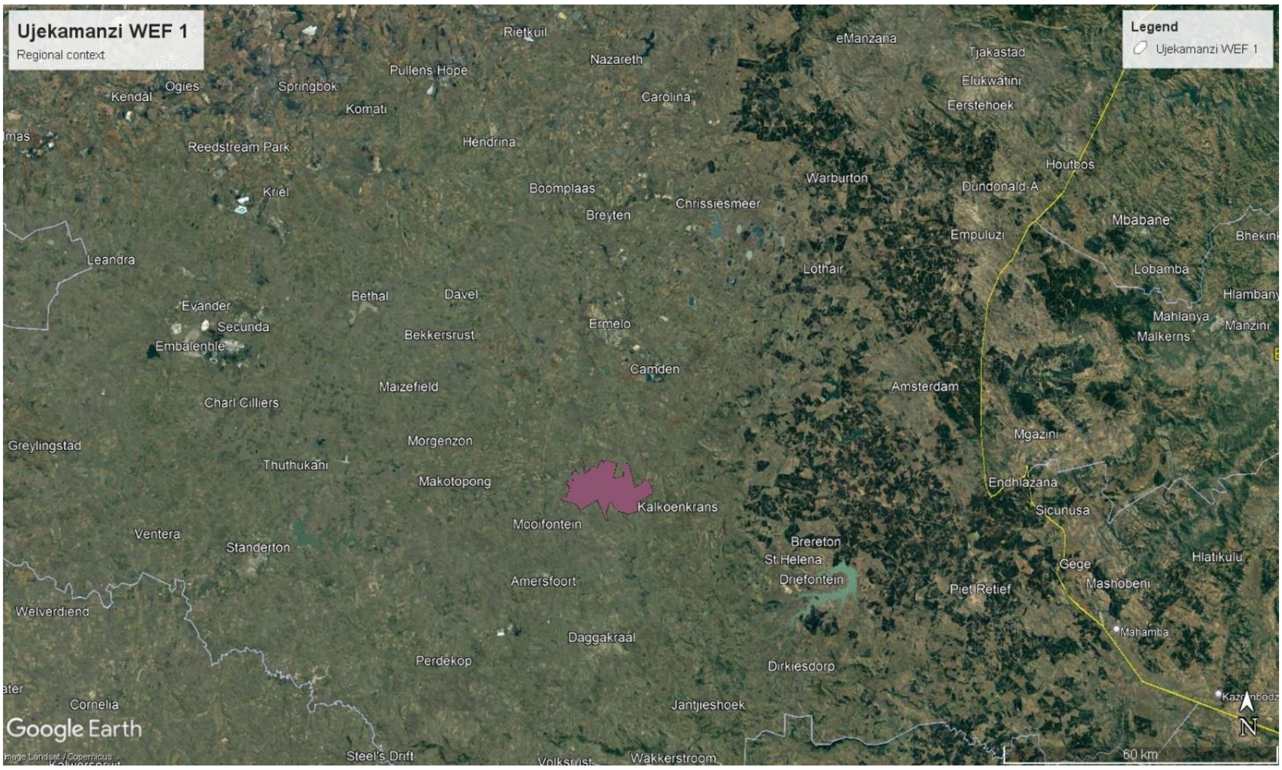


Figure 1: Regional Context Map – Location of Ujekamanzi WEF 1.

The Ujekamanzi WEF 1 Project Site is approximately 13 494 ha in extent (**Figure 2**). Design and layout alternatives will be considered and assessed as part of the EIA. These include alternatives for the Substation locations and also for the construction / laydown area.

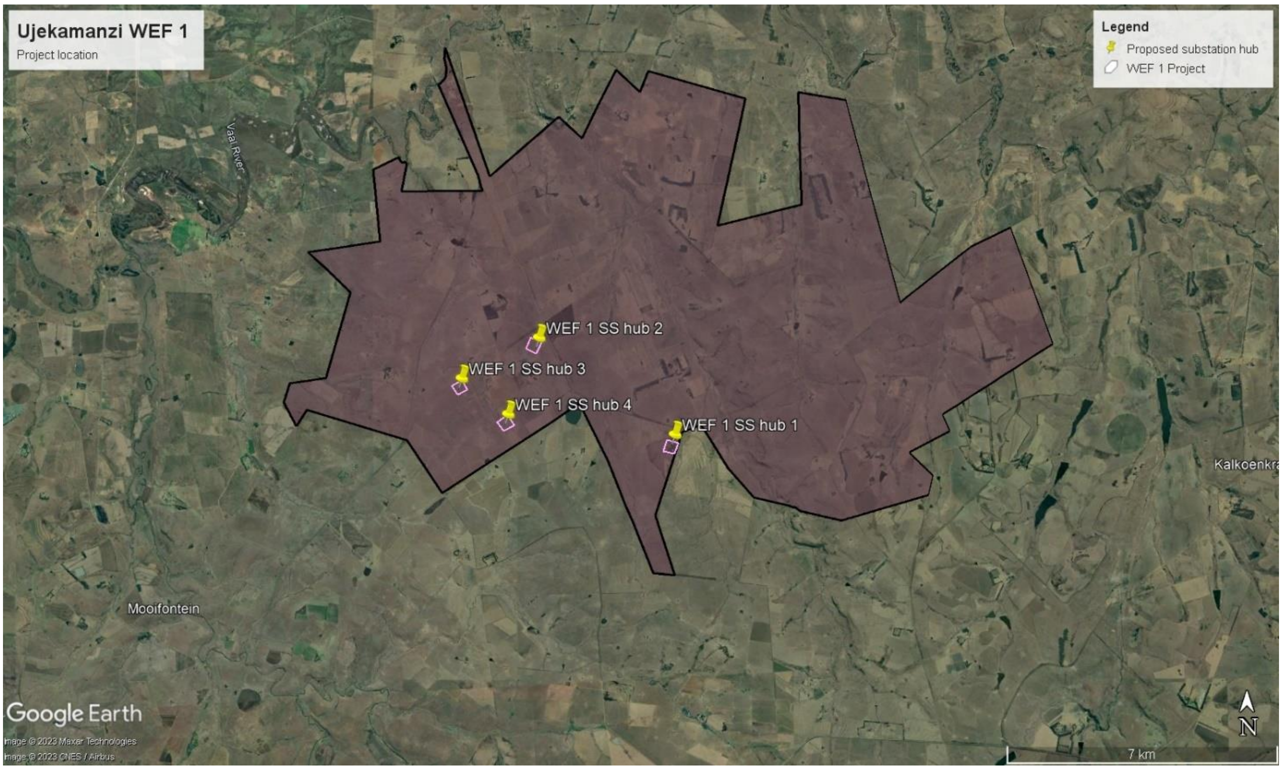


Figure 2: Ujekamanzi WEF 1 Site Locality

3.2 Project Description

The number of turbined will be determined at a later stage. The client is requesting authorization for a buildable area. In summary, the proposed Ujekamanzi WEF 1 development will include the following components:

Ujekamanzi WEF 1		
Component	**Dimensions**	
Wind turbines	Number of turbines:	The number of turbines will be determined at a later stage. The client is requesting authorization for a buildable area.
	MW output per turbine:	Up to 10 MW
	Total installed capacity:	650 MW (TBC)
	Hub Height from ground:	Up to 180 m
	Rotor diameter:	Up to 200 m
	Blade length	Up to 100 m
	Total footprint of turbine and laydown area	Up to approx. 1 ha per turbine (but WTG turbine-dependent)

Ujekamanzi WEF 1		
Component	**Dimensions**	
	(hardstand area) (ha):	
	Crane pad (m^2):	General temporary Hardstand Area (boom erection, storage, and assembly area): 1ha per turbine
	Permanently affected area (foundation size) (m^2):	Up to 1 ha, may be able to rehabilitate some of this area
Roads	Width of internal access roads (m):	up to 10m; circle/bypass TBC (WTG specific)
	Length of internal access roads (km):	TBC
	Site access points:	TBC
Upgrading of existing access road/s	Yes/No:	Yes, where necessary
	Current width (m):	TBC (likely between 6m and 8m)
	Upgraded width (m):	Up to 10m
Construction Compounds and Laydown Areas	Footprint (ha):	Up to Approximately 10ha (for Temporary construction period laydown / staging area)
Operational and Maintenance (O&M) control centre building area	Maximum height (m):	
	Footprint (m^2):	Up to 1ha (within On-site Substation Hub)
On-site Substation Hub	Included	The proposed project will include one on-site substation hub incorporating the facility substation, switchyard, collector infrastructure, battery energy storage system (BESS) and associated O&M buildings.
	Footprint (ha):	Up to 19ha
	Capacity:	33/132 kV (Project 1-2)
	Height (m):	Up to 10m
	Communications tower: Height (m):	Up to 32m (TBC)
Battery storage	Battery technology type:	Electrochemical Batteries including:
		a. Lead Acid and Advanced Lead Acid
		b. Lithium ion, NiCd, NiMH-based Batteries

Ujekamanzi WEF 1 & 2		
Component	**Dimensions**	
		c. High Temperature (NaS, Na-NiCl2, Mg/PB-Sb)
		d. Flow Batteries (VRFB, Zn-Fe, Zn-Br)
		The BESS would therefore comprise the selected batteries together with chargers, inverters and related equipment.
	Approx. footprint (ha):	Up to 5ha (within On-site Substation Hub)
	Maximum height (m):	Up to 8m or higher as recommended?
	Capacity:	500MW/500MWh
Internal transmissions and/or distribution lines on site	Under or aboveground:	Underground, unless not possible due to enviro reasons
	Capacity (kVA):	Typically 33kV
	If above: height (m)	TBC. “Cables to be buried along access roads, where feasible, with overhead 33kV lines grouping turbines to crossing valleys and ridges outside of the road footprints to get to the on-site substation.”
	If below: maximum depth (m)	Up to 1m
	Length (m):	To follow internal site roads (length TBC)
Perimeter fencing	Height (m):	TBC
	Type of material:	TBC
Construction Period (months):	Expected to be 24 months	Expected to be 24 months
Wind Monitoring Masts (if applicable)		Currently 1 met mast is installed with a second met mast planned.
Proximity to grid connection		On-site: The proposed development of a 400 kV Loop-In-Loop-Out (LILO) from the existing 400 kV Overhead Power Line to the proposed MTS

3.3 Layout alternatives

3.3.1 Wind Energy Facility

No other activity or site alternatives are being considered. Renewable Energy development in South Africa is highly desirable from a social, environmental and development point of view and a wind energy facility is considered suitable for this site due to the high wind resource in this area.

The choice of technology selected for the Ujekamanzi WEF 1 is based on environmental constraints and technical and economic considerations. No other technology alternatives are being considered as wind energy facilities are more suitable for the site than other forms of renewable energy due to the high wind resource.

The size of the wind turbines will depend on the development area and the total generation capacity that can be produced as a result. The choice of turbine to be used will ultimately be determined by technological and economic factors at a later stage.

Design and layout alternatives will be considered and assessed as part of the EIA. These include alternatives for the Substation locations and also for the construction / laydown area.

3.3.2 No-go Alternative

The 'no-go' alternative is the option of not undertaking the proposed WEF and / or grid connection infrastructure projects. Hence, if the 'no-go' option is implemented, there would be no development. This alternative would result in no environmental impacts from the proposed project on the site or surrounding local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report.

4. LEGAL REQUIREMENT AND GUIDELINES

Error! Reference source not found. below lists agreements and conventions which South Africa is party to, and which is directly relevant to the conservation of avifauna (BirdLife International 2023).

Table 2: Agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna.

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity	Global

Convention name	Description	Geographic scope
	The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global
Convention on the International Trade in Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Global
Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

4.1 National legislation

4.1.1 Constitution of the Republic of South Africa, 1996

The Constitution of the Republic of South Africa provides in the Bill of Rights that: Everyone has the right –

(a) to an environment that is not harmful to their health or well-being; and

(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

4.1.2 The National Environmental Management Act (Act No. 107 of 1998) (NEMA)

The National Environmental Management Act (Act No. 107 of 1998) (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out several guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated.

NEMA also provides that a wide variety of listed developmental activities, which may significantly affect the environment, may be performed only after an environmental impact assessment has been done and authorization has been obtained from the relevant authority. Many of these listed activities can potentially have negative impacts on bird populations in a variety of ways. The clearance of natural vegetation, for instance, can lead to a loss of habitat and may depress prey populations, while erecting structures needed for generating and distributing energy, communication, and so forth can cause mortalities by collision or electrocution.

NEMA makes provision for the prescription of procedures for the assessment and minimum criteria for reporting on identified environmental themes (Sections 24(5)(a) and (h) and 44) when applying for environmental authorisation. The Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020) is applicable in all cases except for wind developments. In the case of wind energy developments, the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on avifaunal species where the output is 20MW or more (Government Gazette No 43110, 20 March 2020) is applicable[1].

4.1.3 The National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) and the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations)

The most prominent statute containing provisions directly aimed at the conservation of birds is the National Environmental Management: Biodiversity Act 10 of 2004 read with the Threatened or Protected Species Regulations, February 2007 (TOPS Regulations). Chapter 1 sets out the objectives of the Act, and they are aligned with the objectives of the Convention on Biological Diversity, which are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits of the use of genetic resources. The Act also gives effect to CITES, the Ramsar Convention, and the Bonn Convention on Migratory Species of Wild Animals. The State is endowed with the trusteeship of biodiversity and has the responsibility to manage, conserve and sustain the biodiversity of South Africa.

[1] This is only the case with developments in Renewable Energy Development Zones (REDZ).

4.2 Provincial legislation

4.2.1 Mpumalanga Nature Conservation Act 10 of 1998

The current legislation applicable to the conservation of fauna and flora in Mpumalanga is the Mpumalanga Nature Conservation Act 10 of 1998. It consolidated and amended the laws relating to nature conservation within the province and provides for matters connected therewith. All birds are classified as Protected Game (Section 4 (1) (b)), except those listed in Schedule 3, which are classified as Ordinary Game (Section 4 (1)(c)).

4.3 Best Practice Guidelines

The South African "Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy projects in southern Africa" (Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2011) are followed for this study. This document was published by the Endangered Wildlife Trust (EWT) and Birdlife South Africa (BLSA) in March 2011, and subsequently revised in 2011, 2012 and 2015.

5. DESCRIPTION OF THE RECEIVING ENVIRONMENT

5.1 Natural Environment

The PAOI is situated in the Grassland Biome, in the Mesic Highveld Grassland Bioregion (Muchina & Rutherford 2006). Vegetation on site consists predominantly of Amersfoort Highveld Clay Grassland and Wakkerstroom Montane Grassland. Amersfoort Highveld Clay Grassland is comprised of undulating grassland plains, with small, scattered patches of dolerite outcrops in areas, low hills, and pan depressions. The vegetation is comprised of a short, closed grassland cover, largely dominated by a dense *Themeda triandra* sward, often severely grazed to form a short lawn (Mucina & Rutherford 2006). Wakkerstroom Montane Grassland is more prevalent in the east of the Project Site and to the comprises predominantly short montane grasslands on the plateaus and the relatively flat areas, with short forest and *Leucosidea* thickets occurring along steep, mainly east facing slopes and drainage areas. The topography in the project area is characterised by gentle undulating plains. Numerous drainage lines with associated wetlands and farm dams transect the PAOI, and the most prominent river is the Vaal River which meanders through the north of the PAOI. Some of the drainage lines have steep banks and rocky outcrops with low cliffs in some places.

Amersfoort, which is the closest town to the Project Site has a temperate climate. Summers are mild and winters are cold. The mean annual rainfall is around 811mm, and the mean annual temperature is around 20C°. **Figure 3** shows the mean monthly temperature and precipitation of Amersfoort (https://tcktcktck.org/south-africa/mpumalanga/amersfoort#).

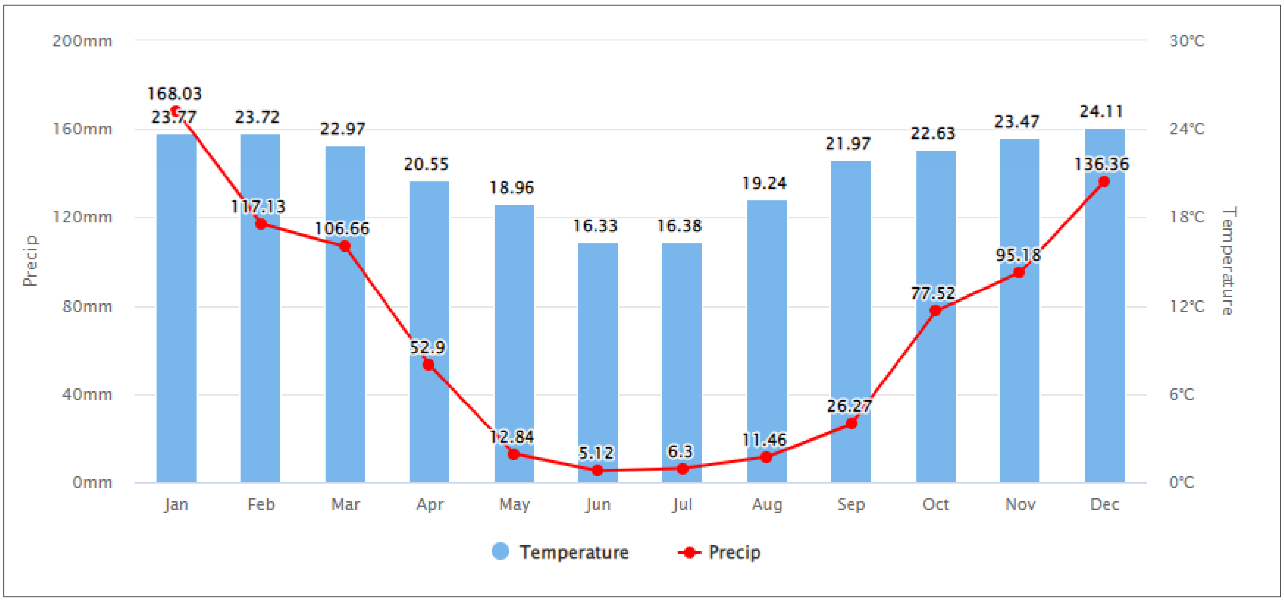


Figure 3: The mean monthly temperature and precipitation of Amersfoort.

5.2 Modified Environment

The predominant land use for this area is livestock grazing with some crop farming, mostly maize, soya beans and pastures.

Whilst the distribution and abundance of the bird species in the broader area are mostly associated with natural vegetation, as this comprises the majority of the habitat, it is also necessary to examine the few external modifications to the environment that have relevance for birds.

The following bird habitat features were identified in the project area (see Appendix 2 for examples of the habitat classes):

5.2.1 Grassland

The majority of the habitat in the project area comprises natural grassland, which is mostly comprised of a short, closed grassland cover.

The priority species which could potentially use the grassland in the PAOI on a regular basis are the following:

African Grass Owl
Amur Falcon
Black-rumped Buttonquail
Black-winged Kite
Black-winged Lapwing
Black-winged Pratincole
Blue Crane
Blue Korhaan
Common Buzzard

Denham's Bustard
Greater Kestrel
Grey-winged Francolin
Jackal Buzzard
Lanner Falcon
Long-crested Eagle
Marsh Owl
Martial Eagle
Montagu's Harrier
Pallid Harrier
Red-footed Falcon
Secretarybird
Southern Bald Ibis
Spotted Eagle-Owl
White Stork
White-bellied Bustard
Yellow-breasted Pipit

The priority species which could occasionally use the grassland in the PAOI are the following:

Black-bellied Bustard
Black-chested Snake Eagle
Botha's Lark
Brown Snake Eagle
Lesser Kestrel
Cape Vulture
Black Harrier
Rudd's Lark

5.2.2 Drainage lines and wetlands

There are several wetlands in the PAOI, most of which are associated with drainage lines. Wetlands are characterised by static or slow flowing water and are extensively covered by tall emergent wetland vegetation.

The priority species which could potentially use the wetlands in the PAOI on a regular basis are the following:

African Fish Eagle
African Grass Owl
African Marsh Harrier
Black-winged Pratincole
Blue Crane
Grey Crowned Crane
Long-crested Eagle
Marsh Owl
Yellow-billed Stork

The priority species which could occasionally use the wetlands in the PAOI are the following:

Black Harrier

5.2.3 Agricultural lands

The PAOI contains a patchwork of agricultural fields. Some fields are lying fallow or are in the process of being re-vegetated by grass.

The priority species which could potentially use the agricultural fields in the PAOI on a regular basis are the following:

Amur Falcon
Black-winged Kite
Black-winged Pratincole
Blue Crane
Common Buzzard
Grey Crowned Crane
Lanner Falcon
Red-footed Falcon
Southern Bald Ibis
White Stork

The priority species which could occasionally use the agricultural lands in the PAOI are the following:

Lesser Kestrel

5.2.4 Alien trees

The PAOI contains few trees. Most trees are alien species, particularly Eucalyptus, Australian Acacia (Wattle), and Salix (Willow) species. Trees are often planted as wind breaks next to agricultural lands and around homesteads. Some of the drainage lines also have trees growing in them.

The priority species which could potentially use the alien trees in the PAOI on a regular basis are the following:

African Fish Eagle
African Harrier-Hawk
Amur Falcon
Black Sparrowhawk
Black-winged Kite
Common Buzzard
Greater Kestrel
Grey Crowned Crane
Jackal Buzzard
Lanner Falcon
Long-crested Eagle
Martial Eagle

Red-footed Falcon
Rufous-breasted Sparrowhawk
Secretarybird
Southern Bald Ibis
Spotted Eagle-Owl
White Stork

The priority species which could occasionally use the alien trees in the PAOI are the following:

Black-chested Snake Eagle
Brown Snake Eagle
Cape Vulture
Lesser Kestrel
Western Osprey

5.2.5 Dams

There are many ground dams of various sizes at the PAOI, located in drainage lines.

The priority species which could potentially use the dams in the PAOI on a regular basis are the following:

African Fish Eagle
Blue Crane
Southern Bald Ibis
Yellow-billed Stork

The priority species which could occasionally use the dams and pans in the PAOI are the following:

Greater Flamingo
Lesser Flamingo
Western Osprey

5.2.6 High voltage lines

The PAOI is transected by the two high voltage lines namely the Camden Incandu 1 and Camden Chivelston 2 400kV powerlines. Many birds use high voltage powerlines to roost on and occasionally even breed on them.

The priority species which could potentially use the high voltage lines in the PAOI on a regular basis are the following:

African Fish Eagle
Amur Falcon
Black-winged Kite
Common Buzzard
Greater Kestrel
Jackal Buzzard
Lanner Falcon

Long-crested Eagle
Martial Eagle
Red-footed Falcon
Southern Bald Ibis

The priority species which could occasionally use the high voltage lines in the PAOI are the following:

Black-chested Snake Eagle
Brown Snake Eagle
Cape Vulture
Lesser Kestrel

5.2.7 Low cliffs and rocky ridges

There are a number of exposed ridges and low cliffs in the PAOI, often associated with the banks of drainage lines. These features are used by a number of priority species.

The priority species which could potentially use the rocky ridges and cliffs in the PAOI on a regular basis are the following:

African Harrier-Hawk
Buff-streaked Chat
Common Buzzard
Greater Kestrel
Jackal Buzzard
Lanner Falcon
Southern Bald Ibis
Spotted Eagle-Owl

The priority species which could occasionally use the rocky outcrops and low cliffs in the PAOI are the following:

Cape Vulture

Appendix 4 provides a photographic record of the habitat at the application site.

5.3 Important Bird Areas (IBAs)

The PAOI partially overlaps with two Important Bird Areas (IBAs), namely but only a small section of the Project Site overlaps with the Amersfoort-Bethal-Carolina IBA SA018 and the Grasslands IBA SA020 (Figure 4). Due to the close proximity of the IBAs, it is possible that some priority species which are also IBA trigger species, and which occur either permanently or sporadically in the IBAs, might be impacted by the project. Species that were recorded in the broader areas and fall within this category are the following:

- Secretarybird
- Pied Avocet
- Denham's Bustard

- Blue Crane
- Grey Crowned Crane
- Wattled Crane
- White-backed Duck
- Yellow-billed Duck
- Martial Eagle
- Lanner Falcon
- Greater Flamingo
- Lesser Flamingo
- Black-necked Grebe
- Little Grebe
- African Marsh Harrier
- Black Harrier
- Southern Bald Ibis
- African Grass Owl
- Southern Pochard
- Cape Shoveler
- White-winged Tern

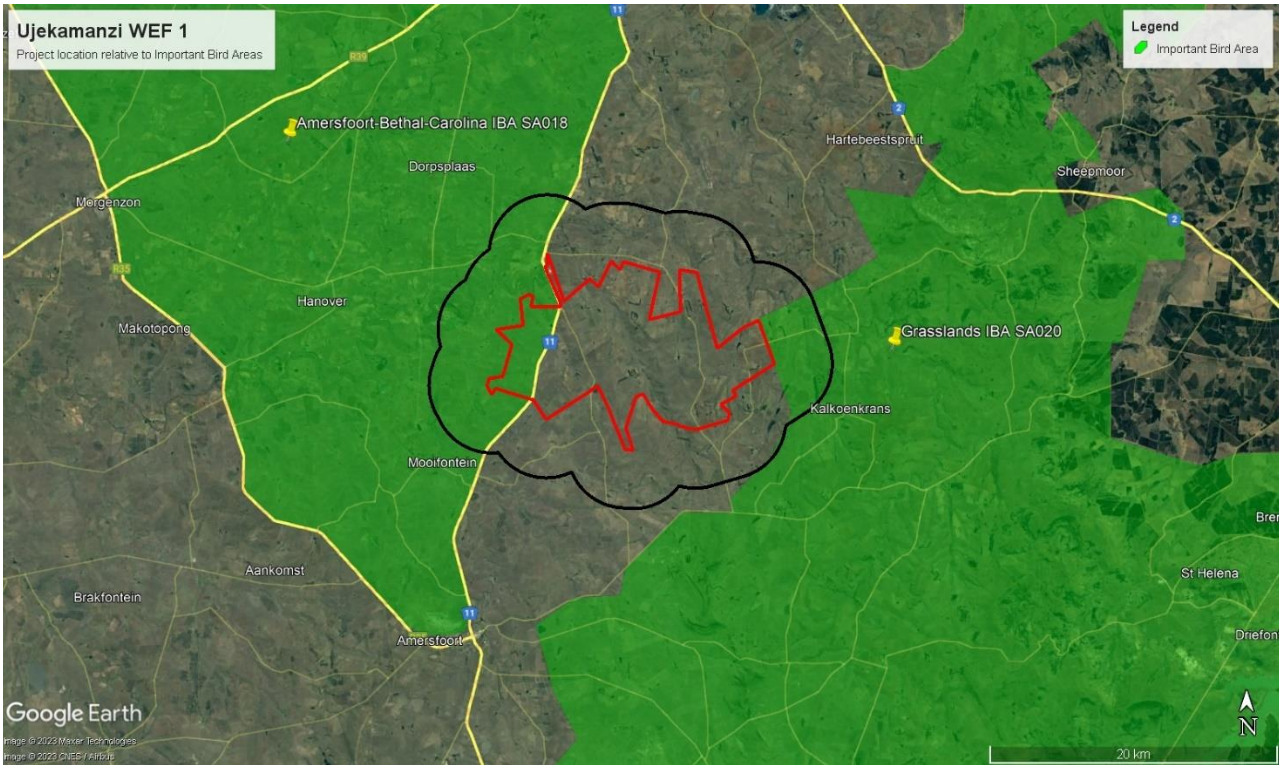


Figure 4: Important Bird Areas in the vicinity of the PAOI.

5.4 The DFFE National Screening Tool

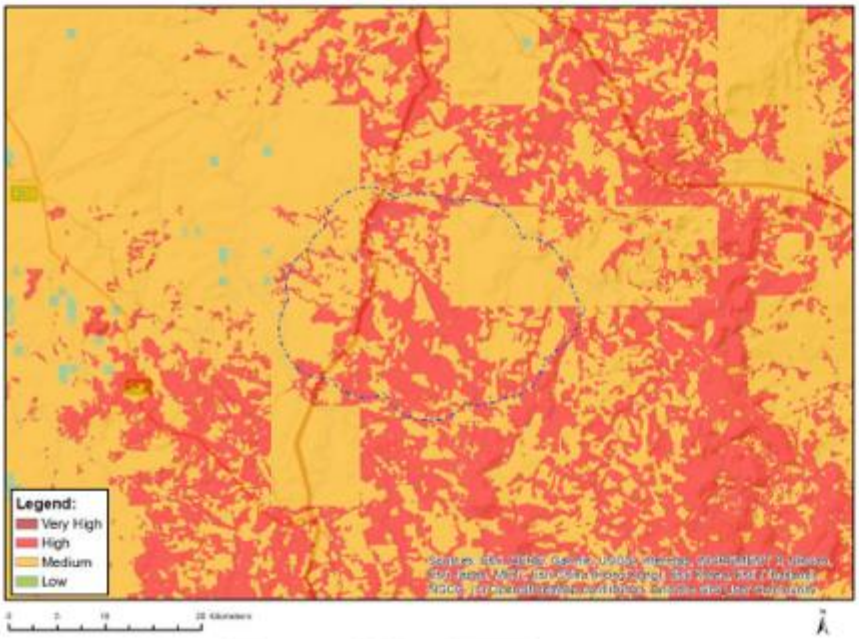
5.4.1 Wind Energy Facility

In the case of the Animal Species Theme, relevant to the proposed WEF, the project area is classified as **Medium and High** sensitivity, based on the potential presence of several species of conservation concern (SCC) namely Grey Crowned Crane (Globally and Regionally Endangered), Southern Bald Ibis (Globally and Regionally Vulnerable), White-bellied Bustard (Regionally Vulnerable), Denham's Bustard (Globally near threatened and Regionally Vulnerable) and Secretarybird (Globally Endangered and Regionally Vulnerable) (Figure 5). This classification was confirmed during the site surveys, based on the presence of recorded SCC:

- Secretarybird (Globally Endangered, Regionally Vulnerable)
- White-bellied Bustard (Regionally Vulnerable),
- Blue Crane (Globally Vulnerable, Regionally Near-threatened),
- Grey Crowned Crane (Globally and Regionally Endangered),
- Martial Eagle (Globally and Regionally Endangered),
- Lanner Falcon (Regionally Vulnerable),
- Black Harrier (Regionally and Globally Endangered),
- Southern Bald Ibis (Regionally and Globally Vulnerable),
- Blue Korhaan (Globally Near-threatened),
- African Grass Owl (Regionally Vulnerable),
- Rudd's Lark (Globally and Regionally Endangered),
- Yellow-billed Stork (Regionally Endangered),
- Yellow-breasted Pipit (Globally and Regionally Vulnerable),
- Black-winged Pratincole (Globally near threatened and Regionally Endangered),
- Black-rumped Buttonquail (Regionally Endangered),
- Pallid Harrier (Globally and Regionally near threatened),
- Red-footed Falcon (Globally Vulnerable and Regionally Near threatened) and
- Cape Vulture (Globally Vulnerable and Regionally Endangered).

See Figure 5 for the Screening Tool Report map.

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Neotis denhami
High	Aves-Balearica regulorum
High	Aves-Geronticus calvus
High	Aves-Sagittarius serpentarius
High	Aves-Eupodotis senegalensis
Medium	Aves-Hydroprogne caspia
Medium	Aves-Neotis denhami
Medium	Aves-Balearica regulorum
Medium	Aves-Sagittarius serpentarius
Medium	Aves-Geronticus calvus
Medium	Aves-Eupodotis senegalensis
Medium	Sensitive species 23
Medium	Aves-Circus ranivorus
Medium	Aves-Tyto capensis

Figure 5: The classification of the PAOI for avifauna according to the terrestrial animal species theme in the DFFE National Screening Tool. The classification of High in the Terrestrial Animal Species theme is linked to the potential presence of species of conservation concern (SCC), namely Denham's Bustard *Neotis denhami*, Grey Crowned Crane *Balearica regulorum*, Southern Bald Ibis *Geronticus calvus*, Secretarybird *Sagitarius serpentarius*, White-bellied *Bustard Eupodotis senegalensis.* The classification of Medium is linked to all of the above species and African Marsh Harrier *Circus ranivorus* and African Grass Owl *Tyto capensis.*

5.5 National Protected Areas

According to the South African Protected Areas database (SAPAD), the centre of the PAOI is located approximately 16km south the Langcarel Private Nature Reserve. Information on the reserve is hard to come by, but from a visual inspection of satellite imagery the habitat in the reserve seems generally similar to that in the PAOI i.e. a mosaic of grassland and agriculture. From an avifaunal perspective the state of the habitat and land use is more important than the legal status. It is therefore not expected that the avifauna in the reserve will differ in any material from that in the PAOI. Given the distance from the PAOI, it is not expected that the avifauna in the reserve will be significantly impacted by the proposed WEF.

5.6 Avifauna in the study area

It is estimated that a total of 263 bird species could potentially occur in the Broader Area. Please refer to Appendix 5 which provides a comprehensive list of all the species recorded in the Broader Area. Of the 263 species, 45 species are classified as priority species for wind developments. Of the priority species in the broader area, 37 were recorded during the 12 months of pre-construction monitoring.

Table 3 below lists all the wind priority sensitive species and the potential impacts on the respective species by the proposed WEF.

EN = Endangered,
VU = Vulnerable,
NT = Near threatened,
LC = Least Concern,
H = High
M = Medium
L = Low

Table 3: Wind energy priority species recorded in the broader area.

Species name	Scientific name	SABAP 2 Full protocol reporting rate	SABAB 2 Ad hoc protocol reporting rate	Global status	SA status	Recorded during monitoring	Likelihood of regular occurrence in PAOI	Grassland	Wetlands and drainage lines	Dams	Low cliffs and rocky ridges	Agriculture	HV lines	Alien trees	WEF-Collision with turbines	WEF-Displacement - habitat transformation	WEF-Displacement - disturbance	MV Powerlines - Electrocution MV	MV Powerlines - Collision
African Fish Eagle	*Haliaeetus vocifer*	11.88	0.00	-	-	x	H		x	x			x	x	x		x	x	
African Grass Owl	*Tyto capensis*	0.00	0.00	LC	VU	x	M	x	x						x	x	x	x	x
African Harrier-Hawk	*Polyboroides typus*	7.66	10.53	-	-	x	M				x			x	x		x	x	
African Marsh Harrier	*Circus ranivorus*	1.53	2.63	LC	EN	x	M		x						x		x	x	
Amur Falcon	*Falco amurensis*	21.84	13.16	-	-	x	H	x				x	x	x	x			x	
Black Harrier	*Circus maurus*	0.38	0.00	EN	EN	x	L	x	x						x		x	x	
Black Sparrowhawk	*Accipiter melanoleucus*	15.33	0.00	-	-	x	H							x	x		x	x	
Black-rumped Buttonquail	*Turnix nanus*	1.15	18.42	LC	EN	x	M	x								x	x		
Black-winged Kite	*Elanus caeruleus*	63.22	10.53	-	-	x	H	x				x	x	x	x		x	x	
Black-winged Lapwing	*Vanellus melanopterus*	18.01	13.16	-	-	x	H	x							x	x			
Black-winged Pratincole	*Glareola nordmanni*	2.30	0.00	NT	NT	x	M	x	x			x			x				
Blue Crane	*Grus paradisea*	26.82	5.26	VU	NT	x	H	x	x	x		x			x	x	x		x
Blue Korhaan	*Eupodotis caerulescens*	12.64	15.79	NT	LC	x	H	x							x	x	x		x
Buff-streaked Chat	*Campicoloides bifasciatus*	5.75	7.89	-	-	x	M				x					x	x		
Cape Vulture	*Gyps coprotheres*	1.92	17.63	VU	EN	x	L	x			x		x	x	x		x	x	x
Common Buzzard	*Buteo buteo*	24.52	36.84	-	-	x	H	x			x	x	x	x	x			x	
Denham's Bustard	*Neotis denhami*	5.36	2.63	NT	VU	x	M	x							x	x	x		x
Greater Kestrel	*Falco rupicoloides*	0.77	7.89	-	-	x	M	x			x		x	x	x		x	x	
Grey Crowned Crane	*Balearica regulorum*	17.62	0.00	EN	EN	x	H		x			x		x	x	x	x	x	x
Grey-winged Francolin	*Scleroptila afra*	39.46	21.05	-	-	x	H	x							x	x	x		
Jackal Buzzard	*Buteo rufofuscus*	26.05	0.00	-	-	x	H	x			x		x	x	x		x	x	
Lanner Falcon	*Falco biarmicus*	16.09	2.63	LC	VU	x	H	x			x	x	x	x	x		x	x	

Species name	Scientific name	SABAP 2 Full protocol reporting rate	SABAB 2 Ad hoc protocol reporting rate	Global status	SA status	Recorded during monitoring	Likelihood of regular occurrence in PAOI	Grassland	Wetlands and drainage lines	Dams	Low cliffs and rocky ridges	Agriculture	HV lines	Alien trees	WEF-Collision with turbines	WEF-Displacement - habitat transformation	WEF-Displacement - disturbance	MV Powerlines - Electrocution MV	MV Powerlines - Collision
Long-crested Eagle	*Lophaetus occipitalis*	2.68	10.53	-	-	x	M	x	x				x	x	x		x	x	
Marsh Owl	*Asio capensis*	9.20	13.16	-	-	x	H	x	x						x	x	x	x	x
Martial Eagle	*Polemaetus bellicosus*	3.45	5.26	EN	EN	x	M	x					x	x	x		x	x	
Montagu's Harrier	*Circus pygargus*	1.53	7.89	-	-	x	M	x							x			x	
Pallid Harrier	*Circus macrourus*	0.00	0.00	NT	NT	x	M	x							x			x	
Red-footed Falcon	*Falco vespertinus*	0.00	0.00	VU	NT	x	M	x				x	x	x	x			x	
Rudd's Lark	*Heteromirafra ruddi*	0.00	5.26	EN	EN	x	M	x							x	x	x		
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	0.77	0.00	-	-	x	M							x	x		x	x	
Secretarybird	*Sagittarius serpentarius*	29.50	2.63	EN	VU	x	H	x						x	x	x	x		x
Southern Bald Ibis	*Geronticus calvus*	43.68	0.00	VU	VU	x	H	x		x	x	x	x	x	x		x	x	x
Spotted Eagle-Owl	*Bubo africanus*	11.88	31.58	-	-	x	H	x			x			x	x		x	x	x
White Stork	*Ciconia ciconia*	11.88	0.00	-	-	x	H	x				x		x	x				x
White-bellied Bustard	*Eupodotis senegalensis*	11.49	23.68	LC	VU	x	H	x							x	x	x		x
Yellow-billed Stork	*Mycteria ibis*	0.00	0.00	LC	EN	x	M		x	x					x				x
Yellow-breasted Pipit	*Anthus chloris*	1.53	0.00	VU	VU	x	M	x							x	x	x		

5.7 Results of pre-construction bird monitoring

Table 4, and **Error! Reference source not found.** 6 and 7 below present the results of the 12-months integrated pre-construction monitoring conducted at the Ujekamanzi I and 2 Project Sites and control area. Monitoring was conducted by means of drive transect counts, walk transect counts, vantage point watches, and focal point counts (see Appendix 3 for more detail on the methodology) as per the requirements of the latest avifaunal best practice guidelines at the time of writing[2]. Wind priority species were identified using the latest (November 2014) BirdLife SA (BLSA) list of priority species for wind farms.

The surveys for the pre-construction monitoring programme at the two proposed Ujekamanzi WEF sites were conducted during the following periods:

- Survey 1: 2 - 10 April 2022, 9 – 24 May 2022
- Survey 2: 4 July - 01 August 2022
- Survey 3: 5 – 27 September 2022
- Survey 4: 12 – 28 January 2023

5.7.1 The results of the transect counts

The results of the transect counts are displayed in Table 4:

Table 4: The results of the transect counts at the WEF and Control Sites

Turbine site	Number
Species composition	
All Species	147
Priority Species (16%)	24
Non-Priority Species	123
Total count	
Drive transects	13818
Walk transects	12831
	26649
Control site	Number
Species composition	
All Species	135
Priority Species (5%)	17
Non-Priority Species	118

[2] Jenkins, A., van Rooyen, C. S., Smallie, J. J., Anderson, M. D., & Smit, A. H. (2015). Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa.

Total count	
Drive transects	8497
Walk transects	3069
	11566

An Index of Kilometric Abundance (IKA = birds/km) was calculated for each priority species recorded during the transect counts at the two WEF sites (see Figures 6 and 7 below).

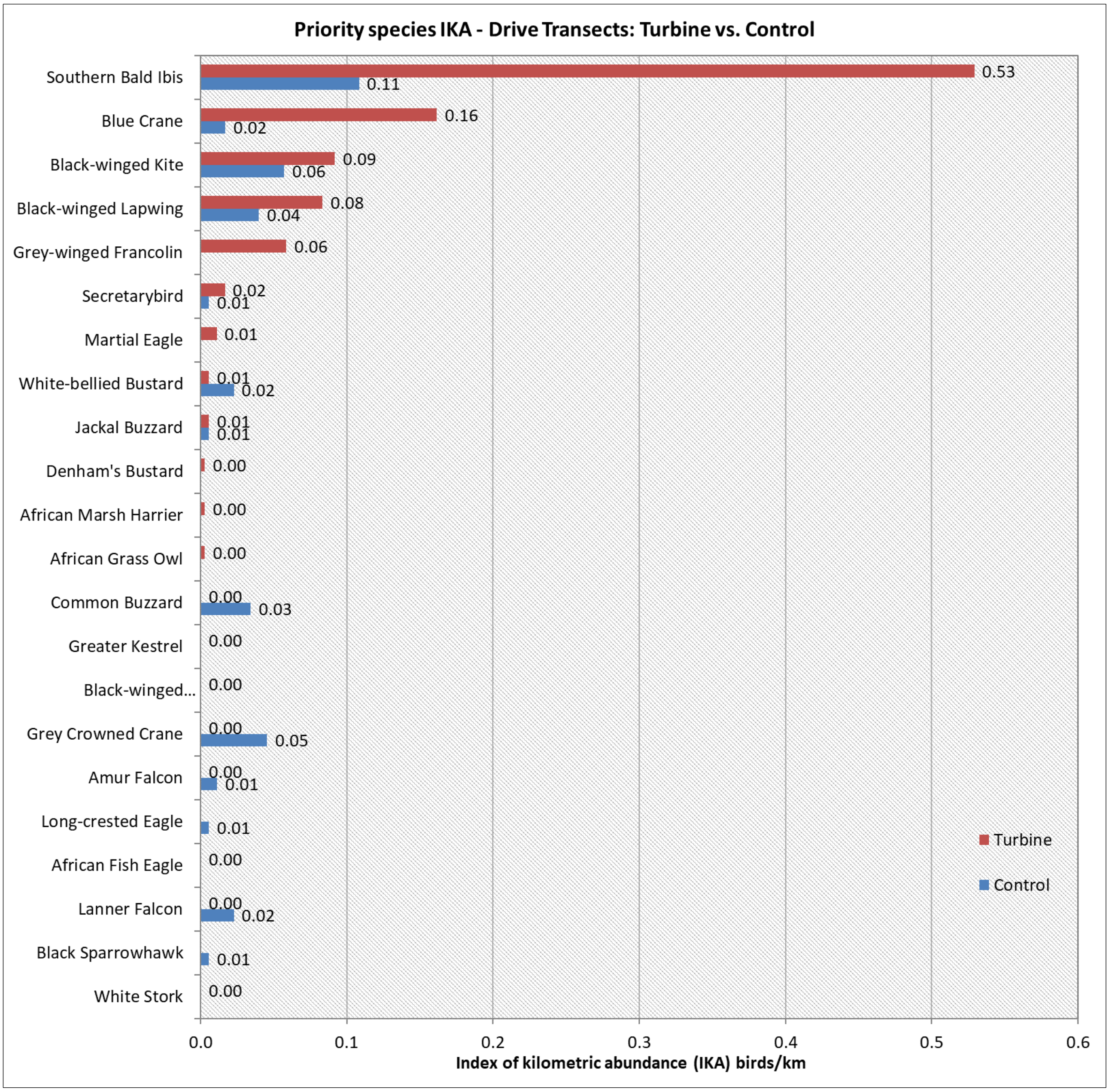


Figure 6: Index of kilometric abundance of priority species recorded at the two WEF sites and control site through drive transect surveys conducted during pre-construction monitoring.

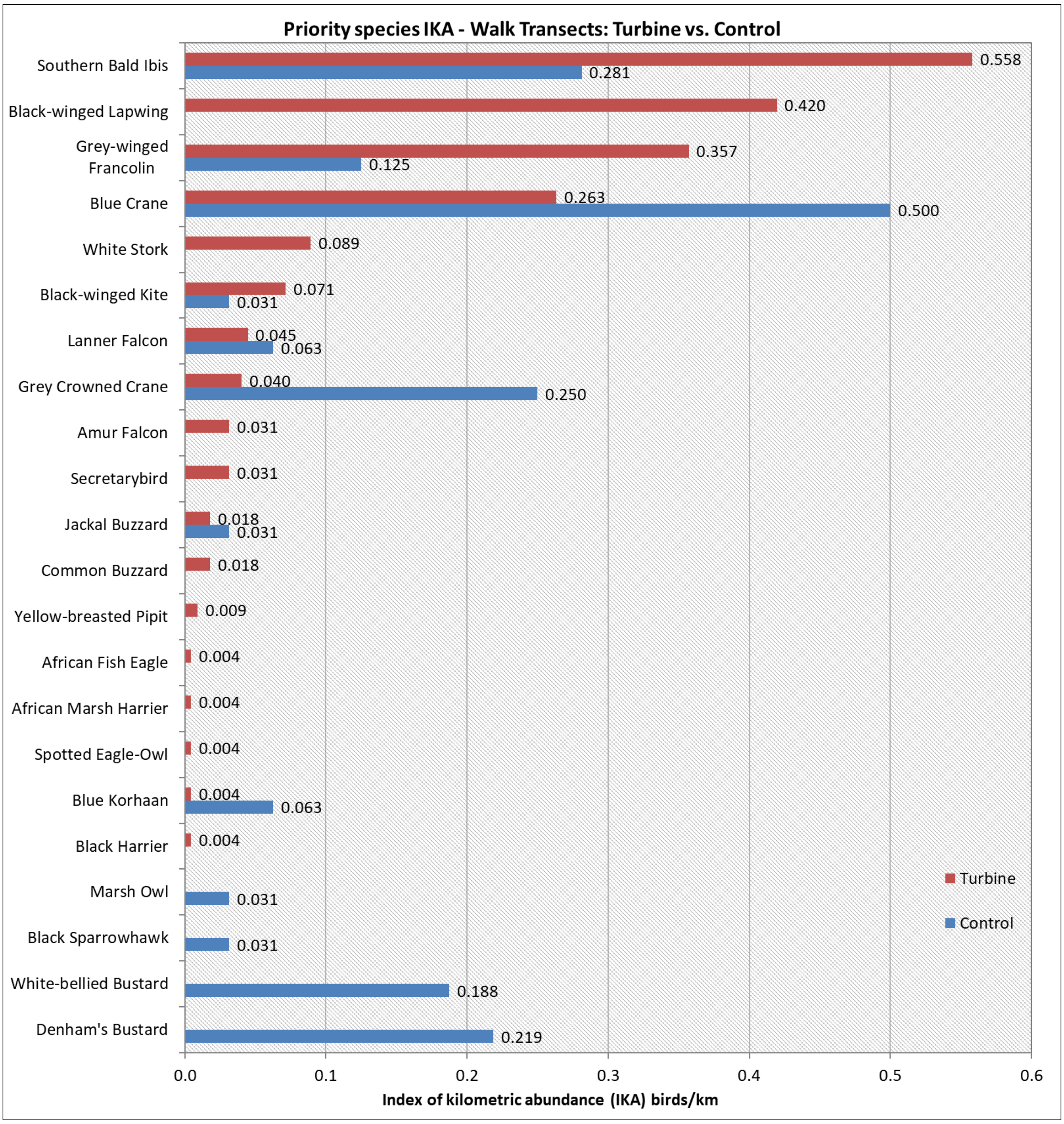


Figure 7: Index of kilometric abundance of priority species recorded at the two WEF sites through walk transect surveys conducted during pre-construction monitoring.

5.7.2 Focal points

See **Table 5** below for a summary of the focal point survey data recorded thus far.

Table 5: Summary of focal point surveys at the two WEF sites during the pre-construction monitoring

Focal points	Survey 1	Survey 2	Survey 3	Survey 4
FP 1 - Pan	Checked- general waterbirds	Checked- Non-priority Spp	Checked - Non-priority spp	General grassland + waterfowl spp recorded, high number of Egyptian Geese

Focal points	Survey 1	Survey 2	Survey 3	Survey 4
FP 2 - roost	Not checked during V1 - off site / time constraints	Checked - Southern Bald Ibis, Long-Crested Eagle, White-Bellied Bustard	Checked - Southern Bald Ibis seen in vicinity	1 Long-Crested Eagle present, Southern Bald Ibis perched 900m west of FP2. 14 Southern Bald Ibis in total
FP 3 - Southern Bald Ibis 2 colony	Checked - 8 Southern Bald Ibis birds seen entering	Checked - Southern Bald Ibis breeding	Checked - Peak breeding activity - unable to count exact numbers due to dense foliage obscuring many nests	31 Southern Bald Ibis at NW side, 75 on SE side.
FP 4 - Grey Crowned Crane roost	Checked - 28 Grey crowned cranes seen entering and cormorants and herons also observed	Checked - Southern Bald Ibis, Jackal Buzzard, no Grey Crowned Crane	Checked - 5 Grey Crowned Cranes	6 Amur Falcons, 1 Common Buzzard, 1 Grey Crowned Crane, general waterbirds as well
FP 5 - Pan	Checked - General waterbirds and southern bald ibis seen	Checked - Grey Crowned Crane calling and White-Bellied Bustards calling, Grey-Winged Francolin	Checked - Non-priority spp and Grey Crowned Cranes calling	Little Grebes, Red-knobbed Coots, Reed Cormorants, Whiskered Terns, Egyptian Geese
FP 6 – Secretarybird nest	-	-	Checked - 2 Sec birds in area, no nest activity	1 individual roosting in nest
FP 7 – Secretarybird nest	-	-	Checked - 2 Sec birds roosting	Black-winged kite
FP 8 – Secretarybird nest	-	-	Checked - no birds using the nest	-
FP 9 – Secretarybird nest	-	-	Checked - no Sec birds	-
FP 10 - Grey Crowned Crane roost	-	Checked - 94 Grey Crowned Crane roosting	Checked - Black-Winged Kites, Black Sparrowhawks	-
FP 11 - Southern Bald Ibis roost	-	-	-	16 Southern Bald Ibis, 150 SA Cliff Swallows
FP12 - Martial Eagle nest	-	-	Nest discovered – adult flying overhead	Nest in good condition – eagles observed in the vicinity
FP13 - Southern Bald Ibis feeding area	-	-	-	200 Southern Bald Ibis. Next morning 21 Southern Bald Ibis leaving valley
FP14 - VP15 Southern Bald Ibis dam	-	-	-	Black-winged kite, Amur falcons, Barn Swallows, Cattle Egrets and Glossy Ibis, 40 Southern Bald Ibis
FP15 - VP29 Southern Bald Ibis dam	-	-	-	73 Southern Bald Ibis, 2 Blue Crane called, Grey Crowned Crane heard and Amur Falcons seen
FP16 - Unconfirmed Grey Crowned Crane roost	-	-	-	2 Grey Crowned Crane's active, 4 Southern Bald Ibis flew

Focal points cont.	Survey 1	Survey 2	Survey 3	Survey 4
FP17 – Secretarybird nest	-	-	-	2 Secretarybird's circled and 1 at the nest later
FP18 - Secretarybird nest VP1	-	-	-	5 Storks
FP19 - White Stork roost	-	-	-	2 Grey Crowned Crane's in area
FP20 - Grey Crowned Crane roost	-	-	-	Black-Winged Kite hunting, Amur Falcons seen
FP21 - Possible Grey Crowned Crane roost	-	-	-	2 Secretarybird's seen
FP22 - Secretarybird nest	-	-	-	2 adult Secretarybird's and one sub-adult

See Appendix 3 and **Figure** 8 for the location of the focal points.

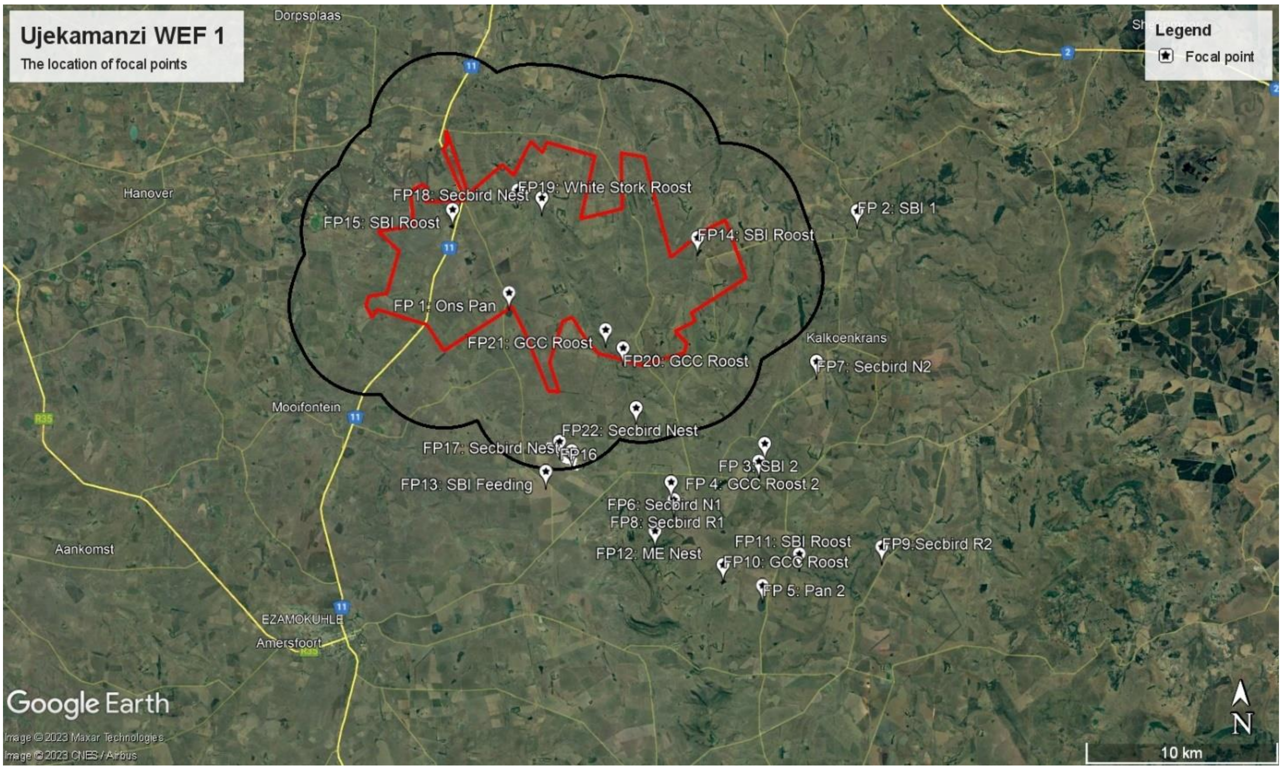


Figure 8: Focal points recorded during the pre-construction monitoring at Ujekamanzi WEF 1. The black line represents the PAOI and the red line the Project Site.

5.7.3 Incidental counts

Table 6 provides an overview of the incidental sightings of priority species recorded at the two WEF sites.

Table 6: Incidental sightings of priority species

Priority Species (Incidentals)		Survey 1	Survey 2	Survey 3	Survey 4	Grand Total
Southern Bald Ibis	*Geronticus calvus*	50	314	109	385	**858**

Priority Species (Incidentals) cont.		Survey 1	Survey 2	Survey 3	Survey 4	Grand Total
Amur Falcon	*Falco amurensis*	0	0	0	532	**532**
Blue Crane	*Grus paradisea*	265	33	21	24	**343**
Grey Crowned Crane	*Balearica regulorum*	130	181	2	7	**320**
Grey-winged Francolin	*Scleroptila afra*	53	79	20	23	**175**
Common Buzzard	*Buteo buteo*	0	0	0	114	**114**
White Stork	*Ciconia ciconia*	0	0	0	106	**106**
Black-winged Kite	*Elanus caeruleus*	19	41	26	15	**101**
Secretarybird	*Sagittarius serpentarius*	17	28	19	14	**78**
Black-winged Lapwing	*Vanellus melanopterus*	14	11	3	32	**60**
Spotted Eagle-Owl	*Bubo africanus*	5	18	2	33	**58**
Jackal Buzzard	*Buteo rufofuscus*	12	9	5	13	**39**
White-bellied Bustard	*Eupodotis senegalensis*	6	14	3	4	**27**
Black-winged Pratincole	*Glareola nordmanni*	0	0	0	21	**21**
Denham's Bustard	*Neotis denhami*	17	2	0	1	**20**
Black Sparrowhawk	*Accipiter melanoleucus*	6	7	2	0	**15**
Blue Korhaan	*Eupodotis caerulescens*	6	0	6	3	**15**
Lanner Falcon	*Falco biarmicus*	4	4	6	0	**14**
African Harrier-Hawk	*Polyboroides typus*	2	3	4	1	**10**
Buff-streaked Chat	*Campicoloides bifasciatus*	2	6	2	0	**10**
Marsh Owl	*Asio capensis*	7	1	1	1	**10**
Martial Eagle	*Polemaetus bellicosus*	1	0	6	2	**9**
Yellow-breasted Pipit	*Anthus chloris*	0	0	7	1	**8**
African Fish Eagle	*Haliaeetus vocifer*	3	1	2	1	**7**
Yellow-billed Stork	*Mycteria ibis*	0	0	0	6	**6**
Greater Kestrel	*Falco rupicoloides*	3	0	0	1	**4**
Long-crested Eagle	*Lophaetus occipitalis*	0	1	1	1	**3**
Black Harrier	*Circus maurus*	0	1	1	0	**2**
African Grass Owl	*Tyto capensis*	0	1	0	0	**1**
Black-rumped Buttonquail	*Turnix nanus*	0	0	1	0	**1**
Red-footed Falcon	*Falco vespertinus*	0	0	0	1	**1**
Rudd's Lark	*Heteromirafra ruddi*	0	0	1	0	**1**

See Appendix 5 for a list of all species recorded during the pre-construction monitoring.

5.7.4 Vantage point observations

Flight patterns of priority species have been recorded at the two WEF sites for 1 272 hours (12 hours per VP per survey) at 29 vantage points[3] at the two Project Sites in three bands (high = >300m; medium = 30m – 300m; low = <30m) during four surveys. Approximate flight altitude was visually judged by an observer with

[3] The VPs 19, 20, 21 and 25 were only utilised for Surveys 1 and 2 after which they were dropped due to a change in the project site area. VP 29 was only utilised for Survey 4 when 24 hours was done. An additional 24 hours will be completed for the final analysis of the data.

the aid of binoculars. Priority species were observed for 1 hour and 38 minutes during the surveys. Medium altitude flights (within rotor altitude) were recorded for 146 hours, 47 minutes and 28 seconds (**Figure 9**).

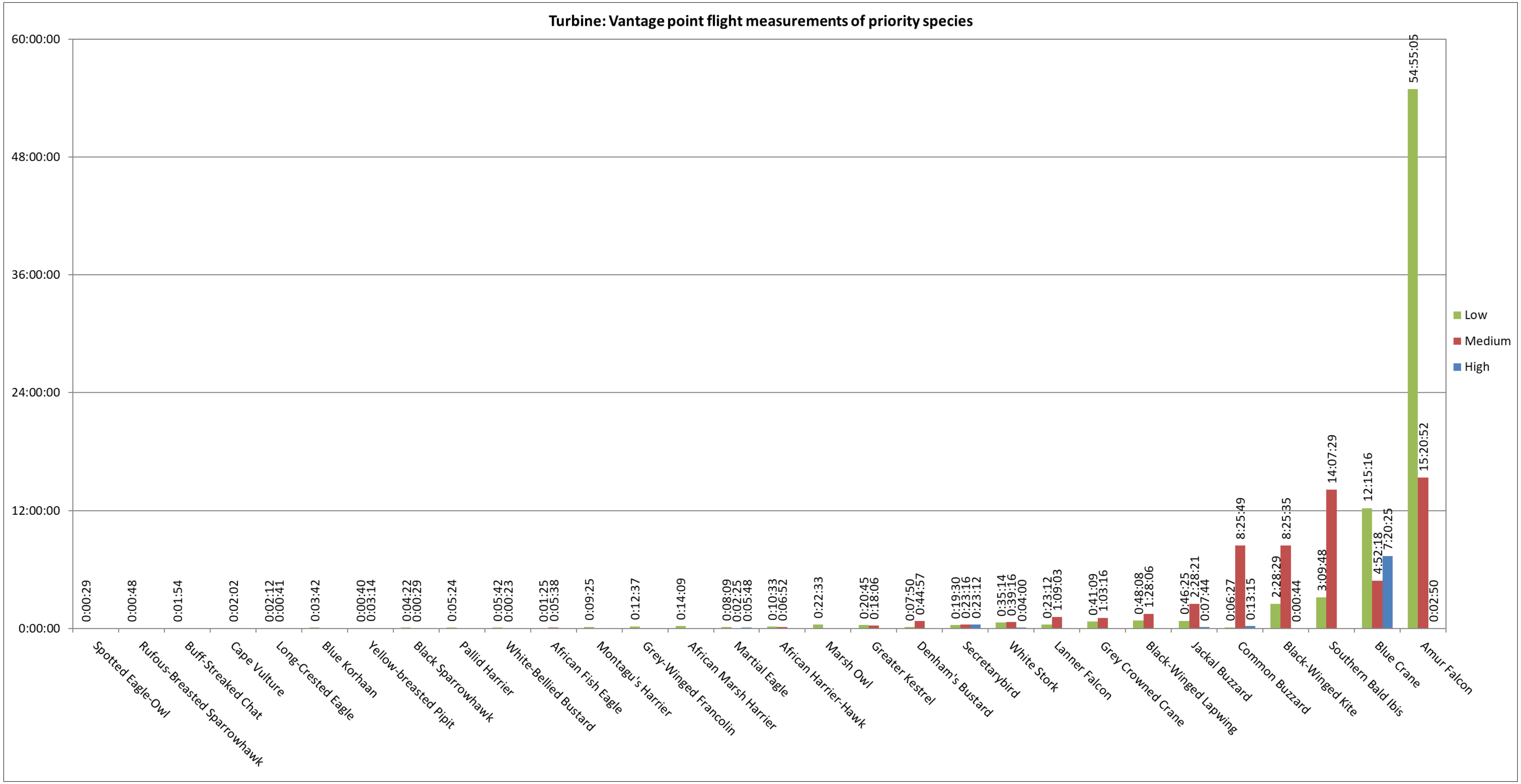


Figure 9: Flight times and altitude recorded for priority species recorded at the two WEF sites (high = >300m; medium = 30m – 300m; low = <30m).

6. SPECIALIST FINDINGS AND ASSESSMENT OF IMPACTS

6.1 Wind Energy Facility (WEF)

The effects of a wind farm on birds are highly variable and depend on a wide range of factors, including the specification of the development, the topography of the surrounding land, the habitats affected and the number and species of birds present. With so many variables involved, the impacts of each wind farm must be assessed individually. The principal areas of concern with regard to effects on birds are listed below. Each of these potential effects can interact with each other, either increasing the overall impact on birds or, in some cases, reducing a particular impact (for example where habitat loss or displacement causes a reduction in birds using an area which might then reduce the risk of collision):

- Mortality of priority avifauna due to collisions with the wind turbines
- Displacement of priority avifauna due to disturbance during construction and operation of the wind farm
- Displacement of priority avifauna due to habitat change and loss at the wind farm
- Mortality of priority avifauna due to electrocution on the medium voltage overhead lines
- Mortality of priority avifauna due to collisions with the medium voltage overhead lines

It should be noted that the assessment is made on the *status quo* as it is currently on site. The possible change in land use in the broader development site is not taken into account because the extent and nature of future developments (not only wind energy development) are unknown at this stage. It is possible that there could be changes in the foreseeable future in the form of mining.

6.1.1 Collision mortality on wind turbines[4]

Wind energy generation has experienced rapid worldwide development over recent decades as its environmental impacts are considered to be relatively lower than those caused by traditional energy sources, with reduced environmental pollution and water consumption (Saidur *et al.*, 2011). However, bird fatalities due to collisions with wind turbines have been consistently identified as a main ecological drawback to wind energy (Drewitt and Langston, 2006).

Collisions with wind turbines appear to kill fewer birds than collisions with other man-made infrastructure, such as power lines, buildings or even traffic (Calvert *et al.* 2013; Erickson *et al.* 2005). Nevertheless, estimates of bird deaths from collisions with wind turbines worldwide range from 0 to almost 40 deaths per turbine per year (Sovacool, 2009). The number of birds killed varies greatly between sites, with some sites posing a higher collision risk than others, and with some species being more vulnerable (e.g. Hull *et al.* 2013; May *et al.* 2012a). These numbers may not reflect the true magnitude of the problem, as some studies do not account for detectability biases such as those caused by scavenging, searching efficiency and search radius (Bernardino *et al.* 2013; Erickson *et al.* 2005; Huso and Dalthorp 2014). Additionally,

[4] This section is based largely on a (2014) review paper by Ana Teresa Marques, Helena Batalha, Sandra Rodrigues, Hugo Costa, Maria João Ramos Pereira,Carlos Fonseca, Miguel Mascarenhas, Joana Bernardino. *Understanding bird collisions at wind farms: An updated review on the causes and possible mitigation strategies*. Biological Conservation 179 (2014) 40– 52.

even for low fatality rates, collisions with wind turbines may have a disproportionate effect on some species. For long-lived species with low productivity and slow maturation rates (e.g. raptors), even low mortality rates can have a significant impact at the population level (e.g. Carrete *et al.* 2009; De Lucas *et al.* 2012a; Drewitt and Langston, 2006). The situation is even more critical for species of conservation concern, which sometimes are most at risk (e.g. Osborn *et al.* 1998).

High bird fatality rates at several wind farms have raised concerns among the industry and scientific community. High profile examples include the Altamont Pass Wind Resource Area (APWRA) in California because of high fatality of Golden eagles (*Aquila chrysaetos*), Tarifa in Southern Spain for Griffon vultures (*Gyps fulvus*), Smøla in Norway for White-tailed eagles (*Haliaatus albicilla*), and the port of Zeebrugge in Belgium for gulls (*Larus* sp.) and terns (*Sterna* sp.) (Barrios and Rodríguez, 2004; Drewitt and Langston, 2006; Everaert and Stienen, 2008; May *et al.* 2012a; Thelander *et al.* 2003). Due to their specific features and location, and characteristics of their bird communities, these wind farms have been responsible for a large number of fatalities that culminated in the deployment of additional measures to minimize or compensate for bird collisions. However, currently, no simple formula can be applied to all sites; in fact, mitigation measures must inevitably be defined according to the characteristics of each wind farm and the diversity of species occurring there (Hull *et al.* 2013; May *et al.* 2012b). An understanding of the factors that explain bird collision risk and how they interact with one another is therefore crucial to proposing and implementing valid mitigation measures.

6.1.1.1 Species-specific factors

- Morphological features

Certain morphological traits of birds, especially those related to size, are known to influence collision risk with structures such as power lines and wind turbines. Janss (2000) identified weight, wing length, tail length and total bird length as being collision risk determinant. Wing loading (ratio of body weight to wing area) and aspect ratio (ratio of wing span squared to wing area) are particularly relevant, as they influence flight type and thus collision risk (Bevanger, 1994; De Lucas *et al.* 2008; Herrera-Alsina *et al.* 2013; Janss, 2000). Birds with high wing loading, such as the Griffon Vulture (*Gyps fulvus*), seem to collide more frequently with wind turbines at the same sites than birds with lower wing loadings, such as Common Buzzards (*Buteo buteo*) and Short-toed Eagles (*Circaetus gallicus*), and this pattern is not related with their local abundance (Barrios and Rodríguez, 2004; De Lucas *et al.* 2008). High wing-loading is associated with low flight manoeuvrability (De Lucas *et al.* 2008), which determines whether a bird can escape an encountered object fast enough to avoid collision.

Information on the wing loading of the priority species potentially occurring regularly at the proposed WEF was not available at the time of writing. However, based on general observations, and research on related species, it can be confidently assumed that priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are bustards and cranes making them less manoeuvrable (Keskin et al. 2019).

- Sensorial perception

Birds are assumed to have excellent visual acuity, but this assumption is contradicted by the large numbers of birds killed by collisions with man-made structures (Drewitt and Langston, 2008; Erickson *et al.*

2005). A common explanation is that birds collide more often with these structures in conditions of low visibility, but recent studies have shown that this is not always the case (Krijgsveld *et al.* 2009). The visual acuity of birds seems to be slightly superior to that of other vertebrates (Martin, 2011; McIsaac, 2001). Unlike humans, who have a broad horizontal binocular field of 120°, some birds have two high acuity areas that overlap in a very narrow horizontal binocular field (Martin, 2011). Relatively small frontal binocular fields have been described for several species that are particularly vulnerable to power line collisions, such as vultures (Gyps sp.) cranes and bustards (Martin and Katzir, 1999; Martin et.al, 2010; Martin, 2012, 2011; O'Rourke *et al.* 2010). Furthermore, for some species, their high resolution vision areas are often found in the lateral fields of view, rather than frontally (e.g. Martin et.al, 2010; Martin, 2012, 2011; O'Rourke *et al.* 2010). Finally, some birds tend to look downwards when in flight, searching for conspecifics or food, which puts the direction of flight completely inside the blind zone of some species (Martin et.al, 2010; Martin, 2011).

Some of the regularly occurring priority species at the proposed WEF have high resolution vision areas found in the lateral fields of view, rather than frontally, e.g., the ibises, bustards and cranes. The exceptions to this are the priority raptors which all have wider binocular fields, although as pointed out by Martin (2011, 2012), this does not necessarily result in these species being able to avoid obstacles better.

- Phenology

Recent studies have shown that, within a wind farm, raptor collision risk and fatalities are higher for resident than for migrating birds of the same species. An explanation for this may be that resident birds generally use the wind farm area several times while a migrant bird crosses it just once (Krijgsveld *et al.* 2009). However, other factors like bird behaviour are certainly relevant. Katzner *et al.* (2012) showed that Golden Eagles performing local movements fly at lower altitudes, putting them at a greater risk of collision than migratory eagles. Resident eagles flew more frequently over cliffs and steep slopes, using low altitude slope updrafts, while migratory eagles flew more frequently over flat areas and gentle slopes where thermals are generated, enabling the birds to use them to gain lift and fly at higher altitudes.

South Africa is at the end of the migration path for summer migrants; therefore, the phenomenon of migratory flyways where birds are concentrated in large numbers for a limited period of time, e.g. the African Rift Valley or Mediterranean Red Sea flyways, is not a feature of the national landscape. The migratory priority species which could occur at the proposed WEF with some regularity, e.g., White Stork, Amur Falcon and Common Buzzard will behave much the same as the resident birds once they arrive in the area. The same is valid for local migrants such as the Denham's Bustard. It is expected that, for the period when they are present, these species will be exposed to the same risks as resident species.

- Bird behaviour

Flight type seems to play an important role in collision risk, especially when associated with hunting and foraging strategies. Kiting flight (hanging in the wind with almost motionless wings), which is used in strong winds and occurs in rotor swept zones, has been highlighted as a factor explaining the high collision rate of Red-tailed Hawks *Buteo jamaicensis* at APWRA (Hoover and Morrison, 2005), and could also be a factor in contributing to the high collision rate for Jackal Buzzards in South Africa (Ralston-Paton & Camagu 2019). The hovering behaviour exhibited by Common Kestrels *Falco tinnunculus* when hunting may also explain the fatality levels of this species at wind farms in the Strait of Gibraltar (Barrios and Rodríguez, 2004). This may also explain the high mortality rate of Rock Kestrels *Falco rupicolus* at wind farms in

South Africa (Ralston-Paton & Camagu 2019). Kiting and hovering are associated with strong winds, which often produce unpredictable gusts that may suddenly change a bird's position (Hoover and Morrison, 2005). Additionally, while birds are hunting and focused on prey, they might lose track of wind turbine positions (Krijgsveld *et al.* 2009; Smallwood *et al.* 2009). In the case of raptors, aggressive interactions may play an important role in turbine fatalities, in that birds involved in these interactions are momentarily distracted, putting them at risk. At least one eye-witness account of a Martial Eagle getting killed by a turbine in South Africa in this fashion is on record (Simmons & Martins 2016).

Social behaviour may also result in a greater collision risk with wind turbines due to a decreased awareness of the surroundings. Several authors have reported that flocking behaviour increases collision risk with power lines as opposed to solitary flights (e.g. Janss, 2000). However, caution must be exercised when comparing the particularities of wind farms with power lines, as some species appear to be vulnerable to collisions with power lines but not with wind turbines, e.g. indications are that bustards, which are highly vulnerable to power line collisions, are not prone to wind turbine collisions – a Spanish database of over 7000 recorded turbine collisions contains no Great Bustards *Otis tarda* (A. Camiña 2012a). Similarly, in South Africa, very few bustard collisions with wind turbines have been reported to date, all Ludwig's Bustards (Ralston-Paton & Camagu 2019). No Denham's Bustards *Neotis denhami* turbine fatalities have been reported to date, despite the species occurring at several wind farm sites.

The priority species which could occur with some regularity at the proposed WEF can be classified as either terrestrial species, soaring species or occasional long-distance fliers. Terrestrial species spend most of the time foraging on the ground. They do not fly often and when they do, they generally fly for short distances at low to medium altitude. At the application site bustards and korhaans are included in this category. Occasional long-distance fliers generally behave as terrestrial species but can and do undertake long distance flights on occasion. Species in this category are White Stork, Denham's Bustard, Blue Crane, Grey Crowned Crane, Southern Bald Ibis and Secretarybird. Soaring species spend a significant time on the wing in a variety of flight modes including soaring, kiting, hovering, and gliding at medium to high altitudes. At the project site, these include all the raptors.

- Avoidance behaviours

Two types of avoidance have been described (Furness *et al.*, 2013): 'macro-avoidance' whereby birds alter their flight path to keep clear of the entire wind farm (e.g. Desholm and Kahlert, 2005; Plonczkier and Simms, 2012; Villegas-Patraca *et al.* 2014), and 'micro-avoidance' whereby birds enter the wind farm but take evasive actions to avoid individual wind turbines (Band *et al.* 2007). This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of birds will successfully avoid the turbines (SNH 2010).

It is anticipated that most birds at the proposed WEF will avoid the wind turbines, as is generally the case at all wind farms (SNH 2010). Exceptions already mentioned are raptors that engage in hunting which might serve to distract them and place them at risk of collision, birds engaged in display behaviour or inter- and intraspecific aggressive interaction. Complete macro-avoidance of the wind farm is unlikely for any of the priority species likely to occur at the proposed WEF.

- Bird abundance

Some authors suggest that fatality rates are related to bird abundance, density or utilization rates (Carrete *et al.* 2012; Kitano and Shiraki, 2013; Smallwood and Karas, 2009), whereas others point out that, as birds use their territories in a non-random way, fatality rates do not depend on bird abundance alone (e.g. Ferrer *et al.* 2012; Hull *et al.* 2013). Instead, fatality rates depend on other factors such as differential use of specific areas within a wind farm (De Lucas *et al.* 2008). For example, at Smøla, White-tailed Eagle flight activity is correlated with collision fatalities (Dahl *et al.* 2013). In the APWRA, Golden Eagles, Red-tailed Hawks and American Kestrels (*Falco spaverius*) have higher collision fatality rates than Turkey Vultures (*Cathartes aura*) and Common Raven (*Corvus corax*), even though the latter are more abundant in the area (Smallwood *et al.* 2009), indicating that fatalities are more influenced by each species' flight behaviour and turbine perception. Also, in southern Spain, bird fatality was higher in the winter, even though bird abundance was higher during the pre-breeding season (De Lucas *et al.* 2008).

The abundance of priority species at the proposed WEF will fluctuate depending on the season of the year. Greater numbers are expected during the rainy season, when foraging conditions are better and certain migratory species are present.

6.1.1.2 Site-specific factors

- Landscape features

Susceptibility to collision can also heavily depend on landscape features at a wind farm site, particularly for soaring birds that predominantly rely on wind updrafts to fly. Some landforms such as ridges, steep slopes and valleys may be more frequently used by some birds, for example for hunting or during migration (Barrios and Rodríguez, 2004; Drewitt and Langston, 2008; Katzner *et al.* 2012; Thelander *et al.* 2003). In APWRA, Red-tailed Hawk fatalities occur more frequently than expected by chance at wind turbines located on ridge tops and swales, whereas Golden Eagle fatalities are higher at wind turbines located on slopes (Thelander *et al.* 2003). Other birds may follow other landscape features, such as peninsulas and shorelines, during dispersal and migration periods. Kitano and Shiraki (2013) found that the collision rate of White-tailed Eagles along a coastal cliff was extremely high, suggesting an effect of these landscape features on fatality rates.

The project site does not contain many landscape features as it is situated on a slightly undulating plain. The most significant landscape features from a collision risk perspective are some of the low ridges which may be utilised by some species for lift especially during soaring flight behaviour.

- Flight paths

For territorial raptors like Golden Eagles (and Verreaux's Eagles – see Ralston-Patton 2017)), foraging areas are preferably located near to the nest, when compared to the rest of their home range. For example, in Scotland 98% of Golden Eagle movements were registered at ranges less than 6 km from the nest, and the core areas were located within a 2 - 3 km radius (McGrady *et al.* 2002). These results, combined with the terrain features selected by Golden Eagles to forage such as areas close to ridges, can be used to predict the areas used by the species to forage (McLeod *et al.* 2002), and therefore provide a sensitivity map and guidance to the development of new wind farms (Bright *et al.* 2006).

Some of the wetlands and dams are act as a focal point for flight activity as birds converge on the wetland and dam, e.g. Grey Crowned Crane in some of the wetlands, and some dams with dead trees used as *roosts by Southern Bald Ibis. The same could be said for the roosts and colonies of Southern bald Ibis on low cliffs which are focal points for flight activity.*

- Food availability

Factors that increase the use of a certain area or that attract birds, like food availability; also play a role in collision risk. For example, the high density of raptors at the APWRA and the high collision fatality due to collision with turbines is thought to result, at least in part, from high prey availability in certain areas (Hoover and Morrison, 2005; Smallwood *et al.* 2001). This may be particularly relevant for birds that are less aware of obstructions such as wind turbines while foraging (Krijgsveld *et al.* 2009; Smallwood *et al.* 2009). It is speculated that the mortality of three Verreaux's Eagles in 2015 at a wind farm site in South Africa may have been linked to the availability of food (Smallie 2015).

The agricultural activity is an attractant for Southern Bald Ibis during certain times of the year. Natural grassland is the foraging habitat of choice for a range of priority species, including Secretarybird, Southern Bald Ibis, Yellow-breasted Pipit, Rudd's Lark, Blue Korhaan, Denham's Bustard and White-bellied Bustard.

6.1.1.3 Summary of turbine collision risk

The proposed WEF will pose a collision risk to several priority species which could occur regularly at the site. Species exposed to this risk are large terrestrial species and occasional long distance fliers i.e., bustards, cranes, storks, Southern Bald Ibis and Secretarybird, although bustards and cranes generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species, i.e., species such as Cape Vulture and a variety of raptors, including several species of eagles, are highly vulnerable to the risk of collisions. The regularly occurring priority species could be at risk of collisions with the turbines are the following: African Fish Eagle, African Grass Owl, African Harrier-Hawk
African Marsh Harrier, Amur Falcon, Black Sparrowhawk, Black-winged Kite, Black-winged Lapwing, Black-winged Pratincole, Blue Crane, Blue Korhaan, Common Buzzard, Denham's Bustard, Greater Kestrel, Grey Crowned Crane, Grey-winged Francolin, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Montagu's Harrier, Pallid Harrier, Red-footed Falcon, Rudd's Lark, Rufous-breasted Sparrowhawk, Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White Stork, White-bellied Bustard, Yellow-billed Stork and Yellow-breasted Pipit.

6.1.2 Displacement due to disturbance

The displacement of birds from areas within and surrounding wind farms due to visual intrusion and disturbance in effect can amount to habitat loss. Displacement may occur during both the construction and operation phases of wind farms and may be caused by the presence of the turbines themselves through visual, noise and vibration impacts, or as a result of vehicle and personnel movements related to site maintenance. The scale and degree of disturbance will vary according to site- and species-specific factors and must be assessed on a site-by-site basis (Drewitt & Langston 2006).

Unfortunately, few studies of displacement due to disturbance are conclusive, often because of the lack of before- and-after and control-impact (BACI) assessments. Indications are that Great Bustard *Otis tarda* could be displaced by wind farms up to one kilometre from the facility (Langgemach 2008). An Austrian study found displacement for Great Bustards up to 600m (Wurm & Kollar as quoted by Raab *et al.* 2009). However, there is also evidence to the contrary; information on Great Bustard received from Spain points to the possibility of continued use of leks at operational wind farms (Camiña 2012b). The same situation seems to prevail at wind farms in the Eastern Cape where Denham's Bustard are still using wind farm sites as leks.[5] Research on small grassland species in North America indicates that permanent displacement is uncommon and very species specific (e.g. see Stevens et.al 2013, Hale et.al 2014). There also seems to be little evidence for a persistent decline in passerine populations at wind farm sites in the UNITED KINGDOM (despite some evidence of turbine avoidance), with some species, including Skylark, showing increased populations after wind farm construction (see Pierce-Higgins et. al 2012). Populations of Thekla Lark *Galerida theklae* were found to be unaffected by wind farm developments in Southern Spain (see Farfan *et al*. 2009).

The consequences of displacement for breeding productivity and survival are crucial to whether or not there is likely to be a significant impact on population size. However, studies of the impact of wind farms on breeding birds are also largely inconclusive or suggest lower disturbance distances, though this apparent lack of effect may be due to the high site fidelity and long life-span of the breeding species studied. This might mean that the true impacts of disturbance on breeding birds will only be evident in the longer term, when new recruits replace existing breeding birds. Few studies have considered the possibility of displacement for short-lived passerines (such as larks), although Leddy *et al.* (1999) found increased densities of breeding grassland passerines with increased distance from wind turbines, and higher densities in the reference area than within 80m of the turbines. A review of minimum avoidance distances of 11 breeding passerines were found to be generally <100m from a wind turbine ranging from 14 – 93m (Hötker *et al.* 2006). A comparative study of nine wind farms in Scotland (Pearce-Higgens *et al.* 2009) found unequivocal evidence of displacement: Seven of the 12 species studied exhibited significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with equivocal evidence of turbine avoidance in a further two. No species were more likely to occur close to the turbines. Levels of turbine avoidance suggest breeding bird densities may be reduced within a 500m buffer of the turbines by 15– 53%, with Common Buzzard *Buteo buteo*, Hen Harrier *Circus cyaneus*, Golden Plover *Pluvialis apricaria*, Snipe *Gallinago gallinago*, Curlew *Numenius arquata* and Wheatear *Oenanthe oenanthe* most affected. In a follow-up study, monitoring data from wind farms located on unenclosed upland habitats in the United Kingdom were collated to test whether breeding densities of upland birds were reduced as a result of wind farm construction or during wind farm operation. Red Grouse *Lagopus lagopus scoticus*, Snipe *Gallinago gallinago* and Curlew *Numenius arquata* breeding densities all declined on wind farms during construction. Red Grouse breeding densities recovered after construction, but Snipe and Curlew densities did not. Post-construction Curlew breeding densities on wind farms were also significantly lower than reference sites. Conversely, breeding densities of Skylark *Alauda arvensis* and Stonechat *Saxicola torquata* increased on wind farms during construction. Overall, there was little evidence for consistent post-construction population declines in any species, suggesting that wind farm construction can have greater impacts upon birds than wind farm operation (Pierce-Higgens *et al.* 2012).

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species in the remaining high-quality grassland, wetlands and wetland fringes the most, as well as Southern Bald Ibis roosting and breeding in the PAOI, as this could temporarily disrupt their reproductive cycle. Some species might be able to recolonise the area after the completion of the construction phase, but for some species, this might only be partially the case, resulting in lower densities than before once the WEF is operational, due to the disturbance factor of the operational turbines, and

[5] Personal communication by Wessel Rossouw, bird monitor based in Jeffreys Bay, from personal observations in the Kouga municipal area.

the habitat fragmentation. In summary, the following species could be impacted by disturbance during the construction phase: African Fish Eagle, African Grass Owl, African Harrier-Hawk, African Marsh Harrier, Black Sparrowhawk, Black-rumped Buttonquail, Black-winged Kite, Blue Crane, Blue Korhaan, Buff-streaked Chat, Denham's Bustard, Greater Kestrel, Grey Crowned Crane, Grey-winged Francolin, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Rudd's Lark, Rufous-breasted Sparrowhawk, Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White-bellied Bustard and Yellow-breasted Pipit.

6.1.3 Displacement due to habitat transformation

The scale of permanent habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, in general, it is likely to be small per turbine base. Typically, actual habitat loss amounts to 2–5% of the total development site (Fox *et al.* 2006 as cited by Drewitt & Langston 2006), though effects could be more widespread where developments interfere with hydrological patterns or flows on wetland or peatland sites (unpublished data). Some changes could also be beneficial. For example, habitat changes following the development of the Altamont Pass wind farm in California led to increased mammal prey availability for some species of raptor (for example through greater availability of burrows for Pocket Gophers *Thomomys bottae* around turbine bases), though this may also have increased collision risk (Thelander *et al.* 2003 as cited by Drewitt & Langston 2006).

However, the results of habitat transformation may be more subtle, whereas the actual footprint of the wind farm may be small in absolute terms, the effects of the habitat fragmentation brought about by the associated infrastructure (e.g. power lines and roads) may be more significant. Sometimes Great Bustard can be seen close to or under power lines, but a study done in Spain (Lane *et al.* 2001 as cited by Raab *et al.* 2009) indicates that the total observation of Great Bustard flocks was significantly higher further from power lines than at control points. Shaw (2013) found that Ludwig’s Bustard generally avoid the immediate proximity of roads within a 500m buffer. Bidwell (2004) found that Blue Cranes select nesting sites away from roads. This means that power lines and roads also cause loss and fragmentation of the habitat used by the population in addition to the potential direct mortality. The physical encroachment increases the disturbance and barrier effects that contribute to the overall habitat fragmentation effect of the infrastructure (Raab *et al.* 2010). It has been shown that fragmentation of natural grassland in Mpumalanga (in that case by afforestation) has had a detrimental impact on the densities and diversity of grassland species (Allan *et al.* 1997).

The construction of additional roads is likely to result in further habitat fragmentation, although the site already has a large number of access roads, most of which will be upgraded and utilised for the wind farm development. This, together with the disturbance factor of the operating turbines, could have an effect on the density of several species, particularly larger terrestrial species which would utilise the remaining natural grassland, wetlands and wetland fringes as breeding habitat. It is not expected that any priority species will be permanently displaced from the development site, but densities may be reduced. In summary, the following terrestrial species and raptors are likely to be most affected by habitat transformation: African Grass Owl, Black-rumped Buttonquail, Black-winged Lapwing, Blue Crane, Blue Korhaan, Buff-streaked Chat, Denham's Bustard, Grey Crowned Crane, Grey-winged Francolin, Marsh Owl, Rudd's Lark, Secretarybird, White-bellied Bustard and Yellow-breasted Pipit.

6.1.4 Electrocution on the medium voltage network

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2000). The electrocution risk is largely determined by the design of the electrical hardware.

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. In these instances, the electricity could potentially pose an electrocution risk to several power line sensitive species that could on occasion perch on these poles.

The following priority species are potentially vulnerable to electrocution on the 33kV overhead lines: African Fish Eagle, African Grass Owl, African Harrier-Hawk, African Marsh Harrier, Amur Falcon, Black Sparrowhawk, Black-winged Kite, Common Buzzard, Greater Kestrel, Grey Crowned Crane, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Montagu's Harrier, Pallid Harrier, Red-footed Falcon, Rufous-breasted Sparrowhawk, Southern Bald Ibis and Spotted Eagle-Owl.

6.1.5 Collisions with the medium voltage network

Collisions are one of the biggest threat posed by overhead lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes, and various species of waterbirds, and to a lesser extent, vultures. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen 2004, Anderson 2001).

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (see **Figure 11**).

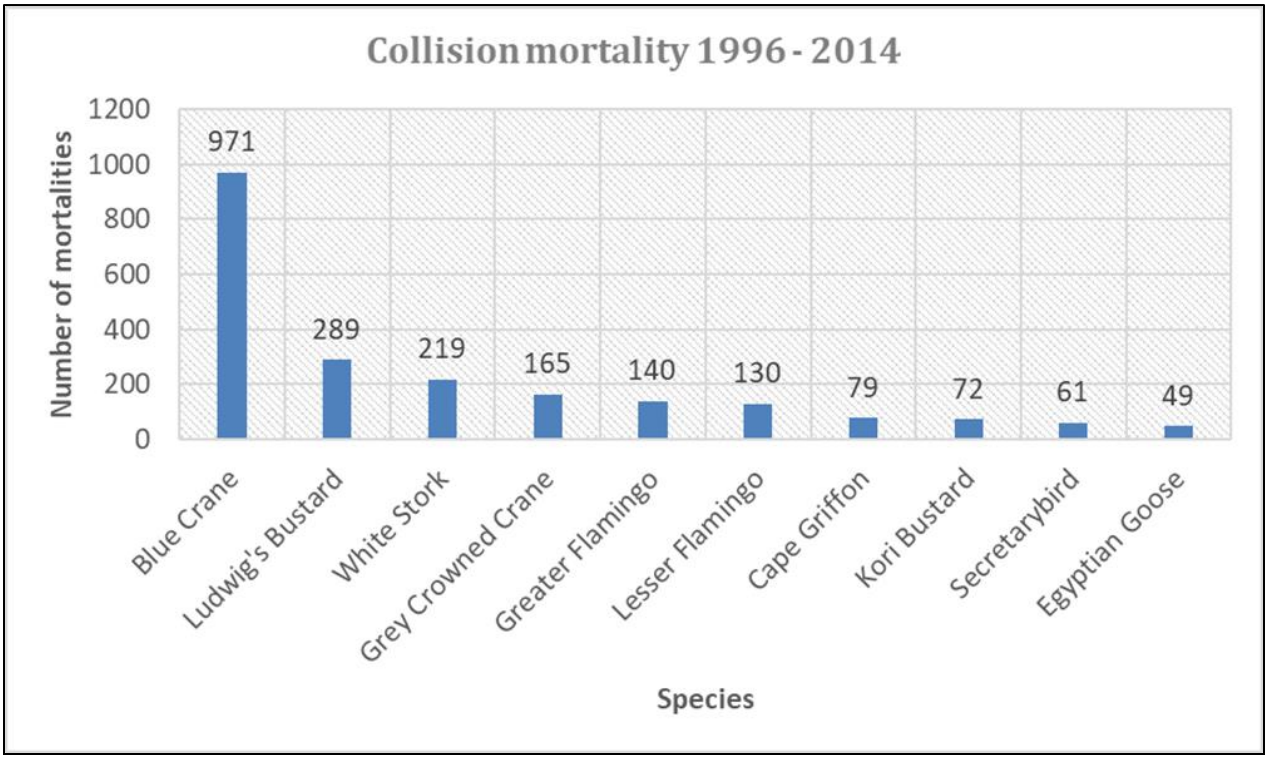


Figure 10: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/Endangered Wildlife Trust Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data).

Power line collisions are generally accepted as a key threat to bustards (Raab *et al*. 2009; Raab *et al*. 2010; Jenkins & Smallie 2009; Barrientos *et al*. 2012, Shaw 2013). In one study, carcass surveys were performed under high voltage transmission lines in the Karoo for two years, and low voltage distribution lines for one year (Shaw 2013). Ludwig's Bustard was the most common collision victim (69% of carcasses), with bustards generally comprising 87% of mortalities recovered. Total annual mortality was estimated at 41% of the Ludwig's Bustard population, with Kori Bustards *Ardeotis kori* also dying in large numbers (at least 14% of the South African population killed in the Karoo alone). Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw 2013).

Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the Endangered Wildlife Trust (EWT) and Eskom tested the effectiveness of two types of line markers in reducing power line collision mortalities of large birds on three 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, with a 92% reduction in mortality, and large birds in general with a 56% reduction in mortality, but not for bustards, including the endangered Ludwig's Bustard. The two different marking devices were approximately equally effective, namely spirals and bird flappers, they found no evidence supporting the preferential use of one type of marker over the other (Shaw et al. 2017).

Distribution lines i.e. 11kV to 88kV are often overlooked in collision studies, but given their far greater extent they can represent a serious source of mortality (Shaw et al. 2010a, 2010b).

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. These spans could pose a *collision risk to priority avifauna, depending on where those spans are located. Priority species potentially at risk are African Grass Owl, Blue Crane, Blue Korhaan, Denham's Bustard, Grey Crowned Crane, Marsh Owl Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White Stork, White-bellied Bustard and Yellow-billed Stork.*

6.2 The identification and assessment of potential impacts: Wind Energy Facility

The potential impacts on avifauna identified in the course of the study are listed and assessed in the tables below. **This is a preliminary scoping phase assessment and may be revised during the EIA phase.**

The impact criteria are explained in Appendix 6.

6.2.1 Construction Phase

- Displacement of priority species due to disturbance associated with the construction of the wind turbines and associated infrastructure.
- Displacement of priority species due to habitat transformation associated with the construction of the wind turbines and associated infrastructure.

Table 7: Rating of impacts: Construction Phase

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Construction Phase																				
Avifauna	Displacement due to disturbance associated with the construction of the wind turbines and associated infrastructure.	1	4	2	3	1	3	33		Medium	(1) Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species. (2) Measures to control noise and dust should be applied according to current best practice in the industry. (3) No construction should take place in all infrastructure exclusion zones as indicated in Section 6.3.	1	4	2	3	1	2	22		Low
Avifauna	Displacement due to habitat transformation associated with the construction of the wind turbines and associated infrastructure.	1	3	2	3	3	2	24		Medium	(1) Removal of vegetation must be restricted to a minimum and must be rehabilitated to its former state where possible after construction. (2) Construction of new roads should	1	2	2	2	3	2	20		Low

											only be considered if existing roads cannot be upgraded. (3) The recommendations of biodiversity specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned to limit the impact of habitat transformation on priority species. (4) No construction should take place in all infrastructure exclusion zones as indicated in Section 6.3.									

6.2.2 Operational Phase

- Mortality due to collisions with the wind turbines.
- Mortality due to electrocutions on the overhead sections of the internal 33kV cables.
- Mortality due to collisions with the overhead sections of the internal 33kV cables.

Table 8: Rating of impacts: Operational Phase

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Operation Phase																				
Avifauna	Mortality of priority species due to collisions with the wind turbines.	2	4	2	3	3	3	42		Medium	(1) No turbines (including the rotor swept area) should be located in turbine exclusion zones as indicated in Section 6.3. (2) Pro-active mitigation in the form of Shutdown on Demand (SDoD) or automated curtailment must be implemented in the medium risk zones as indicated in Section 6.3. (3) Live-bird monitoring and carcass searches should be implemented in the operational phase, as per the most recent edition of the Best Practice Guidelines at the time (Jenkins *et al.* 2015) to assess collision rates. (4) All wind turbines must have one blade painted according to a CAA approved pattern to reduce the risk of raptor collisions. It is acknowledged that blade painting as a mitigation strategy is still in an experimental phase in South Africa, but	2	2	2	2	3	2	22		Low

											research indicates that it has a very good chance of reducing raptor mortality, based on research conducted in Norway (see Simmons et al. 2021 (Appendix 8) for an explanation of the science and research behind this mitigation method). (5) If at any time estimated collision rates indicate unacceptable mortality levels of priority species, i.e., if it exceeds the mortality threshold determined by the avifaunal specialist after consultation with other avifaunal specialists and BirdLife South Africa, additional measures will have to be implemented.									
Avifauna	Mortality of priority species due to electrocutions on the overhead sections of the internal 33kV cables.	2	3	1	3	3	2	24		Medium	(1) Underground cabling should be used as much as is practically possible. (2) If the use of overhead lines is unavoidable due to technical reasons, the Avifaunal Specialist must be consulted timeously to ensure that a raptor friendly pole design is used, and that appropriate mitigation is implemented pro-actively for complicated pole structures e.g., insulation of live components to prevent electrocutions on terminal structures and pole transformers. (3) Regular inspections of the overhead sections of the internal reticulation	2	2	1	2	3	1	10		Low

											network must be conducted during the operational phase to look for carcasses, as per the most recent edition of the Best Practice Guidelines at the time (Jenkins *et al.* 2015).									
Avifauna	Mortality due to collisions with the overhead sections of the internal 33kV cables.	2	3	2	3	3	2	26		Medium	Bird flight diverters should be installed on all the overhead line sections for the full span length according to the applicable Eskom standard at the time.	2	1	1	2	3	1	9		Low

6.2.3 Decommissioning Phase

- Displacement due to disturbance associated with the decommissioning (dismantling) of the wind turbines and associated infrastructure.

Table 9: Rating of impacts: Decommissioning Phase

ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
Decommissioning Phase																				
Avifauna	Displacement due to disturbance associated with the dismantling of the wind turbines and associated infrastructure.	1	4	1	2	1	2	18		Low	(1) Dismantling activity should be restricted to the immediate footprint of the infrastructure as far as possible. (2) Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species. (3) Measures to control noise and dust should be applied according to current best practice in the industry.	1	3	1	2	1	2	16		Low

6.3 The identification of environmental sensitivities: Wind Energy facility

Preliminary avifaunal sensitivities[6] were identified through a synthesis of professional judgment and avian risk modelling. The aim of the avian risk modelling was to assess if any associations existed between observed risky flight behaviour (i.e. flights within rotor sweep height) and underlying environmental and habitat conditions. A range of variables were therefore generated to characterise the environment within the area of interest. Subsequently, predictor variables were generated related to various aspects of topography, hydrology/drainage, vegetation, and land cover. Topographical variables characterised slope, aspect, elevational change, solar radiation, and ruggedness. Drainage specifically characterized the presence and magnitude of drainage lines. Habitat and vegetation were characterized using a range of remote sensing indices generated from Sentinel-2 imagery. Indices included seasonal and annual averages of respective indices, as well as dynamic variables. Lastly, if any nest, colony and/or roost sites were identified by observers for any of the species being assessed, these were used to create an additional predictor variable, namely distance (m) to nest/colony/roost site. See Appendix 8 for an explanation of the methodology used during the modelling process.

From the above, following preliminary environmental sensitivities were identified from an avifaunal perspective for the proposed wind energy facility:

6.3.1 Very High sensitivity: All infrastructure exclusion zones

Included in this category are the following areas:

- Medium and high sensitivity buffers as defined by the aquatic specialist around drainage lines, dams and wetlands. This is to prevent the disturbance of priority species breeding and roosting in these areas and to reduce the risk of turbine collisions. Priority species in this category include African Fish Eagle, African Grass Owl, African Marsh Harrier, Black-winged Pratincole, Blue Crane, Grey Crowned Crane, Long-crested Eagle, Marsh Owl and Yellow-billed Stork.
- 1km buffers around Southern Bald Ibis roosts and colonies to prevent displacement of birds due to disturbance and to reduce the risk of turbine collisions.
- 500m buffers around Secretarybird nests to prevent displacement of birds due to disturbance and to reduce the risk of turbine collisions.
- 500m buffers around Grey Crowned Crane roosts and potential breeding areas to prevent displacement of birds due to disturbance and to reduce the risk of turbine collisions.
- All the modelled Rudd's Lark habitat.
- All the modelled Yellow-breasted Pipit habitat.

6.3.2 High sensitivity: Turbine exclusion zones

- A 5km turbine exclusion zone around the Martial Eagle nest (FP12)
- A shaped turbine exclusion zone based on the modelled flight activity of the Southern Bald Ibis recorded during the pre-construction monitoring.

[6] Subject to further refinement during the EIA phase

- A shaped turbine exclusion zone based on the modelled flight activity of the Secretarybird recorded during the pre-construction monitoring.

6.3.3 Medium sensitivity: Pro-active mitigation zones (shutdown on demand)

- All medium sensitivity flight risk zones modelled for Grey Crowned Crane
- All medium sensitivity flight risk zones modelled for Secretarybird

See **Figure 11** for a map indicating the preliminary avifaunal sensitivity zones.

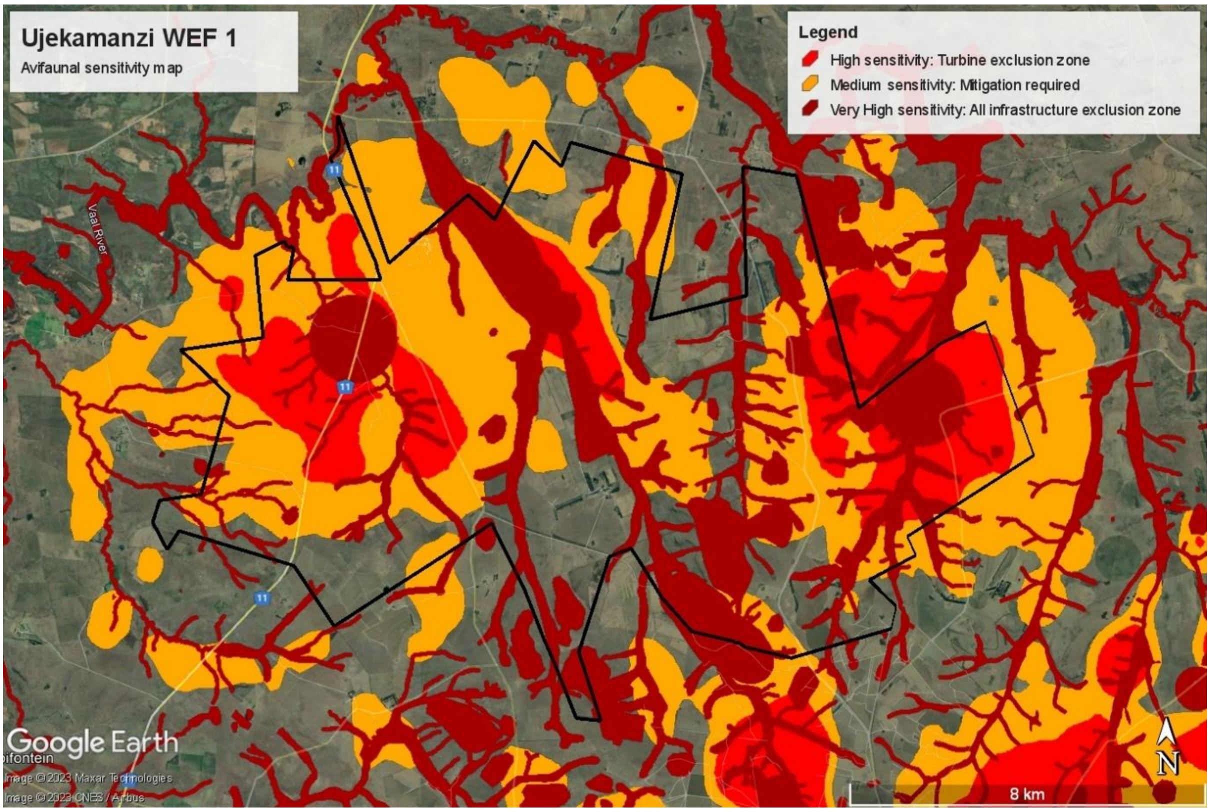


Figure 11: Preliminary avifaunal sensitivity zones.

7. COMPARATIVE ASSESSMENT OF ALTERNATIVES

7.1 Wind Energy Facility

Table 10 10 provides a summary of the proposed alternatives relating to the WEF and associated infrastructure, namely the four onsite substation options.

Key

PREFERRED	The alternative will result in a low impact / reduce the impact / result in a positive impact
FAVOURABLE	The impact will be relatively insignificant
LEAST PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Table 10: Comparative assessment of WEF components

Alternative	**Preference**	**Reasons**
SUBSTATION SITE ALTERNATIVES		
Substation Option 1	Favourable. The impact will be relatively insignificant	This option is located in an agricultural field where the natural grassland has already been transformed.
Substation Option 2	The alternative will increase the impact.	This alternative is located in natural grassland and is therefore least preferred as it will lead to further transformation and fragmentation of the natural grassland.
Substation Option 3	The alternative will increase the impact.	This alternative is located in natural grassland and is therefore least preferred as it will lead to further transformation and fragmentation of the natural grassland.
Substation Option 4	Favourable. The impact will be relatively insignificant	This option is located in an agricultural field where the natural grassland has already been transformed.

7.2 No-Go Alternative

7.2.1 Wind Energy Facility

The no-go alternative will result in the current *status quo* being maintained as far as the avifauna is concerned. The low human population in the area is definitely advantageous to sensitive avifauna, especially Red Data species. The no-go option would eliminate any additional impact on the ecological integrity of the proposed PAOI as far as avifauna is concerned.

8. CONCLUSION AND SUMMARY

8.1 Summary of Findings

The proposed Ujekamanzi WEF 1 will have several potential impacts on priority avifauna. These impacts are the following:

- Displacement of priority species due to disturbance linked to construction activities in the construction phase.
- Displacement due to habitat transformation in the construction phase.
- ~~Collision mortality caused by the wind turbines in the operational phase.~~
- Electrocution on the 33kV MV overhead lines (if any) linking the turbines in the operational phase.
- Collisions with the 33kV MV overhead lines (if any) linking the turbines in the operational phase.

- Displacement of priority species due to disturbance linked to dismantling activities in the decommissioning phase.

8.1.1 *Displacement of priority species due to disturbance linked to construction activities in the construction phase.*

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species in the remaining high-quality grassland, wetlands and wetland fringes the most, as well as Southern Bald Ibis roosting and breeding in the PAOI, as this could temporarily disrupt their reproductive cycle. Some species might be able to recolonise the area after the completion of the construction phase, but for some species, this might only be partially the case, resulting in lower densities than before once the WEF is operational, due to the disturbance factor of the operational turbines, and the habitat fragmentation. In summary, the following species could be impacted by disturbance during the construction phase: African Fish Eagle, African Grass Owl, African Harrier-Hawk, African Marsh Harrier, Black Sparrowhawk, Black-rumped Buttonquail, Black-winged Kite, Blue Crane, Blue Korhaan, Buff-streaked Chat, Denham's Bustard, Greater Kestrel, Grey Crowned Crane, Grey-winged Francolin, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Rudd's Lark, Rufous-breasted Sparrowhawk, Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White-bellied Bustard and Yellow-breasted Pipit. The impact is rated as **Medium** but could be mitigated to **Low** levels.

8.1.2 *Displacement due to habitat transformation in the construction phase.*

The construction of additional roads is likely to result in further habitat fragmentation, although the site already has a large number of access roads, most of which will be upgraded and utilised for the wind farm development. This, together with the disturbance factor of the operating turbines, could have an effect on the density of several species, particularly larger terrestrial species which would utilise the remaining natural grassland, wetlands and wetland fringes as breeding habitat. It is not expected that any priority species will be permanently displaced from the development site, but densities may be reduced. In summary, the following terrestrial species and raptors are likely to be most affected by habitat transformation: African Grass Owl, Black-rumped Buttonquail, Black-winged Lapwing, Blue Crane, Blue Korhaan, Buff-streaked Chat, Denham's Bustard, Grey Crowned Crane, Grey-winged Francolin, Marsh Owl, Rudd's Lark, Secretarybird, White-bellied Bustard and Yellow-breasted Pipit. The impact is rated as **Medium** pre- mitigation and **Low** post-mitigation.

8.1.3 *Collision mortality caused by the wind turbines in the operational phase.*

The proposed WEF will pose a collision risk to several priority species which could occur regularly at the site. Species exposed to this risk are large terrestrial species and occasional long-distance fliers i.e., bustards, cranes, storks, Southern Bald Ibis and Secretarybird, although bustards and cranes generally seem to be not as vulnerable to turbine collisions as was originally anticipated (Ralston-Paton & Camagu 2019). Soaring priority species, i.e., species such as Cape Vulture and a variety of raptors, including several species of eagles, are highly vulnerable to the risk of collisions. The regularly occurring priority species could be at risk of collisions with the turbines are the following: African Fish Eagle, African Grass Owl, African Harrier-Hawk

African Marsh Harrier, Amur Falcon, Black Sparrowhawk, Black-winged Kite, Black-winged Lapwing, Black-winged Pratincole, Blue Crane, Blue Korhaan, Common Buzzard, Denham's Bustard, Greater Kestrel, Grey Crowned Crane, Grey-winged Francolin, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Montagu's Harrier, Pallid Harrier, Red-footed Falcon, Rudd's Lark, Rufous-breasted Sparrowhawk, Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White Stork, White-bellied Bustard, Yellow-billed Stork and Yellow-breasted Pipit. The impact is rated as **Medium** pre-mitigation and **Low** post-mitigation.

8.1.4 Electrocution on the 33kV MV overhead lines (if any) in the operational phase.

The following priority species are potentially vulnerable to electrocution on the 33kV overhead lines: African Fish Eagle, African Grass Owl, African Harrier-Hawk, African Marsh Harrier, Amur Falcon, Black Sparrowhawk, Black-winged Kite, Common Buzzard, Greater Kestrel, Grey Crowned Crane, Jackal Buzzard, Lanner Falcon, Long-crested Eagle, Marsh Owl, Martial Eagle, Montagu's Harrier, Pallid Harrier, Red-footed Falcon, Rufous-breasted Sparrowhawk, Southern Bald Ibis and Spotted Eagle-Owl. The impact is rated as **Medium** pre-mitigation and L**ow** post-mitigation.

8.1.5 Collisions with the 33kV MV overhead lines (if any) in the operational phase.

While the intention is to place the medium voltage reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. These spans could pose a collision risk to priority avifauna, depending on where those spans are located. Priority species potentially at risk are African Grass Owl, Blue Crane, Blue Korhaan, Denham's Bustard, Grey Crowned Crane, Marsh Owl
Secretarybird, Southern Bald Ibis, Spotted Eagle-Owl, White Stork, White-bellied Bustard and Yellow-billed Stork. The impact is rated as **Medium** pre-mitigation and **Low** post-mitigation.

8.1.6 Displacement of priority species due to disturbance linked to dismantling activities in the decommissioning phase.

The impact is likely to be similar in nature to the construction phase.

Table 11**11** summarises the expected impacts of the proposed WEF and proposed mitigation measures per impact.

Table 11: Overall Impact Significance for the WEF (Pre- and Post-Mitigation)

Nature of impact and Phase	Overall Impact Significance (Pre -Mitigation)	Proposed mitigation	Overall Impact Significance (Post - Mitigation)
Construction: Displacement due to disturbance	Medium	(1) Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species. (2) Measures to control noise and dust should be applied according to current best practice in the industry. (3) No construction should take place in all infrastructure exclusion zones as indicated in Section 6.3.	Low
Construction: Displacement due to habitat transformation	Medium	(1) Removal of vegetation must be restricted to a minimum and must be rehabilitated to its former state where possible after construction. (2) Construction of new roads should only be considered if existing roads cannot be upgraded. (3) The recommendations of biodiversity specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned to limit the impact of habitat transformation on priority species. (4) No construction should take place in all infrastructure exclusion zones as indicated in Section 6.3.	Low
Operational: Collisions with the turbines	Medium	(1) No turbines (including the rotor swept area) should be located in turbine exclusion zones as indicated in Section 6.3. (2) Pro-active mitigation in the form of Shutdown on Demand (SDoD) or automated curtailment must be implemented in the medium risk zones as indicated in Section 6.3. (3) Live-bird monitoring and carcass searches should be implemented in the operational phase, as per the most recent edition of the Best Practice	Low

Nature of impact and Phase	Overall Impact Significance (Pre -Mitigation)	Proposed mitigation	Overall Impact Significance (Post - Mitigation)
		Guidelines at the time (Jenkins et al. 2015) to assess collision rates. (4) All wind turbines must have one blade painted according to a CAA approved pattern to reduce the risk of raptor collisions. It is acknowledged that blade painting as a mitigation strategy is still in an experimental phase in South Africa, but research indicates that it has a very good chance of reducing raptor mortality, based on research conducted in Norway (see Simmons et al. 2021 (Appendix 8) for an explanation of the science and research behind this mitigation method). (5) If at any time estimated collision rates indicate unacceptable mortality levels of priority species, i.e., if it exceeds the mortality threshold determined by the avifaunal specialist after consultation with other avifaunal specialists and BirdLife South Africa, additional measures will have to be implemented.	
Operational: Electrocutions on the 33kV MV network	Medium	(1) Underground cabling should be used as much as is practically possible. (2) If the use of overhead lines is unavoidable due to technical reasons, the Avifaunal Specialist must be consulted timeously to ensure that a raptor friendly pole design is used, and that appropriate mitigation is implemented pro-actively for complicated pole structures e.g., insulation of live components to prevent electrocutions on terminal structures and pole transformers. (3) Regular inspections of the overhead sections of the internal reticulation network must be conducted during the operational phase to look for carcasses, as per the most recent edition of the Best Practice Guidelines at the time (Jenkins *et al.* 2015).	Low
Operational: Collisions with the 33kV MV network	Medium	Bird flight diverters should be installed on all the overhead line sections for the full span length according to the applicable Eskom standard at the time.	Low

Nature of impact and Phase	Overall Impact Significance (Pre -Mitigation)	Proposed mitigation	Overall Impact Significance (Post - Mitigation)
Decommissioning: Displacement due to disturbance	Medium	(1) Dismantling activity should be restricted to the immediate footprint of the infrastructure as far as possible. Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species. (2) Measures to control noise and dust should be applied according to current best practice in the industry.	Low

8.2 Conclusion and Impact Statement

The proposed Ujekamanzi WEF 1 will have a moderate impact on avifauna which, in all instances, could be reduced to a low impact through appropriate mitigation. No fatal flaws were discovered during the onsite investigations. **The development is therefore supported, provided the mitigation measures listed in this report are strictly implemented.**

9. FINAL LAYOUT

The final layout is yet to be determined. Design and layout alternatives will be considered and assessed as part of the next phase of the EIA. These will include alternatives for the Substation locations and also for the construction / laydown area.

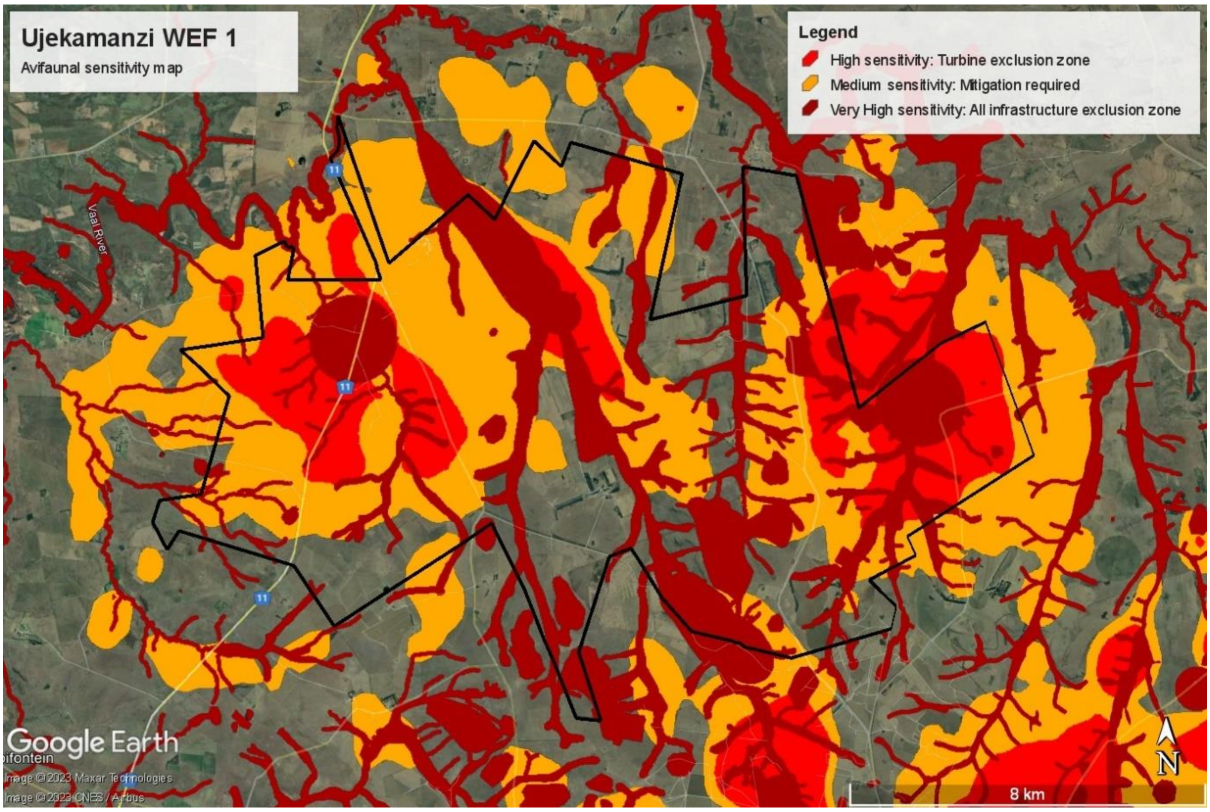


Figure 12: Sensitivities for the Ujekamanzi WEF 1 project.

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APPENDIX 1: TERMS OF REFERENCE

SPECIALIST REPORT REQUIREMENTS

1.1 Site Sensitivity Verification and Reporting

The requirements for Specialist Studies being undertaken in support of applications for Environmental Authorisation are specified in **Appendix 6** of the 2014 NEMA EIA Regulations (as amended), as well as the Assessment Protocols that were published on 20 March 2020, in Government Gazette 43110, GN 320. These protocols stipulate the Procedures for the Assessment and Minimum Criteria for reporting on identified environmental themes in terms of Sections 24(5)(A) and (H) and 44 of the NEMA, when applying for EA.

The Assessment Protocols as per GN320 are as follows:

- **PART A:** This relates to the Site Sensitivity Verification (SSV) and Reporting requirements where a Specialist Assessment is required but no specific Assessment Protocol has been prescribed. In this instance, specialist assessment must comply with **Appendix 6** of the 2014 NEMA EIA Regulations (as amended). However, the current use of the land and the environmental sensitivity of the site under consideration as identified by the DFFE Screening Tool must be verified and confirmed and an SSV report must be compiled and included as an appendix to the Specialist Assessment. Where there are no sensitivity layers on the Screening Tool for a particular Specialist Assessment, then this must be stated in the actual Specialist Assessment and in the accompanying SSV report.
- **PART B:** This relates to the Site Sensitivity Verification (SSV) and Reporting requirements where a Specialist Assessment is required and a specific Assessment Protocol has been prescribed. The following Assessment Protocols are relevant to the proposed project:
    - Agriculture
    - Terrestrial Biodiversity
    - Aquatic Biodiversity
    - Archaeological, Cultural and Paleontology
    - Avifauna
    - Bat
    - Flicker
    - Geotechnical
    - Noise
    - Risk Assessment
    - Social
    - Traffic
    - Visual
    - Terrestrial Plant Species
    - Terrestrial Animal Species

1.2 Specialist Assessment Reports / Compliance Statements

Specialists are requested to provide ***four (4)*** scoping and environmental impact assessment reports and / or compliance statements that provides an assessment process for the following:

- Ujekamanzi WEF 1
- Ujekamanzi WEF 2
- Ujekamanzi MTS & LILO (On the WEF 1 site)
- Ujekamanzi LILO & LILO (On the WEF 2 site)

The specialist assessment reports and / or compliance statements should include the following sections:

1.2.1 Project Description

The specialist report must include the project description as provided above.

1.2.2 Terms of Reference

The specialist report must include an explanation of the terms of reference (TOR) applicable to the specialist study. Where relevant, a table must be provided at the beginning of the specialist report, listing the requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations, 2014 (as amended) and cross referencing these requirements with the relevant sections in the report. An MS Word version of this table will be provided by SiVEST.

1.2.3 Legal Requirements and Guidelines

The specialist report must include a thorough overview of all applicable best practice guidelines, relevant legislation, prescribed Assessment Protocols and authority requirements.

1.2.4 Methodology

The report must include a description of the methodology applied in carrying out the specialist assessment.

1.2.5 Specialist Findings / Identification of Impacts

The report must present the findings of the specialist studies and explain the implications of these findings for the proposed development (e.g. permits, licenses etc.). This section of the report should also identify any sensitive and/or 'no-go' areas on the PAOI or within the power line assessment corridors. These areas must be mapped clearly with a supporting explanation provided.

This section of the report should also specify if any further assessment will be required.

1.2.6 Environmental Impact Assessment

The impacts (both direct and indirect) of the proposed WEF and the proposed grid connection infrastructure (during the Construction, Operation and Decommissioning phases) are to be assessed and rated *separately* according to the methodology developed by SiVEST. Specialists will be required to make use of the impact rating matrix provided (in Excel format) for this purpose, and *separate tables* must be provided for the WEF and for the grid connection infrastructure respectively. **Please note that the significance of Cumulative Impacts should also be rated in this section.** Both the methodology and the rating matrix will be provided by SiVEST.

Please be advised that this section must include mitigation measures aimed at minimising the impact of the proposed development.

1.2.7 Input to The Environmental Management Programme (EMPr)

The report must include a description of the key monitoring recommendations for each applicable mitigation measure identified for each phase of the project for inclusion in the Environmental Management Programme (EMPr) or Environmental Authorisation (EA).

Please make use of the Impact Rating Table (in Excel format) for each of the phases i.e. Design, Construction, Operation and Decommissioning.

1.2.8 Cumulative Impact Assessment

Cumulative impact assessments must be undertaken for the proposed WEF and associated grid connection infrastructure to determine the cumulative impact that will materialise if other Renewable Energy Facilities (REFs) and large scale industrial developments are constructed within 35kms of the proposed development.

The cumulative impact assessment must contain the following:

- A cumulative environmental impact statement noting whether the overall impact is acceptable; and
- A review of the specialist reports undertaken for other REFs and an indication of how the recommendations, mitigation measures and conclusion of the studies have been considered.

In order to assist the specialists in this regard, SiVEST will provide the following documentation/data:

- A summary table listing all REFs identified within 35kms of the proposed WEF;
- A map showing the location of the identified REFs; and
- KML files.

It should be noted that it is the specialist's responsibility to source the relevant EIA / BA reports that are available in the public domain. SiVEST will assist, where possible.

1.2.9 No Go Alternative

Consideration must be given to the "no-go" option in the EIA process. The "no-go" option assumes that the site remains in its current state, i.e. there is no construction of a WEF and associated infrastructure in the proposed project area and the status quo would be preserved.

1.2.10 Comparative Assessment of Alternatives

As mentioned, alternatives for the Substation location, construction / laydown area and power line route alignment have been identified. These alternatives are being considered as part of the EIA / BA processes and as such specialists are required to undertake a comparative assessment of the alternatives mentioned above as per the latest table provided by SiVEST.

1.2.11 Conclusion / Impact Statement

The conclusion section of the specialist report must include an Impact Statement, indicating whether any fatal flaws have been identified and ultimately whether the proposed development can be authorised or not (i.e. whether EA should be granted / issued or not).

1.2.12 Executive Summary

Specialists must provide an Executive Summary summarising the findings of their report to allow for easy inclusion in the EIA / BA reports.

1.2.13 Specialist Declaration of Independence

A copy of the Specialist Declaration of Interest (DoI) form, containing original signatures, must be appended to all Draft and Final Reports. This form will be provided to the specialists. *Please note that the undertaking / affirmation under oath section of the report must be signed by a Commissioner* of Oaths.

APPENDIX 2: SPECIALIST CV

Curriculum vitae: Chris van Rooyen

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	BA LLB
Nationality	:	South African
Years of experience	:	27 years

Key Experience

Chris van Rooyen has twenty-seven years' experience in the assessment of avifaunal interactions with industrial infrastructure. He was employed by the Endangered Wildlife Trust as head of the Eskom-EWT Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has consulted in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. He also has extensive project management experience and he has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author and/or co-author of 17 conference papers, co-author of two book chapters, several research reports and the current best practice guidelines for avifaunal monitoring at wind farm sites. He has completed around 130 power line assessments; and has to date been employed as specialist avifaunal consultant on more than 50 renewable energy generation projects. He has also conducted numerous risk assessments on existing power lines infrastructure. He also works outside the electricity industry and he has done a wide range of bird impact assessment studies associated with various residential and industrial developments. He serves on the Birds and Wind Energy Specialist Group which was formed in 2011 to serve as a liaison body between the ornithological community and the wind industry.

Key Project Experience

Bird Impact Assessment Studies and avifaunal monitoring for wind-powered generation facilities:

1. Eskom Klipheuwel Experimental Wind Power Facility, Western Cape
2. Mainstream Wind Facility Jeffreys Bay, Eastern Cape (EIA and monitoring)
3. Biotherm, Swellendam, (Excelsior), Western Cape (EIA and monitoring)
4. Biotherm, Napier, (Matjieskloof), Western Cape (pre-feasibility)
5. Windcurrent SA, Jeffreys Bay, Eastern Cape (2 sites) (EIA and monitoring)
6. Caledon Wind, Caledon, Western Cape (EIA)
7. Innowind (4 sites), Western Cape (EIA)
8. Renewable Energy Systems (RES) Oyster Bay, Eastern Cape (EIA and monitoring)
9. Oelsner Group (Kerriefontein), Western Cape (EIA)
10. Oelsner Group (Langefontein), Western Cape (EIA)
11. InCa Energy, Vredendal Wind Energy Facility Western Cape (EIA)
12. Mainstream Loeriesfontein Wind Energy Facility (EIA and monitoring)
13. Mainstream Noupoort Wind Energy Facility (EIA and monitoring)
14. Biotherm Port Nolloth Wind Energy Facility (Monitoring)
15. Biotherm Laingsburg Wind Energy Facility (EIA and monitoring)
16. Langhoogte Wind Energy Facility (EIA)
17. Vleesbaai Wind Energy Facility (EIA and monitoring)
18. St. Helena Bay Wind Energy Facility (EIA and monitoring)
19. Electrawind, St Helena Bay Wind Energy Facility (EIA and monitoring)
20. Electrawind, Vredendal Wind Energy Facility (EIA)
21. SAGIT, Langhoogte and Wolseley Wind Energy facilities
22. Renosterberg Wind Energy Project – 12-month preconstruction avifaunal monitoring project
23. De Aar – North (Mulilo) Wind Energy Project – 12-month preconstruction avifaunal monitoring project
24. De Aar – South (Mulilo) Wind Energy Project – 12-month bird monitoring

25. Namies – Aggenys Wind Energy Project – 12-month bird monitoring
26. Pofadder - Wind Energy Project – 12-month bird monitoring
27. Dwarsrug Loeriesfontein - Wind Energy Project – 12-month bird monitoring
28. Waaihoek – Utrecht Wind Energy Project – 12-month bird monitoring
29. Amathole – Butterworth Utrecht Wind Energy Project – 12-month bird monitoring & EIA specialist
30. Phezukomoya and San Kraal Wind Energy Projects 12-month bird monitoring & EIA specialist study (Innowind)
31. Beaufort West Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
32. Leeuwdraai Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
33. Sutherland Wind Energy Facility 12-month bird monitoring (Mainstream)
34. Maralla Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
35. Esizayo Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
36. Humansdorp Wind Energy Facility 12-month bird monitoring & EIA specialist study (Cennergi)
37. Aletta Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
38. Eureka Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
39. Makambako Wind Energy Faclity (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
40. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
41. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
42. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
43. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
44. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
45. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
46. Dassieklip Wind Energy Facility 3 years post-construction monitoring (Biotherm)
47. Loeriesfontein 2 Wind Energy Facility 2 years post-construction monitoring (Mainstream)
48. Khobab Wind Energy Facility 2 years post-construction monitoring (Mainstream)
49. Excelsior Wind Energy Facility 18 months construction phase monitoring (Biotherm)
50. Boesmansberg Wind Energy Facility 12-months pre-construction bird monitoring (juwi)
51. Mañhica Wind Energy Facility, Mozambique, 12-months pre-construction monitoring (Windlab)
52. Kwagga Wind Energy Facility, Beaufort West, 12-months pre-construction monitoring (ABO)
53. Pienaarspoort Wind Energy Facility, Touws River, Western Cape, 12-months pre-construction monitoring (ABO).
54. Ujekamanzi and 2 Wind Energy Facilities, Beaufort West, Western Cape, 12 months pre-construction monitoring (Genesis Eco-energy)
55. Duiker Wind Energy Facility, Vredendal, Western Cape 12 months pre-construction monitoring (ABO)
56. Perdekraal East Wind Energy Facility, Touws River, Western Cape, 18 months construction phase monitoring (Mainstream).
57. Swellendam Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Veld Renewables)
58. Lombardskraal Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Enertrag SA)
59. Mainstream Kolkies & Heuweltjies Wind Energy Facilities, Western Cape, 12-month pre-construction monitoring (Mainstream)
60. Great Karoo Wind Energy Facility, Northern Cape, 12-month pre-construction monitoring (African Green Ventures).
61. Mpumalanga & Gauteng Wind and Hybrid Energy Facilities (6x), pre-construction monitoring (Enertrag SA)
62. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (Enertrag SA)
63. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (ACED)
64. Nanibees North & South Wind Energy Facilities, Northern Cape, Screening Report (juwi)
65. Sutherland Wind Energy Facilities, Northern Cape, Screening Report (WKN Windcurrent)
66. Pofadder Wind Energy Facility, Northren Cape, Screening Report (Atlantic Energy)
67. Haga Haga Wind Energy Facility, Eastern Cape, Amendment Report (WKN Windcurrent)
68. Banken Wind Energy Facility, Northern Cape, Screening Report (Atlantic Energy)
69. Hartebeest Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (juwi).

Bird Impact Assessment Studies for Solar Energy Plants:

1. Concentrated Solar Power Plant, Upington, Northern Cape.
2. Globeleq De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
3. JUWI Kronos PV project, Copperton, Northern Cape
4. Sand Draai CSP project, Groblershoop, Northern Cape
5. Biotherm Helena PV Project, Copperton, Northern Cape
6. Biotherm Letsiao CSP Project, Aggeneys, Northern Cape
7. Biotherm Enamandla PV Project, Aggeneys, Northern Cape
8. Biotherm Sendawo PV Project, Vryburg, North-West
9. Biotherm Tlisitseng PV Project, Lichtenburg, North-West
10. JUWI Hotazel Solar Park Project, Hotazel, Northern Cape
11. Namakwa Solar Project, Aggeneys, Northern Cape
12. Brypaal Solar Power Project, Kakamas, Northern Cape
13. ABO Vryburg 1,2,3 Solar PV Project, Vryburg, North-West
14. NamPower CSP Facility near Arandis, Namibia
15. Dayson Klip PV Facility near Upington, Northern Cape
16. Geelkop PV Facility near Upington, Northern Cape
17. Oya PV Facility, Ceres, Western Cape
18. Vrede and Rondawel PV Facilities, Free State
19. Kolkies & Sadawa PV Facilities, Western Cape
20. Leeuwbosch PV1 and 2 and Wildebeeskuil PV1 and 2 Facilities, North-West
21. Kenhardt PV 3,4 and 5, Northern Cape
22. Wittewal PV, Grootfontein PV and Hoekdoornen PV Facilities, Touws River, Western Cape

Bird Impact Assessment Studies for the following overhead line projects:

1. Chobe 33kV Distribution line
2. Athene - Umfolozi 400kV
3. Beta-Delphi 400kV
4. Cape Strengthening Scheme 765kV
5. Flurian-Louis-Trichardt 132kV
6. Ghanzi 132kV (Botswana)
7. Ikaros 400kV
8. Matimba-Witkop 400kV
9. Naboomspruit 132kV
10. Tabor-Flurian 132kV
11. Windhoek - Walvisbaai 220 kV (Namibia)
12. Witkop-Overyssel 132kV
13. Breyten 88kV
14. Adis-Phoebus 400kV
15. Dhuva-Janus 400kV
16. Perseus-Mercury 400kV
17. Gravelotte 132kV
18. Ikaros 400 kV
19. Khanye 132kV (Botswana)
20. Moropule – Thamaga 220 kV (Botswana)
21. Parys 132kV
22. Simplon –Everest 132kV
23. Tutuka-Alpha 400kV
24. Simplon-Der Brochen 132kV
25. Big Tree 132kV
26. Mercury-Ferrum-Garona 400kV
27. Zeus-Perseus 765kV
28. Matimba B Integration Project
29. Caprivi 350kV DC (Namibia)
30. Gerus-Mururani Gate 350kV DC (Namibia)
31. Mmamabula 220kV (Botswana)

32. Steenberg-Der Brochen 132kV
33. Venetia-Paradise T 132kV
34. Burgersfort 132kV
35. Majuba-Umfolozi 765kV
36. Delta 765kV Substation
37. Braamhoek 22kV
38. Steelpoort Merensky 400kV
39. Mmamabula Delta 400kV
40. Delta Epsilon 765kV
41. Gerus-Zambezi 350kV DC Interconnector: Review of proposed avian mitigation measures for the Okavango and Kwando River crossings
42. Giyani 22kV Distribution line
43. Liqhobong-Kao 132/11kV distribution power line, Lesotho
44. 132kV Leslie – Wildebeest distribution line
45. A proposed new 50 kV Spoornet feeder line between Sishen and Saldanha
46. Cairns 132kv substation extension and associated power lines
47. Pimlico 132kv substation extension and associated power lines
48. Gyani 22kV
49. Matafin 132kV
50. Nkomazi_Fig Tree 132kV
51. Pebble Rock 132kV
52. Reddersburg 132kV
53. Thaba Combine 132kV
54. Nkomati 132kV
55. Louis Trichardt – Musina 132kV
56. Endicot 44kV
57. Apollo Lepini 400kV
58. Tarlton-Spring Farms 132kV
59. Kuschke 132kV substation
60. Bendstore 66kV Substation and associated lines
61. Kuiseb 400kV (Namibia)
62. Gyani-Malamulele 132kV
63. Watershed 132kV
64. Bakone 132kV substation
65. Eerstegoud 132kV LILO lines
66. Kumba Iron Ore: SWEP - Relocation of Infrastructure
67. Kudu Gas Power Station: Associated power lines
68. Steenberg Booysendal 132kV
69. Toulon Pumps 33kV
70. Thabatshipi 132kV
71. Witkop-Silica 132kV
72. Bakubung 132kV
73. Nelsriver 132kV
74. Rethabiseng 132kV
75. Tilburg 132kV
76. GaKgapane 66kV
77. Knobel Gilead 132kV
78. Bochum Knobel 132kV
79. Madibeng 132kV
80. Witbank Railway Line and associated infrastructure
81. Spencer NDP phase 2 (5 lines)
82. Akanani 132kV
83. Hermes-Dominion Reefs 132kV
84. Cape Pensinsula Strengthening Project 400kV
85. Magalakwena 132kV
86. Benficosa 132kV
87. Dithabaneng 132kV
88. Taunus Diepkloof 132kV
89. Taunus Doornkop 132kV
90. Tweedracht 132kV
91. Jane Furse 132kV
92. Majeje Sub 132kV

93. Tabor Louis Trichardt 132kV
94. Riversong 88kV
95. Mamatsekele 132kV
96. Kabokweni 132kV
97. MDPP 400kV Botswana
98. Marble Hall NDP 132kV
99. Bokmakiere 132kV Substation and LILO lines
100. Styldrift 132kV
101. Taunus – Diepkloof 132kV
102. Bighorn NDP 132kV
103. Waterkloof 88kV
104. Camden – Theta 765kV
105. Dhuva – Minerva 400kV Diversion
106. Lesedi –Grootpan 132kV
107. Waterberg NDP
108. Bulgerivier – Dorset 132kV
109. Bulgerivier – Toulon 132kV
110. Nokeng-Fluorspar 132kV
111. Mantsole 132kV
112. Tshilamba 132kV
113. Thabamoopo - Tshebela – Nhlovuko 132kV
114. Arthurseat 132kV
115. Borutho 132kV MTS
116. Volspruit - Potgietersrus 132kV
117. Neotel Optic Fibre Cable Installation Project: Western Cape
118. Matla-Glockner 400kV
119. Delmas North 44kV
120. Houwhoek 11kV Refurbishment
121. Clau-Clau 132kV
122. Ngwedi-Silwerkrans 134kV
123. Nieuwehoop 400kV walk-through
124. Booysendal 132kV Switching Station
125. Tarlton 132kV
126. Medupi - Witkop 400kV walk-through
127. Germiston Industries Substation
128. Sekgame 132kV
129. Botswana – South Africa 400kV Transfrontier Interconnector
130. Syferkuil – Rampheri 132kV
131. Queens Substation and associated 132kV powerlines
132. Oranjemond 400kV Transmission line
133. Aries – Helios – Juno walk-down
134. Kuruman Phase 1 and 2 Wind Energy facilities 132kV Grid connection
135. Transnet Thaba 132kV

Bird Impact Assessment Studies for the following residential and industrial developments:

1. Lizard Point Golf Estate
2. Lever Creek Estates
3. Leloko Lifestyle Estates
4. Vaaloewers Residential Development
5. Clearwater Estates Grass Owl Impact Study
6. Somerset Ext. Grass Owl Study
7. Proposed Three Diamonds Trading Mining Project (Portion 9 and 15 of the Farm Blesbokfontein)
8. N17 Section: Springs To Leandra –“Borrow Pit 12 And Access Road On (Section 9, 6 And 28 Of The Farm Winterhoek 314 Ir)
9. South African Police Services Gauteng Radio Communication System: Portion 136 Of The Farm 528 Jq, Lindley.
10. Report for the proposed upgrade and extension of the Zeekoegat Wastewater Treatment

Works, Gauteng.

11. Bird Impact Assessment for Portion 265 (a portion of Portion 163) of the farm Rietfontein 189-JR, Gauteng.
12. Bird Impact Assessment Study for Portions 54 and 55 of the Farm Zwartkop 525 JQ, Gauteng.
13. Bird Impact Assessment Study Portions 8 and 36 of the Farm Nooitgedacht 534 JQ, Gauteng.
14. Shumba's Rest Bird Impact Assessment Study
15. Randfontein Golf Estate Bird Impact Assessment Study
16. Zilkaatsnek Wildlife Estate
17. Regenstein Communications Tower (Namibia)
18. Avifaunal Input into Richards Bay Comparative Risk Assessment Study
19. Maquasa West Open Cast Coal Mine
20. Glen Erasmia Residential Development, Kempton Park, Gauteng
21. Bird Impact Assessment Study, Weltevreden Mine, Mpumalanga
22. Bird Impact Assessment Study, Olifantsvlei Cemetery, Johannesburg
23. Camden Ash Disposal Facility, Mpumalanga
24. Lindley Estate, Lanseria, Gauteng
25. Proposed open cast iron ore mine on the farm Lylyveld 545, Northern Cape
26. Avifaunal monitoring for the Sishen Mine in the Northern Cape as part of the EMPr requirements
27. Steelpoort CNC Bird Impact Assessment Study

Professional affiliations

I work under the supervision of and in association with Albert Froneman (MSc Conservation Biology) (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003.

Curriculum vitae: Albert Froneman

Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	MSc (Conservation
Biology) Nationality	:	South African
Years of experience	:	24 years

Key Qualifications

Albert Froneman (*Pr.Sci.Nat*) has more than two decades of experience in the management of avifaunal interactions with industrial infrastructure. He holds a M.Sc. degree in Conservation Biology from the University of Cape Town. He managed the Airports Company South Africa (ACSA) – Endangered Wildlife Trust Strategic Partnership from 1999 to 2008 which has been internationally recognized for its achievements in addressing airport wildlife hazards in an environmentally sensitive manner at ACSA's airports across South Africa. Albert is recognized worldwide as an expert in the field of bird hazard management on airports and has worked in South Africa, Swaziland, Botswana, Namibia, Kenya, Israel, and the USA. He has served as the vice chairman of the International Bird Strike Committee and has presented various papers at international conferences and workshops. At present he is consulting to ACSA with wildlife hazard management on all their airports. He also an accomplished specialist ornithological consultant outside the aviation industry and has completed a wide range of bird impact assessment studies. He has co-authored many avifaunal specialist studies and pre-construction monitoring reports for proposed renewable energy developments across South Africa. He also has vast experience in using Geographic Information Systems to analyse and interpret avifaunal data spatially and derive meaningful conclusions. Since 2009 Albert has been a registered Professional Natural Scientist (reg. nr 400177/09) with The South African Council for Natural Scientific Professions, specialising in Zoological Science.

Key Project Experience

Renewable Energy Facilities – avifaunal monitoring projects in association with Chris van Rooyen Consulting

1. Jeffrey's Bay Wind Farm – 12-months preconstruction avifaunal monitoring project
2. Oysterbay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
3. Ubuntu Wind Energy Project near Jeffrey's Bay – 12-months preconstruction avifaunal monitoring project
4. Bana-ba-Pifu Wind Energy Project near Humansdorp – 12-months preconstruction avifaunal monitoring project
5. Excelsior Wind Energy Project near Caledon – 12-months preconstruction avifaunal monitoring project
6. Laingsburg Spitskopvlakte Wind Energy Project – 12-months preconstruction avifaunal monitoring project
7. Loeriesfontein Wind Energy Project Phase 1, 2 & 3 – 12-months preconstruction avifaunal monitoring project
8. Noupoort Wind Energy Project – 12-months preconstruction avifaunal monitoring project
9. Vleesbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
10. Port Nolloth Wind Energy Project – 12-months preconstruction avifaunal monitoring project
11. Langhoogte Caledon Wind Energy Project – 12-months preconstruction avifaunal monitoring project
12. Lunsklip – Stilbaai Wind Energy Project – 12-months preconstruction avifaunal monitoring project
13. Indwe Wind Energy Project – 12-months preconstruction avifaunal monitoring project
14. Zeeland St Helena bay Wind Energy Project – 12-months preconstruction avifaunal monitoring project
15. Wolseley Wind Energy Project – 12-months preconstruction avifaunal monitoring project
16. Renosterberg Wind Energy Project – 12-months preconstruction avifaunal monitoring project

17. De Aar – North (Mulilo) Wind Energy Project – 12-months preconstruction avifaunal monitoring project (2014)
18. De Aar – South (Mulilo) Wind Energy Project – 12-months bird monitoring
19. Namies – Aggenys Wind Energy Project – 12-months bird monitoring
20. Pofadder - Wind Energy Project – 12-months bird monitoring
21. Dwarsrug Loeriesfontein - Wind Energy Project – 12-months bird monitoring
22. Waaihoek – Utrecht Wind Energy Project – 12-months bird monitoring
23. Amathole – Butterworth Wind Energy Project – 12-months bird monitoring & EIA specialist study
24. De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
25. Makambako Wind Energy Faclity (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
26. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
27. Aletta Wind Energy Facility 12-month bird monitoring (Biotherm)
28. Maralla Wind Energy Facility 12-month bird monitoring (Biotherm)
29. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
30. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
31. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
32. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
33. KurumanWind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
34. Mañhica Wind Energy Facility 12-month bird monitoring & EIA specialist study (Windlab)
35. Klipheuwel-Dassiefontein Wind Energy Facility, Caledon, Western Cape – Operational phase bird monitoring – Year 5 (Klipheuwel-Dassiefontein Wind Energy Facility)
36. Kwagga Wind Energy Facility, Beaufort West, 12-months pre-construction monitoring (ABO)
37. Pienaarspoort Wind Energy Facility, Touws River, Western Cape, 12-months pre-construction monitoring (ABO). Ujekamanzi and 2 Wind Energy Facilities, Beaufort West, Western Cape, 12 months pre-construction monitoring (Genesis Eco-energy)
38. Duiker Wind Energy Facility, Vredendal, Western Cape 12 months pre-construction monitoring (ABO)
39. Perdekraal East Wind Energy Facility, Touws River, Western Cape, 18 months construction phase monitoring (Mainstream).
40. Swellendam Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Veld Renewables)
41. Lombardskraal Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (Enertrag SA)
42. Mainstream Kolkies & Heuweltjies Wind Energy Facilities, Western Cape, 12-month pre- construction monitoring (Mainstream)
43. Great Karoo Wind Energy Facility, Northern Cape, 12-month pre-construction monitoring (African Green Ventures).
44. Mpumalanga & Gauteng Wind and Hybrid Energy Facilities (6x), pre-construction monitoring (Enertrag SA)
45. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (Enertrag SA)
46. Dordrecht Wind Energy Facilities, Eastern Cape, Screening Report (ACED)
47. Nanibees North & South Wind Energy Facilities, Northern Cape, Screening Report (juwi)
48. Kappa Solar PV facility, Touwsrivier, Western Cape, pre-construction monitoring (Veroniva)
49. Sutherland Wind Energy Facilities, Northern Cape, Screening Report (WKN Windcurrent)
50. Pofadder Wind Energy Facility, Northren Cape, Screening Report (Atlantic Energy)
51. Haga Haga Wind Energy Facility, Eastern Cape, Amendment Report (WKN Windcurrent)
52. Banken Wind Energy Facility, Northern Cape, Screening Report (Atlantic Energy)
53. Hartebeest Wind Energy Facility, Western Cape, 12-month pre-construction monitoring (juwi).
54. Iphiko Wind Energy facilities, Laingsburg, Western Cape, screening and pre- construction monitoring (G7 Energies)
55. Kangnas Wind Energy Facility, Northern Cape, Operational Phase 2 years

avifaunal monitoring (Mainstream)

56. Perdekraal East Wind Energy Facility, Northern Cape, Operational Phase 2 years avifaunal monitoring (Mainstream)
57. Aberdeen 1, 2 & Aberdeen Kudu (3&4) Wind Energy Facilities, Eastern Cape, 12- month pre-construction monitoring (Atlantic Renewable Energy Partners)
58. Loxton / Beaufort West Wind Energy Facilities, Northern Cape, 12-month pre- construction monitoring (Genesis Eco-Energy Developments)
59. Ermelo & Volksrust Wind Energy Facilities, Northern Cape, Screening Report (WKN Windcurrent)
60. Aardvark Solar PV facility, Copperton, Northern Cape, 12-month pre-construction monitoring (ABO)
61. Bestwood Solar PV facility, Kathu, Northern Cape, pre-construction monitoring (AMDA)
62. Boundary Solar PV facility, Kimberley, Northern Cape, Site sensitivity verification (Atlantic Renewable Energy Partners)
63. Excelsior Wind Energy Facility, Swellendam, Western Cape, Operational Phase 2 years avifaunal monitoring & implementation of Shut Down on Demand (SDOD) pro-active mitigation strategy (Biotherm)
64. De Aar cluster Solar PV facilities, De Aar, Western Cape, Site sensitivity verification (Atlantic Renewable Energy Partners)
65. Rinkhals Solar PV facilities, Kimberley, Northern Cape, Pre-construction monitoring (ABO)
66. Kolkies Sadawa Solar PV facilities, Touwsrivier, Western Cape, pre-construction monitoring (Mainstream)
67. Leeudoringstad Solar PV facilities, Leeudoringstad, North West, Pre-construction monitoring (Upgrade Energy)
68. Noupoort Umsobomvu Solar PV facilities, Noupoort, Northern Cape, Pre-construction monitoring (EDF Renewables)
69. Oya Solar PV facilities, Matjiesfontein, Western Cape, pre-construction monitoring (G7 Energies)
70. Scafell Solar PV facilities, Sasolburg, Free state, pre-construction monitoring (Mainstream)
71. Vrede & Rondawel Solar PV facilities, Kroonstad, Free state, pre-construction monitoring (Mainstream)
72. Gunstfontein Wind Energy Facilities, Sutherland, Northern Cape, additional pre- construction monitoring (ACED)
73. Ezelsjacht Wind Energy Facility, De Doorns, Western Cape, pre-construction monitoring (Mainstream)
74. Ujekamanzi Wind Energy Facility Phase 1, Fraserburg, Northern Cape, avifaunal screening (Ujekamanzi WEF)
75. Pofadder Wind Energy Facility, Pofadder, Northern Cape, pre-construction monitoring (Atlantic Renewable Energy Partners)

Bird Impact Assessment studies and / or GIS analysis:

1. Aviation Bird Hazard Assessment Study for the proposed Madiba Bay Leisure Park adjacent to Port Elizabeth Airport.
2. Extension of Runway and Provision of Parallel Taxiway at Sir Seretse Khama Airport, Botswana Bird / Wildlife Hazard Management Specialist Study
3. Maun Airport Improvements Bird / Wildlife Hazard Management Specialist Study
4. Bird Impact Assesment Study - Bird Helicopter Interaction – The Bitou River, Western Cape Province South Africa
5. Proposed La Mercy Airport – Bird Aircraft interaction specialists study using bird detection radar to assess swallow flocking behaviour
6. KwaZulu Natal Power Line Vulture Mitigation Project – GIS analysis
7. Perseus-Zeus Powerline EIA – GIS Analysis
8. Southern Region Pro-active GIS Blue Crane Collision Project.

9. Specialist advisor ~ Implementation of a bird detection radar system and development of an airport wildlife hazard management and operational environmental management plan for the King Shaka International Airport
10. Matsapha International Airport – bird hazard assessment study with management recommendations
11. Evaluation of aviation bird strike risk at candidate solid waste disposal sites in the Ekurhuleni Metropolitan Municipality
12. Gateway Airport Authority Limited – Gateway International Airport, Polokwane: Bird hazard assessment; Compile a bird hazard management plan for the airport
13. Bird Specialist Study - Evaluation of aviation bird strike risk at the Mwakirunge Landfill site near Mombasa Kenya
14. Bird Impact Assessment Study - Proposed Weltevreden Open Cast Coal Mine Belfast, Mpumalanga
15. Avian biodiversity assessment for the Mafube Colliery Coal mine near Middelburg Mpumalanga
16. Avifaunal Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
17. Avifaunal Impact Assessment Study (with specific reference to African Grass Owls and other Red List species) Stone Rivers Arch
18. Airport bird and wildlife hazard management plan and training to Swaziland Civil Aviation Authority (SWACAA) for Matsapha and Sikhupe International Airports.Bird Impact Assessment Study - Proposed 60 year Ash Disposal Facility near to the Kusile Power Station
19. Avifaunal pre-feasibility assessment for the proposed Montrose dam, Mpumalanga
20. Bird Impact Assessment Study – Proposed ESKOM Phantom Substation near Knysna, Western Cape
21. Habitat sensitivity map for Denham's Bustard, Blue Crane and White-bellied Korhaan in the Kouga Municipal area of the Eastern Cape Province
22. Swaziland Civil Aviation Authority – Sikhuphe International Airport – Bird hazard management assessment
23. Avifaunal monitoring – extension of Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
24. Avifaunal Specialist Study – Meerkat Hydro Electric Dam – Hope Town, Northern Cape
25. The Stewards Pan Reclamation Project – Bird Impact Assessment study
26. Airports Company South Africa – Avifaunal Specialist Consultant – Airport Bird and Wildlife Hazard Mitigation
27. Strategic Environmental Assessment For Gas Pipeline Development, CSIR
28. Avifaunal Specialist Assessment - Proposed monopole telecommunications mast – Roodekrans, Roodepoort, Gauteng (Enviroworks)
29. Gromis-Nama-Aggeneis 400kv Ipp Integration: Environmental Screening - Avifaunal Specialist Desktop Study
30. Melkspruit - Rouxville 132kV Distribution Line - Avifaunal Amendment and Walk-through Report
31. Gamma - Kappa 2nd 765kV transmission line – Avifaunal impact assessment GIS analysis

Geographic Information System analysis & maps

1. ESKOM Power line Makgalakwena EIA – GIS specialist & map production
2. ESKOM Power line Benficosa EIA – GIS specialist & map production
3. ESKOM Power line Riversong EIA – GIS specialist & map production
4. ESKOM Power line Waterberg NDP EIA – GIS specialist & map production
5. ESKOM Power line Bulge Toulon EIA – GIS specialist & map production
6. ESKOM Power line Bulge DORSET EIA – GIS specialist & map production
7. ESKOM Power lines Marblehall EIA – GIS specialist & map production
8. ESKOM Power line Grootpan Lesedi EIA – GIS specialist & map production
9. ESKOM Power line Tanga EIA – GIS specialist & map production
10. ESKOM Power line Bokmakierie EIA – GIS specialist & map production
11. ESKOM Power line Rietfontein EIA – GIS specialist & map production

12. Power line Anglo Coal EIA – GIS specialist & map production
13. ESKOM Power line Camcoll Jericho EIA – GIS specialist & map production
14. Hartbeespoort Residential Development – GIS specialist & map production
15. ESKOM Power line Mantsole EIA – GIS specialist & map production
16. ESKOM Power line Nokeng Flourspar EIA – GIS specialist & map production
17. ESKOM Power line Greenview EIA – GIS specialist & map production
18. Derdepoort Residential Development – GIS specialist & map production
19. ESKOM Power line Boynton EIA – GIS specialist & map production
20. ESKOM Power line United EIA – GIS specialist & map production
21. ESKOM Power line Gutshwa & Malelane EIA – GIS specialist & map production
22. ESKOM Power line Origstad EIA – GIS specialist & map production
23. Zilkaatsnek Development Public Participation –map production
24. Belfast – Paarde Power line - GIS specialist & map production
25. Solar Park Solar Park Integration Project Bird Impact Assessment Study – avifaunal GIS analysis.
26. Kappa-Omega-Aurora 765kV Bird Impact Assessment Report – Avifaunal GIS analysis.
27. Gamma – Kappa 2nd 765kV – Bird Impact Assessment Report – Avifaunal GIS analysis.
28. ESKOM Power line Kudu-Dorstfontein Amendment EIA – GIS specialist & map production.
29. Proposed Heilbron filling station EIA – GIS specialist & map production
30. ESKOM Lebatlhane EIA – GIS specialist & map production
31. ESKOM Pienaars River CNC EIA – GIS specialist & map production
32. ESKOM Lemara Phiring Ohrigstad EIA – GIS specialist & map production
33. ESKOM Pelly-Warmbad EIA – GIS specialist & map production
34. ESKOM Rosco-Bracken EIA –GIS specialist & map production
35. ESKOM Ermelo-Uitkoms EIA – GIS specialist & map production
36. ESKOM Wisani bridge EIA – GIS specialist & map productionCity of Tswane – New bulkfeeder pipeline projects x3 Map production
37. ESKOM Lebohang Substation and 132kV Distribution Power Line Project Amendment GIS specialist & map production
38. ESKOM Geluk Rural Powerline GIS & Mapping
39. Eskom Kimberley Strengthening Phase 4 Project GIS & Mapping
40. ESKOM Kwaggafontein - Amandla Amendment Project GIS & Mapping
41. ESKOM Lephalale CNC – GIS Specialist & Mapping
42. ESKOM Marken CNC – GIS Specialist & Mapping
43. ESKOM Lethabong substation and powerlines – GIS Specialist & Mapping
44. ESKOM Magopela- Pitsong 132kV line and new substation – GIS Specialist & Mapping
45. Vlakfontein Filling Station – GIS Specialist & Mapping - EIA
46. Prieska – Hoekplaas Solar PV & BESS - GIS Specialist & Mapping – EIA
47. Mulilo Total Hydra Storage (MTHS) De Aar - GIS Specialist & Mapping – EIA
48. Merensky Uchoba Powerline, Steelpoort - GIS Specialist & Mapping – EIA
49. Douglas Solar Part 2 Amendment – grid connection - GIS Specialist & Mapping – EIA

Professional affiliations

- South African Council for Natural Scientific Professions (SACNASP) registered Professional Natural Scientist (reg. nr 400177/09) – specialist field: Zoological Science. Registered since 2009.
- Southern African Wildlife Management Association - Member
- Zoological Society of South Africa - Member

APPENDIX 3: PRE-CONSTRUCTION MONITORING PROTOCOL

Objectives

The objective of the pre-construction monitoring at the proposed Ujekamanzi Wind Energy Facility WEF 1 and 2 was to gather baseline data over a period of four seasons on the following aspects pertaining to avifauna:

- The abundance and diversity of birds at the wind farm sites and a suitable control site to measure the potential displacement effect of the wind farm.
- Flight patterns of priority species at the wind farm sites to assess the potential collision risk with the turbines.

Methods

One set of guidelines are applicable to this wind facility:

- Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa.* Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa. Hereafter referred to as the wind guidelines.

The wind guidelines are applicable to all wind energy facilities which require environmental authorisation. The wind guidelines require a minimum of four site visits a year. Wind priority species were identified using the latest (November 2014) BirdLife SA (BLSA) list of priority species for wind farms. Red List species were identified from Taylor *et al.* (2015).

The monitoring surveys were conducted at the proposed WEF site and a control site by a team of monitors in the following time envelopes:

- Survey 1: 2 - 10 April 2022, 9 – 24 May 2022
- Survey 2: 4 July - 01 August 2022
- Survey 3: 5 – 27 September 2022
- Survey 4: 12 – 28 January 2023

Monitoring was conducted in the following manner:

- Two drive transects were identified totalling 19.5km and 20.4km respectively on the development site, and one drive transect in the control site with a total length of 14.6km.
- One or two monitors travelling slowly (± 10km/h) in a vehicle recorded all birds on both sides of the transect. The observer(s) stopped at regular intervals (every 500m) to scan the environment with binoculars. Drive transects were counted three times per sampling session.
- In addition, 14 walk transects of 1km each were identified at the development site, and two at the control site, and counted 4 times per sampling season. All birds were recorded during walk transects.
- The following variables were recorded:
    - Species
    - Number of birds
    - Date
    - Start time and end time
    - Estimated distance from transect
    - Wind direction

- Wind strength (estimated Beaufort scale)
  - Weather (sunny; cloudy; partly cloudy; rain; mist)
  - Temperature (cold; mild; warm; hot)
  - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground) and
  - Co-ordinates (priority species only)

The aim with drive transects is primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects are primarily aimed at recording small passerines. The objective of the transect monitoring is to gather baseline data on the use of the site by birds in order to measure potential displacement by the wind farm activities.

- Twenty-nine vantage points[7] (VPs) were identified from which the majority of the proposed development area can be observed, to record the flight altitude and patterns of priority species. One VP was also identified on the control site. The following variables were recorded for each flight:
  - Species
  - Number of birds
  - Date
  - Start time and end time
  - Wind direction
  - Wind strength (estimated Beaufort scale 1-7)
  - Weather (sunny; cloudy; partly cloudy; rain; mist)
  - Temperature (cold; mild; warm; hot)
  - Flight altitude (high i.e. >300m; medium i.e. 30m – 300m; low i.e. <30m)
  - Flight mode (soar; flap; glide; kite; hover) and
  - Flight time (in 15 second-intervals).

The objective of vantage point counts is to measure the potential collision risk with the turbines.

Ten potential focal points (FP) of bird activity have been identified thus far. The focal points are as follows:

- FP 1 - Pan
- FP 2 - Southern Bald Ibis 1 - roost
- FP 3 - Southern Bald Ibis 2 - colony 2 (Kalkoenkrans)
- FP 4 - Grey Crowned Crane roost 1 and heronry
- FP 5 - Pan
- FP 6 - Secretarybird nest N1
- FP 7 - Secretarybird nest N2
- FP 8 - Secretarybird roost R1
- FP 9 - Secretarybird roost R2
- FP 10 – Grey Crowned Crane roost 2
- FP 11 – Southern Bald Ibis 3 – roost / colony
- FP 12 – Martial Eagle nest
- FP 13 – Southern Bald Ibis feeding area
- FP 14 -- Southern Bald Ibis feeding roost
- FP 15 - Southern Bald Ibis feeding roost
- FP 16 – Grey Crowned Crane roost
- FP 17 – Secretarybird nest

[7] The VPs 19, 20, 21 and 25 were only utilised for Surveys 1 and 2 after which they were dropped due to a change in the project site area. VP 29 was only utilised for Survey 4 when 24 hours was done when the project site was changed at the last minute. An additional 24 hours will be completed for the final analysis of the data.

- FP18 - Secretarybird nest
- FP 19 – White Stork roost
- FP 20 – Grey Crowned Crane roost
- FP 21 – Grey Crowned Crane roost
- FP 22 – Secretarybird nest

See Figure 1 for a map of the transects, vantage points and focal points used for the monitoring.

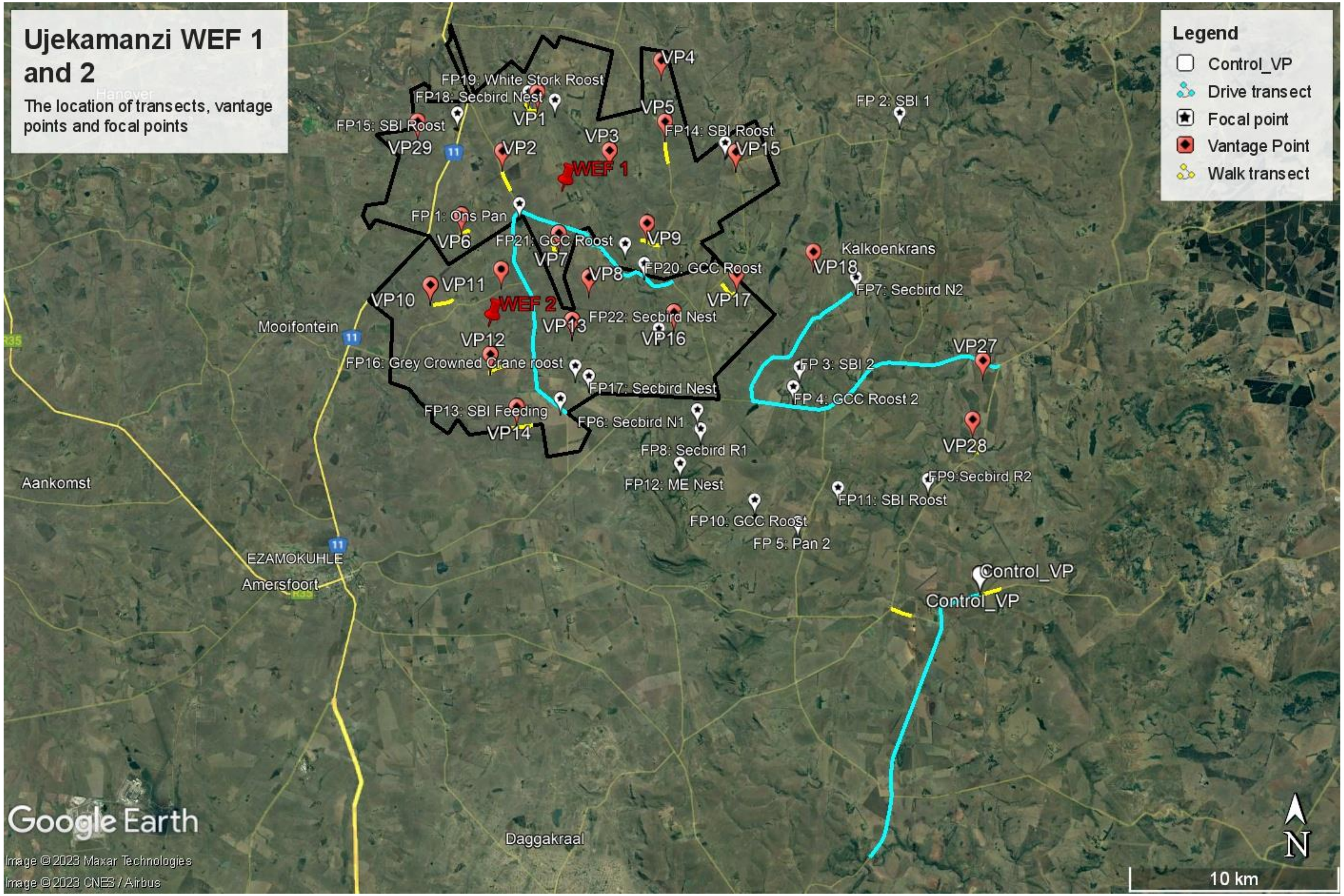


Figure 1: Area where monitoring is being implemented, with position of VPs, focal points, drive transects, walk transects and Ujekamanzi WEF 1 and 2. The control area is located approximately 14km south-east of the Ujekamanzi WEF 2 project site.

APPENDIX 4: BIRD HABITAT

Figure 1: Natural grassland

Figure 2: Drainage line and wetland

Figure 3: Farm dam (FP 15 Southern Bald Ibis roost)

Figure 4: Agriculture

Figure 5: High voltage lines

Figure 5: Alien trees

APPENDIX 5: SABAP2 SPECIES LIST FOR THE BROADER AREA

Species name	Scientific name	SABAP 2 full protocol reporting rate	SABAP 2 Ad hoc protocol reporting rate	Global status	SA status
African Black Duck	*Anas sparsa*	12.26	0.00	-	-
African Black Swift	*Apus barbatus*	1.92	1.22	-	-
African Darter	*Anhinga rufa*	23.75	2.63	-	-
African Fish Eagle	*Haliaeetus vocifer*	11.88	0.00	-	-
African Grass Owl	*Tyto capensis*	0.00	0.00	-	VU
African Harrier-Hawk	*Polyboroides typus*	7.66	10.53	-	-
African Hoopoe	*Upupa africana*	4.60	31.58	-	-
African Jacana	*Actophilornis africanus*	0.38	2.63	-	-
African Marsh Harrier	*Circus ranivorus*	1.53	2.63	-	EN
African Olive Pigeon	*Columba arquatrix*	1.15	7.89	-	-
African Palm Swift	*Cypsiurus parvus*	0.38	0.00	-	-
African Paradise Flycatcher	*Terpsiphone viridis*	4.98	2.63	-	-
African Pipit	*Anthus cinnamomeus*	79.31	5.26	-	-
African Rail	*Rallus caerulescens*	6.51	0.00	-	-
African Reed Warbler	*Acrocephalus baeticatus*	1.53	0.91	-	-
African Sacred Ibis	*Threskiornis aethiopicus*	58.24	5.26	-	-
African Snipe	*Gallinago nigripennis*	13.79	0.00	-	-
African Spoonbill	*Platalea alba*	26.82	0.00	-	-
African Stonechat	*Saxicola torquatus*	93.10	0.00	-	-
African Swamphen	*Porphyrio madagascariensis*	3.07	0.30	-	-
African Wattled Lapwing	*Vanellus senegallus*	26.05	0.00	-	-
African Yellow Warbler	*Iduna natalensis*	2.68	28.27	-	-
Alpine Swift	*Tachymarptis melba*	1.15	0.30	-	-
Amethyst Sunbird	*Chalcomitra amethystina*	1.92	5.78	-	-
Amur Falcon	*Falco amurensis*	21.84	13.16	-	-
Ant-eating Chat	*Myrmecocichla formicivora*	86.97	0.00	-	-
Banded Martin	*Riparia cincta*	34.48	0.00	-	-
Barn Swallow	*Hirundo rustica*	32.18	0.30	-	-
Bar-throated Apalis	*Apalis thoracica*	3.45	0.00	-	-
Black Crake	*Zapornia flavirostra*	6.51	0.00	-	-
Black Harrier	*Circus maurus*	0.38	0.00	EN	EN
Black Heron	*Egretta ardesiaca*	0.00	0.00	-	-
Black Saw-wing	*Psalidoprocne pristoptera*	0.38	0.00	-	-
Black Sparrowhawk	*Accipiter melanoleucus*	15.33	0.00	-	-
Black-bellied Bustard	*Lissotis melanogaster*	0.38	36.84	-	-
Black-chested Prinia	*Prinia flavicans*	6.51	0.00	-	-
Black-chested Snake Eagle	*Circaetus pectoralis*	1.53	2.63	-	-
Black-collared Barbet	*Lybius torquatus*	13.41	13.16	-	-
Black-crowned Night Heron	*Nycticorax nycticorax*	0.38	2.63	-	-
Black-headed Heron	*Ardea melanocephala*	57.85	0.00	-	-
Black-headed Oriole	*Oriolus larvatus*	5.75	2.63	-	-
Black-necked Grebe	*Podiceps nigricollis*	3.83	0.00	-	-
Black-rumped Buttonquail	*Turnix nanus*	1.15	18.42	-	EN

Species name	Scientific name	SABAP 2 full protocol reporting rate	SABAP 2 Ad hoc protocol reporting rate	Global status	SA status
Blacksmith Lapwing	*Vanellus armatus*	57.09	13.16	-	-
Black-throated Canary	*Crithagra atrogularis*	50.96	7.89	-	-
Black-winged Kite	*Elanus caeruleus*	63.22	10.53	-	-
Black-winged Lapwing	*Vanellus melanopterus*	18.01	13.16	-	-
Black-winged Pratincole	*Glareola nordmanni*	2.30	0.00	NT	NT
Black-winged Stilt	*Himantopus himantopus*	6.90	0.00	-	-
Blue Crane	*Grus paradisea*	26.82	5.26	VU	NT
Blue Korhaan	*Eupodotis caerulescens*	12.64	15.79	NT	LC
Blue-billed Teal	*Spatula hottentota*	1.15	3.95	-	-
Bokmakierie	*Telophorus zeylonus*	50.96	28.95	-	-
Botha's Lark	*Spizocorys fringillaris*	0.77	0.00	EN	EN
Brown Snake Eagle	*Circaetus cinereus*	0.38	5.26	-	-
Brown-hooded Kingfisher	*Halcyon albiventris*	0.00	0.00	-	-
Brown-throated Martin	*Riparia paludicola*	44.44	0.00	-	-
Buff-streaked Chat	*Campicoloides bifasciatus*	5.75	7.89	-	-
Buffy Pipit	*Anthus vaalensis*	0.00	0.00	-	-
Cape Bunting	*Emberiza capensis*	10.73	13.16	-	-
Cape Canary	*Serinus canicollis*	73.18	2.63	-	-
Cape Crow	*Corvus capensis*	55.56	2.63	-	-
Cape Grassbird	*Sphenoeacus afer*	18.39	2.63	-	-
Cape Longclaw	*Macronyx capensis*	89.66	0.00	-	-
Cape Robin-Chat	*Cossypha caffra*	37.93	0.00	-	-
Cape Rock Thrush	*Monticola rupestris*	0.38	0.30	-	-
Cape Shoveler	*Spatula smithii*	20.69	0.00	-	-
Cape Sparrow	*Passer melanurus*	76.25	0.00	-	-
Cape Starling	*Lamprotornis nitens*	9.96	0.00	-	-
Cape Teal	*Anas capensis*	0.38	0.61	-	-
Cape Turtle Dove	*Streptopelia capicola*	85.82	0.00	-	-
Cape Vulture	*Gyps coprotheres*	1.92	17.63	VU	EN
Cape Wagtail	*Motacilla capensis*	77.39	0.30	-	-
Cape Weaver	*Ploceus capensis*	34.48	0.00	-	-
Cape White-eye	*Zosterops virens*	21.07	3.04	-	-
Capped Wheatear	*Oenanthe pileata*	7.28	13.37	-	-
Cardinal Woodpecker	*Dendropicos fuscescens*	1.92	0.30	-	-
Cinnamon-breasted Bunting	*Emberiza tahapisi*	2.68	0.00	-	-
Cloud Cisticola	*Cisticola textrix*	17.24	18.42	-	-
Common Buttonquail	*Turnix sylvaticus*	0.38	7.89	-	-
Common Buzzard	*Buteo buteo*	24.52	36.84	-	-
Common Greenshank	*Tringa nebularia*	4.98	7.89	-	-
Common House Martin	*Delichon urbicum*	4.60	0.00	-	-
Common Moorhen	*Gallinula chloropus*	26.82	2.63	-	-
Common Myna	*Acridotheres tristis*	9.20	0.00	-	-
Common Ostrich	*Struthio camelus*	1.92	10.53	-	-
Common Quail	*Coturnix coturnix*	38.31	0.00	-	-
Common Sandpiper	*Actitis hypoleucos*	2.30	0.00	-	-
Common Swift	*Apus apus*	0.00	27.96	-	-

Species name	Scientific name	SABAP 2 full protocol reporting rate	SABAP 2 Ad hoc protocol reporting rate	Global status	SA status
Common Waxbill	*Estrilda astrild*	60.15	14.89	-	-
Crested Barbet	*Trachyphonus vaillantii*	1.92	10.53	-	-
Croaking Cisticola	*Cisticola natalensis*	0.38	26.32	-	-
Crowned Lapwing	*Vanellus coronatus*	57.85	10.53	-	-
Cuckoo Finch	*Anomalospiza imberbis*	1.15	5.26	-	-
Curlew Sandpiper	*Calidris ferruginea*	0.38	0.00	NT	LC
Dark-capped Bulbul	*Pycnonotus tricolor*	33.33	0.00	-	-
Denham's Bustard	*Neotis denhami*	5.36	2.63	NT	VU
Desert Cisticola	*Cisticola aridulus*	0.00	0.00	-	-
Diederik Cuckoo	*Chrysococcyx caprius*	18.39	0.00	-	-
Drakensberg Prinia	*Prinia hypoxantha*	12.26	0.00	-	-
Eastern Clapper Lark	*Mirafra fasciolata*	9.20	5.26	-	-
Eastern Long-billed Lark	*Certhilauda semitorquata*	4.98	0.00	-	-
Egyptian Goose	*Alopochen aegyptiaca*	85.82	2.63	-	-
European Bee-eater	*Merops apiaster*	0.00	31.58	-	-
Fairy Flycatcher	*Stenostira scita*	0.38	10.53	-	-
Fan-tailed Widowbird	*Euplectes axillaris*	30.27	3.04	-	-
Fiery-necked Nightjar	*Caprimulgus pectoralis*	0.38	0.00	-	-
Fiscal Flycatcher	*Melaenornis silens*	8.05	0.00	-	-
Fork-tailed Drongo	*Dicrurus adsimilis*	9.96	21.05	-	-
Fulvous Whistling Duck	*Dendrocygna bicolor*	0.77	0.00	-	-
Giant Kingfisher	*Megaceryle maxima*	6.90	2.63	-	-
Glossy Ibis	*Plegadis falcinellus*	8.43	0.00	-	-
Golden-breasted Bunting	*Emberiza flaviventris*	2.30	13.16	-	-
Golden-tailed Woodpecker	*Campethera abingoni*	0.00	0.00	-	-
Goliath Heron	*Ardea goliath*	4.21	0.00	-	-
Great Crested Grebe	*Podiceps cristatus*	4.98	0.00	-	-
Great Egret	*Ardea alba*	6.13	0.00	-	-
Great Reed Warbler	*Acrocephalus arundinaceus*	0.77	0.91	-	-
Greater Flamingo	*Phoenicopterus roseus*	2.30	23.68	-	NT
Greater Honeyguide	*Indicator indicator*	0.38	0.00	-	-
Greater Kestrel	*Falco rupicoloides*	0.77	7.89	-	-
Greater Striped Swallow	*Cecropis cucullata*	48.28	9.73	-	-
Green Wood Hoopoe	*Phoeniculus purpureus*	2.30	1.52	-	-
Grey Crowned Crane	*Balearica regulorum*	17.62	0.00	EN	EN
Grey Heron	*Ardea cinerea*	32.18	36.84	-	-
Grey-headed Gull	*Chroicocephalus cirrocephalus*	0.77	36.84	-	-
Grey-winged Francolin	*Scleroptila afra*	39.46	21.05	-	-
Ground Woodpecker	*Geocolaptes olivaceus*	0.77	0.00	NT	LC
Groundscraper Thrush	*Turdus litsitsirupa*	0.00	0.00	-	-
Hadada Ibis	*Bostrychia hagedash*	86.97	5.26	-	-
Hamerkop	*Scopus umbretta*	18.01	2.63	-	-
Helmeted Guineafowl	*Numida meleagris*	50.57	0.00	-	-
Horus Swift	*Apus horus*	1.53	1.22	-	-
House Sparrow	*Passer domesticus*	22.61	0.00	-	-
Intermediate Egret	*Ardea intermedia*	9.20	21.05	-	-

Species name	Scientific name	SABAP 2 full protocol reporting rate	SABAP 2 Ad hoc protocol reporting rate	Global status	SA status
Jackal Buzzard	*Buteo rufofuscus*	26.05	0.00	-	-
Karoo Thrush	*Turdus smithi*	3.45	0.30	-	-
Kittlitz's Plover	*Charadrius pecuarius*	5.75	0.00	-	-
Klaas's Cuckoo	*Chrysococcyx klaas*	0.00	13.16	-	-
Knob-billed Duck	*Sarkidiornis melanotos*	0.77	2.63	-	-
Kurrichane Thrush	*Turdus libonyana*	2.68	10.33	-	-
Lanner Falcon	*Falco biarmicus*	16.09	2.63	-	VU
Laughing Dove	*Spilopelia senegalensis*	27.20	0.00	-	-
Lazy Cisticola	*Cisticola aberrans*	3.07	5.26	-	-
Lesser Flamingo	*Phoeniconaias minor*	0.38	2.63	NT	NT
Lesser Grey Shrike	*Lanius minor*	0.38	0.00	-	-
Lesser Honeyguide	*Indicator minor*	0.77	0.00	-	-
Lesser Kestrel	*Falco naumanni*	0.00	0.00	-	-
Lesser Moorhen	*Paragallinula angulata*	0.00	21.05	-	-
Lesser Striped Swallow	*Cecropis abyssinica*	0.38	0.61	-	-
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	8.81	5.47	-	-
Levaillant's Cisticola	*Cisticola tinniens*	70.50	0.00	-	-
Lilac-breasted Roller	*Coracias caudatus*	0.00	0.00	-	-
Little Egret	*Egretta garzetta*	1.15	0.00	-	-
Little Grebe	*Tachybaptus ruficollis*	46.36	0.00	-	-
Little Rush Warbler	*Bradypterus baboecala*	4.60	0.00	-	-
Little Stint	*Calidris minuta*	2.30	0.00	-	-
Little Swift	*Apus affinis*	12.64	6.69	-	-
Long-billed Pipit	*Anthus similis*	0.38	2.63	-	-
Long-crested Eagle	*Lophaetus occipitalis*	2.68	10.53	-	-
Long-tailed Widowbird	*Euplectes progne*	86.21	1.22	-	-
Maccoa Duck	*Oxyura maccoa*	6.13	5.26	EN	NT
Malachite Kingfisher	*Corythornis cristatus*	10.34	10.53	-	-
Malachite Sunbird	*Nectarinia famosa*	8.81	2.74	-	-
Marsh Owl	*Asio capensis*	9.20	13.16	-	-
Marsh Sandpiper	*Tringa stagnatilis*	0.77	0.00	-	-
Martial Eagle	*Polemaetus bellicosus*	3.45	5.26	EN	EN
Montagu's Harrier	*Circus pygargus*	1.53	7.89	-	-
Mountain Wheatear	*Myrmecocichla monticola*	10.34	11.85	-	-
Namaqua Dove	*Oena capensis*	2.30	2.63	-	-
Neddicky	*Cisticola fulvicapilla*	2.30	0.00	-	-
Nicholson's Pipit	*Anthus nicholsoni*	1.53	0.00	-	-
Olive Thrush	*Turdus olivaceus*	0.38	3.95	-	-
Olive Woodpecker	*Dendropicos griseocephalus*	2.30	4.26	-	-
Orange-breasted Waxbill	*Amandava subflava*	9.96	4.56	-	-
Pale-crowned Cisticola	*Cisticola cinnamomeus*	20.31	0.00	-	-
Pallid Harrier	*Circus macrourus*	0.00	0.00	NT	NT
Pied Avocet	*Recurvirostra avosetta*	1.53	0.00	-	-
Pied Crow	*Corvus albus*	6.90	2.63	-	-
Pied Kingfisher	*Ceryle rudis*	12.64	0.00	-	-
Pied Starling	*Lamprotornis bicolor*	54.41	0.00	-	-

Species name	Scientific name	SABAP 2 full protocol reporting rate	SABAP 2 Ad hoc protocol reporting rate	Global status	SA status
Pink-billed Lark	*Spizocorys conirostris*	1.53	7.89	-	-
Pin-tailed Whydah	*Vidua macroura*	50.57	0.00	-	-
Plain-backed Pipit	*Anthus leucophrys*	1.15	0.00	-	-
Purple Heron	*Ardea purpurea*	6.51	2.63	-	-
Quailfinch	*Ortygospiza atricollis*	53.64	2.63	-	-
Red-backed Shrike	*Lanius collurio*	0.38	0.00	-	-
Red-billed Quelea	*Quelea quelea*	55.17	0.00	-	-
Red-billed Teal	*Anas erythrorhyncha*	22.99	0.00	-	-
Red-capped Lark	*Calandrella cinerea*	76.25	2.63	-	-
Red-chested Cuckoo	*Cuculus solitarius*	0.38	0.00	-	-
Red-chested Flufftail	*Sarothrura rufa*	1.15	2.63	-	-
Red-collared Widowbird	*Euplectes ardens*	6.51	16.72	-	-
Red-eyed Dove	*Streptopelia semitorquata*	58.24	36.84	-	-
Red-faced Mousebird	*Urocolius indicus*	1.92	0.00	-	-
Red-footed Falcon	*Falco vespertinus*	0.00	0.00	VU	NT
Red-headed Finch	*Amadina erythrocephala*	0.77	15.79	-	-
Red-knobbed Coot	*Fulica cristata*	71.65	10.53	-	-
Red-throated Wryneck	*Jynx ruficollis*	23.75	20.67	-	-
Red-winged Francolin	*Scleroptila levaillantii*	24.14	7.89	-	-
Red-winged Starling	*Onychognathus morio*	3.45	0.00	-	-
Reed Cormorant	*Microcarbo africanus*	63.60	0.00	-	-
Rock Dove	*Columba livia*	6.51	0.00	-	-
Rock Kestrel	*Falco rupicolus*	7.66	23.68	-	-
Rock Martin	*Ptyonoprogne fuligula*	8.81	0.00	-	-
Rudd's Lark	*Heteromirafra ruddi*	0.00	5.26	EN	EN
Ruff	*Calidris pugnax*	5.36	0.00	-	-
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	0.77	0.00	-	-
Rufous-naped Lark	*Mirafra africana*	1.15	2.63	-	-
Sand Martin	*Riparia riparia*	0.77	5.26	-	-
Secretarybird	*Sagittarius serpentarius*	29.50	2.63	EN	VU
Sentinel Rock Thrush	*Monticola explorator*	0.38	5.17	NT	LC
South African Cliff Swallow	*Petrochelidon spilodera*	42.15	6.99	-	-
South African Shelduck	*Tadorna cana*	49.04	0.00	-	-
Southern Bald Ibis	*Geronticus calvus*	43.68	0.00	VU	VU
Southern Black Flycatcher	*Melaenornis pammelaina*	0.38	2.63	-	-
Southern Boubou	*Laniarius ferrugineus*	8.81	2.63	-	-
Southern Fiscal	*Lanius collaris*	87.74	2.63	-	-
Southern Grey-headed Sparrow	*Passer diffusus*	62.45	0.00	-	-
Southern Masked Weaver	*Ploceus velatus*	84.29	9.12	-	-
Southern Pochard	*Netta erythrophthalma*	11.11	0.00	-	-
Southern Red Bishop	*Euplectes orix*	89.27	2.63	-	-
Speckled Mousebird	*Colius striatus*	14.94	2.63	-	-
Speckled Pigeon	*Columba guinea*	59.77	10.53	-	-
Spike-heeled Lark	*Chersomanes albofasciata*	61.69	2.63	-	-
Spotted Eagle-Owl	*Bubo africanus*	11.88	31.58	-	-
Spotted Flycatcher	*Muscicapa striata*	1.53	0.00	-	-

Species name	Scientific name	SABAP 2 full protocol reporting rate	SABAP 2 Ad hoc protocol reporting rate	Global status	SA status
Spotted Thick-knee	*Burhinus capensis*	16.48	1.52	-	-
Spur-winged Goose	*Plectropterus gambensis*	54.79	15.79	-	-
Squacco Heron	*Ardeola ralloides*	1.15	31.58	-	-
Streaky-headed Seedeater	*Crithagra gularis*	9.96	0.00	-	-
Swainson's Spurfowl	*Pternistis swainsonii*	65.13	0.00	-	-
Tawny-flanked Prinia	*Prinia subflava*	0.00	0.00	-	-
Three-banded Plover	*Charadrius tricollaris*	41.76	0.00	-	-
Village Weaver	*Ploceus cucullatus*	2.30	10.33	-	-
Wailing Cisticola	*Cisticola lais*	3.45	5.26	-	-
Western Barn Owl	*Tyto alba*	6.90	5.26	-	-
Western Cattle Egret	*Bubulcus ibis*	27.97	23.68	-	-
Western Osprey	*Pandion haliaetus*	0.38	10.53	-	-
Whiskered Tern	*Chlidonias hybrida*	14.18	0.61	-	-
White Stork	*Ciconia ciconia*	11.88	0.00	-	-
White-backed Duck	*Thalassornis leuconotus*	8.81	0.00	-	-
White-bellied Bustard	*Eupodotis senegalensis*	11.49	23.68	-	VU
White-bellied Sunbird	*Cinnyris talatala*	0.00	0.00	-	-
White-breasted Cormorant	*Phalacrocorax lucidus*	26.82	15.79	-	-
White-browed Sparrow-Weaver	*Plocepasser mahali*	0.77	0.00	-	-
White-rumped Swift	*Apus caffer*	25.67	0.30	-	-
White-throated Swallow	*Hirundo albigularis*	39.85	0.30	-	-
White-winged Tern	*Chlidonias leucopterus*	1.53	0.30	-	-
White-winged Widowbird	*Euplectes albonotatus*	0.00	2.13	-	-
Willow Warbler	*Phylloscopus trochilus*	1.92	0.30	-	-
Wing-snapping Cisticola	*Cisticola ayresii*	43.30	0.00	-	-
Wood Sandpiper	*Tringa glareola*	6.51	0.00	-	-
Yellow Bishop	*Euplectes capensis*	2.30	0.00	-	-
Yellow Canary	*Crithagra flaviventris*	7.28	2.63	-	-
Yellow-billed Duck	*Anas undulata*	68.20	0.00	-	-
Yellow-billed Kite	*Milvus aegyptius*	1.92	0.00	-	-
Yellow-billed Stork	*Mycteria ibis*	0.00	0.00	-	EN
Yellow-breasted Pipit	*Anthus chloris*	1.53	0.00	VU	VU
Yellow-crowned Bishop	*Euplectes afer*	37.16	13.16	-	-
Yellow-fronted Canary	*Crithagra mozambica*	4.98	10.53	-	-
Yellow-throated Bush Sparrow	*Gymnoris superciliaris*	0.00	0.00	-	-
Zitting Cisticola	*Cisticola juncidis*	37.93	0.00	-	-

APPENDIX 6: ASSESSMENT CRITERIA

1 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) METHODOLOGY

The Environmental Impact Assessment (EIA) Methodology assists in evaluating the overall effect of a proposed activity on the environment. Determining of the significance of an environmental impact on an environmental parameter is determined through a systematic analysis.

1.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale (i.e. site, local, national or global), whereas intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated as shown in **Table 1**.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

1.2 Impact Rating System

The impact assessment must take account of the nature, scale and duration of effects on the environment and whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the various project stages, as follows:

- Planning;
- Construction;
- Operation; and
- Decommissioning.

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

1.2.1 Rating System Used to Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the possible mitigation of the impact. Impacts have been consolidated into one (1) rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

Table 1: Rating of impacts criteria

ENVIRONMENTAL PARAMETER		
A brief description of the environmental aspect likely to be affected by the proposed activity (e.g. Surface Water).		
ISSUE / IMPACT / ENVIRONMENTAL EFFECT / NATURE		
Include a brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity (e.g. oil spill in surface water).		
EXTENT (E)		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY (P)		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY (R)		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES (L)		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION (D)		

This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity.		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
INTENSITY / MAGNITUDE (I / M)		
Describes the severity of an impact (i.e. whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily).		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
SIGNIFICANCE (S)		

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula: **Significance = (Extent + probability + reversibility + irreplaceability + duration) x magnitude/intensity.**

The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact Significance Rating	Description
5 to 23	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
5 to 23	Positive Low impact	The anticipated impact will have minor positive effects.
24 to 42	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
24 to 42	Positive Medium impact	The anticipated impact will have moderate positive effects.
43 to 61	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
43 to 61	Positive High impact	The anticipated impact will have significant positive effects.
62 to 80	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
62 to 80	Positive Very high impact	The anticipated impact will have highly significant positive effects.

APPENDIX 7: SITE SENSITIVITY VERIFICATION

RECONNAISSANCE REPORT (IN TERMS OF PART B OF THE ASSESSMENT PROTOCOLS PUBLISHED IN GN 320 ON 20 MARCH 2020 AND GN 43855 ON 30 OCTOBER 2020)

Introduction

In accordance with Appendix 6 of the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014, a reconnaissance visit has been undertaken in order to confirm the current land use and environmental sensitivity of the proposed project area as identified by the National Web-Based Environmental Screening Tool (Screening Tool).

Site Sensitivity Verification

The following methods and sources were used to compile this report:

The following methods and sources were used to compile this report:

- The **Project Area of Impact (PAOI)** of the proposed WEF was defined as an area comprising the proposed **Project Site** and a 4km buffer around the site which has an extent of approximately 44 000 hectares.
- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the University of Cape Town (https://sabap2.birdmap.africa/), as a means to ascertain which species occur within the **Broader Area** i.e. within a block consisting of 20 pentads. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2007 to date, a total of 261 full protocol lists (i.e. surveys lasting a minimum of two hours each) have been completed for this area. In addition, 329 ad hoc protocol lists (i.e. surveys lasting less than two hours but still yielding valuable data) have been completed.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (Taylor *et al.* 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the (2022.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- A classification of the vegetation in the WEF application site was obtained from the Atlas of Southern African Birds 1 (SABAP 1) (Harrison *et al.* 1997) and the National Vegetation Map (2018 beta2) from the South African National Biodiversity Institute website (Mucina & Rutherford 2006 & http://bgisviewer.sanbi.org).
- The Important Bird Areas of Southern Africa (Marnewick *et al.* 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).

- Satellite imagery (Google Earth ©2023) was used to view the broader area on a landscape level and to help identify sensitive bird habitat.
- Priority species for wind development were identified from the most recent (November 2014) list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012).
- The South African National Biodiversity BGIS map viewer was used to determine the locality of the proposed site relative to National Protected Areas.
- The DFFE National Screening Tool was used to determine the assigned avian sensitivity of the PAOI.
- The primary source of information on avifaunal diversity, abundance, and flight patterns at the site were the results of a pre-construction programme currently conducted over four seasons at the two proposed Ujekamanzi WEF application sites. The primary methods of data capturing are walk transect counts, drive transect counts, focal point monitoring, vantage point counts and incidental sightings (see Appendix 3 for a detailed explanation of the monitoring methods).

OUTCOME OF SITE RECOINASSANCE

Natural Environment

The PAOI is situated in the Grassland Biome, in the Mesic Highveld Grassland Bioregion (Muchina & Rutherford 2006). Vegetation on site consists predominantly of Amersfoort Highveld Clay Grassland and Wakkerstroom Montane Grassland. Amersfoort Highveld Clay Grassland is comprised of undulating grassland plains, with small, scattered patches of dolerite outcrops in areas, low hills, and pan depressions. The vegetation is comprised of a short, closed grassland cover, largely dominated by a dense *Themeda triandra* sward, often severely grazed to form a short lawn (Mucina & Rutherford 2006). Wakkerstroom Montane Grassland is more prevalent in the east of the Project Site and to the comprises predominantly short montane grasslands on the plateaus and the relatively flat areas, with short forest and *Leucosidea* thickets occurring along steep, mainly east facing slopes and drainage areas. The topography in the project area is characterised by gentle undulating plains. Numerous drainage lines with associated wetlands and farm dams transect the PAOI, and the most prominent river is the Vaal River which meanders through the north of the PAOI. Some of the drainage lines have steep banks and rocky outcrops with low cliffs in some places.

Amersfoort, which is the closest town to the Project Site has a temperate climate. Summers are mild and winters are cold. The mean annual rainfall is around 811mm, and the mean annual temperature is around 20C°. **Figure 1** shows the mean monthly temperature and precipitation of Amersfoort (https://tcktcktck.org/south-africa/mpumalanga/amersfoort#).

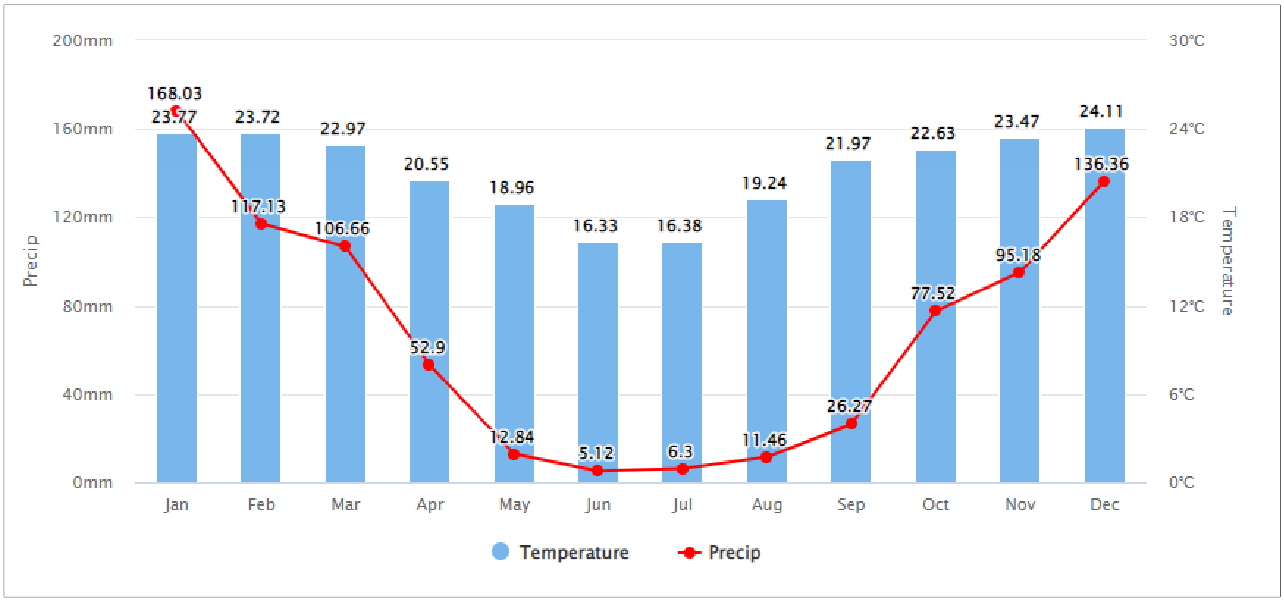


Figure 1: The mean monthly temperature and precipitation of Amersfoort.

Modified Environment

The predominant land use for this area is livestock grazing with some crop farming, mostly maize, soya beans and pastures.

Whilst the distribution and abundance of the bird species in the broader area are mostly associated with natural vegetation, as this comprises the majority of the habitat, it is also necessary to examine the few external modifications to the environment that have relevance for birds.

The following bird habitat features were identified in the project area (see Appendix 2 for examples of the habitat classes):

- **Grassland**

The majority of the habitat in the project area comprises natural grassland (Figure 2), which is mostly comprised of a short, closed grassland cover.

Figure 2: Grassland habitat in the PAOI.

The priority species which could potentially use the grassland in the PAOI on a regular basis are the following:

African Grass Owl
Amur Falcon
Black-rumped Buttonquail
Black-winged Kite
Black-winged Lapwing
Black-winged Pratincole
Blue Crane
Blue Korhaan
Common Buzzard
Denham's Bustard
Greater Kestrel
Grey-winged Francolin
Jackal Buzzard
Lanner Falcon
Long-crested Eagle
Marsh Owl
Martial Eagle
Montagu's Harrier
Pallid Harrier
Red-footed Falcon
Secretarybird
Southern Bald Ibis

Spotted Eagle-Owl
White Stork
White-bellied Bustard
Yellow-breasted Pipit

The priority species which could occasionally use the grassland in the PAOI are the following:

Black-bellied Bustard
Black-chested Snake Eagle
Botha's Lark
Brown Snake Eagle
Lesser Kestrel
Cape Vulture
Black Harrier
Rudd's Lark

- **Drainage lines and wetlands**

There are several wetlands in the PAOI, most of which are associated with drainage lines (Figure 3). Wetlands are characterised by static or slow flowing water and are extensively covered by tall emergent wetland vegetation.

Figure 3: Drainage Line in PAOI.

The priority species which could potentially use the wetlands in the PAOI on a regular basis are the following:

African Fish Eagle
African Grass Owl
African Marsh Harrier
Black-winged Pratincole
Blue Crane
Grey Crowned Crane
Long-crested Eagle
Marsh Owl
Yellow-billed Stork

The priority species which could occasionally use the wetlands in the PAOI are the following:

Black Harrier

- **Agricultural lands**

The PAOI contains a patchwork of agricultural fields (Figure 4). Some fields are lying fallow or are in the process of being re-vegetated by grass.

Figure 4: Crop field in PAOI.

The priority species which could potentially use the agricultural fields in the PAOI on a regular basis are the following:

Amur Falcon

Black-winged Kite
Black-winged Pratincole
Blue Crane
Common Buzzard
Grey Crowned Crane
Lanner Falcon
Red-footed Falcon
Southern Bald Ibis
White Stork

The priority species which could occasionally use the agricultural lands in the PAOI are the following:

Lesser Kestrel

- **Alien trees**

The PAOI contains few trees. Most trees are alien species, particularly Eucalyptus, Australian Acacia (Wattle), and Salix (Willow) species (Figure 5). Trees are often planted as wind breaks next to agricultural lands and around homesteads. Some of the drainage lines also have trees growing in them.

Figure 5: Alien trees in PAOI.

The priority species which could potentially use the alien trees in the PAOI on a regular basis are the following:

African Fish Eagle

African Harrier-Hawk
Amur Falcon
Black Sparrowhawk
Black-winged Kite
Common Buzzard
Greater Kestrel
Grey Crowned Crane
Jackal Buzzard
Lanner Falcon
Long-crested Eagle
Martial Eagle
Red-footed Falcon
Rufous-breasted Sparrowhawk
Secretarybird
Southern Bald Ibis
Spotted Eagle-Owl
White Stork

The priority species which could occasionally use the alien trees in the PAOI are the following:

Black-chested Snake Eagle
Brown Snake Eagle
Cape Vulture
Lesser Kestrel
Western Osprey

- **Dams**

There are many ground dams of various sizes at the PAOI (Figure 6), located in drainage lines.

Figure 6: Ground dam in PAOI.

The priority species which could potentially use the dams in the PAOI on a regular basis are the following:

African Fish Eagle
Blue Crane
Southern Bald Ibis
Yellow-billed Stork

The priority species which could occasionally use the dams and pans in the PAOI are the following:

Greater Flamingo
Lesser Flamingo
Western Osprey

- **High voltage lines**

The PAOI is transected by the two high voltage lines namely the Camden Incandu 1 and Camden Chivelston 2 400kV powerlines (Figure 7). Many birds use high voltage powerlines to roost on and occasionally even breed on them.

Figure 7: High voltage powerline at PAOI.

The priority species which could potentially use the high voltage lines in the PAOI on a regular basis are the following:

African Fish Eagle
Amur Falcon
Black-winged Kite
Common Buzzard
Greater Kestrel
Jackal Buzzard
Lanner Falcon
Long-crested Eagle
Martial Eagle
Red-footed Falcon
Southern Bald Ibis

The priority species which could occasionally use the high voltage lines in the PAOI are the following:

Black-chested Snake Eagle
Brown Snake Eagle
Cape Vulture
Lesser Kestrel

- **Low cliffs and rocky ridges**

There are a number of exposed ridges and low cliffs in the PAOI, often associated with the banks of drainage lines (Figure 8). These features are used by a number of priority species.

Figure 8: Low cliff at PAOI.

The priority species which could potentially use the rocky ridges and cliffs in the PAOI on a regular basis are the following:

African Harrier-Hawk
Buff-streaked Chat
Common Buzzard
Greater Kestrel
Jackal Buzzard
Lanner Falcon
Southern Bald Ibis
Spotted Eagle-Owl

The priority species which could occasionally use the rocky outcrops and low cliffs in the PAOI are the following:

Cape Vulture

Appendix 4 provides a photographic record of the habitat at the Project Site.

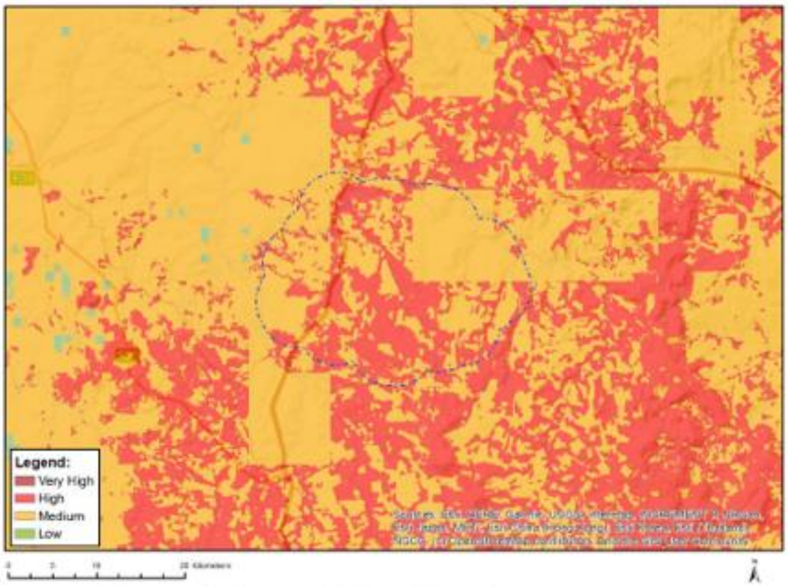
The DFFE National Screening Tool

In the case of the Animal Species theme, relevant to the proposed WEF, the project area is classified as **Medium and High** sensitivity, based on the potential presence of several species of conservation concern (SCC) namely Grey Crowned Crane (Globally and Regionally Endangered), Southern Bald Ibis (Globally and Regionally Vulnerable), White-bellied Bustard (Regionally Vulnerable), Denham's Bustard (Globally near threatened and Regionally Vulnerable) and Secretarybird (Globally Endangered and Regionally Vulnerable) (Figure 9). This classification was confirmed during the site surveys, based on the presence of recorded SCC:

- Secretarybird (Globally Endangered, Regionally Vulnerable)
- White-bellied Bustard (Regionally Vulnerable),
- Blue Crane (Globally Vulnerable, Regionally Near-threatened),
- Grey Crowned Crane (Globally and Regionally Endangered),
- Martial Eagle (Globally and Regionally Endangered),
- Lanner Falcon (Regionally Vulnerable),
- Black Harrier (Regionally and Globally Endangered),
- Southern Bald Ibis (Regionally and Globally Vulnerable),
- Blue Korhaan (Globally Near-threatened),
- African Grass Owl (Regionally Vulnerable),
- Rudd's Lark (Globally and Regionally Endangered),
- Yellow-billed Stork (Regionally Endangered),
- Yellow-breasted Pipit (Globally and Regionally Vulnerable),
- Black-winged Pratincole (Globally near threatened and Regionally Endangered),
- Black-rumped Buttonquail (Regionally Endangered),
- Pallid Harrier (Globally and Regionally near threatened),
- Red-footed Falcon (Globally Vulnerable and Regionally Near threatened) and
- Cape Vulture (Globally Vulnerable and Regionally Endangered).

See Figure 9 for the Screening Tool report.

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Neotis denhami
High	Aves-Balearica regulorum
High	Aves-Geronticus calvus
High	Aves-Sagittarius serpentarius
High	Aves-Eupodotis senegalensis
Medium	Aves-Hydroprogne caspia
Medium	Aves-Neotis denhami
Medium	Aves-Balearica regulorum
Medium	Aves-Sagittarius serpentarius
Medium	Aves-Geronticus calvus
Medium	Aves-Eupodotis senegalensis
Medium	Sensitive species 23
Medium	Aves-Circus ranivorus
Medium	Aves-Tyto capensis

Figure 9: The classification of the PAOI for avifauna according to the terrestrial animal species theme in the DFFE National Screening Tool. The classification of High in the Terrestrial Animal Species theme is linked to the potential presence of species of conservation concern (SCC), namely Denham's Bustard *Neotis denhami*, Grey Crowned Crane *Balearica regulorum*, Southern Bald Ibis *Geronticus calvus*, Secretarybird *Sagitarius serpentarius*, White-bellied *Bustard Eupodotis senegalensis.* The classification of Medium is linked to all of the above species and African Marsh Harrier *Circus ranivorus* and African Grass Owl *Tyto capensis.*

Conclusion

The PAOI contains confirmed habitat for species of conservation concern (SCC) as defined in the Protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial animal species (Government Gazette No 43855, 30 October 2020). The occurrence of SCC was confirmed during the integrated pre-construction monitoring programme. Based on the field surveys, a classification of **High** sensitivity for avifauna in the screening tool is suggested.

APPENDIX 8: BLADE PAINTING AS MITIGATION

Coloured-blade mitigation at Africa's wind farms to reduce eagle deaths: implementation, challenges and solutions

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Introduction

The recent publication of the ground-breaking experimental study of black-blade mitigation at an operational wind farms in Norway (May et al. 2020) has opened up a new and exciting method that could reduce avian fatalities at wind farms in other, more biologically diverse area of the world where renewable energies are being rolled out. This contribution :

- Explains what black/coloured-blade mitigation is
- Outlines the theory behind the black-blade mitigation
- Outlines the field test of the idea
- Summarises the challenges for rolling it out in Africa
- Assesses what it could mean for reducing raptor fatalities in Africa

Figure 1: The single black-blade in the process of being painted in situ, at the Smøla Wind Farm. Painting white blades black after they are erected is more expensive than producing them at source.

Rationale

Research around the world has shown that avian populations are declining due to climate change effects arising from increasing temperature and decreased rainfall in arid areas (www.ipcc.ch/, Thomas et al. 2004, Simmons et al. 2004, Phipps et al. 2017). In the USA, non-renewable fossil fuel energy sources are estimated to kill ~14.5 million birds annually, whereas green wind energy kills about 234 000 birds per year (Sovacool 2013, Loss et al. 2013). That is a 62-fold difference and a powerful environmental argument in support of renewable energy for our future needs. But while wind farms have many positive effects, they also pose some environmental challenges, particularly where wind farms are poorly positioned (on migration corridors for example Smallwood references).

In Africa two data sets on avian fatalities indicate that an average of 2.0 bird (adjusted) fatalities occur per MW per year in South Africa (Perold et al. 2020), and at one farm 1 raptor per month is killed of which 17% are breeding red data raptors (Simmons and Martins 2018). With about 2294 MW already being produced by 27 operational farms here in 2019 (energy.org.za), the cumulative impacts of South African wind farms alone are in excess of 4500 birds annually. If about 36% (>1600 birds per annum) are predicted to be raptors (Ralston-Paton et al. 2017) and about 17% (Simmons and Martins 2018) are known to be red data species, then an estimated 280 red data raptors are likely to be killed per year in South Africa in 2020. Since taller and longer-bladed turbines kill significantly more birds (Loss et al. 2013) and bats (Barclay et al. 2007) then Africa's threatened birds face increasing risks.

The need for urgent mitigations to reduce these costs is at a premium. Enter the coloured-blade mitigation.

What is coloured-blade mitigation?

This is a new mitigation technique in which one of the three white blades on a wind turbine are painted black (figure 1). About two thirds of the blade to the tip is painted this way. This is designed to increase visibility and decrease avian impacts (May et al. 2020). Since Civil Aviation in South Africa does not allow black but does allow "Signal Red" we propose that this is used in experiments here in South Africa. The amount of paint required can also be reduced by using the two-strip patterning shown in the experiments of McIsaac (see below).

Why black-blade mitigation?

Several innovative mitigation measures have recently been proposed for wind farms (flashing UV lights, automated shut-down-on demand, habitat management: May et al. 2017) and in a few cases have reduced collisions. However, developers are reticent to implement these.

The idea for **Black-blade mitigation** arose from work by Hodos (2003) who argued that a bird's retina views moving objects differently at different distances and as the bird gets close to a fast-moving object, the retinal image is moving so fast that the birds' brain can no longer process it. This was dubbed "motion smear" and means that birds approaching a fast-moving object no longer see it, with disastrous consequences. He suggested that a single coloured-blade may break up the motion smear. This is supported by recent work from Sweden (Potier et al. 2018) who show that raptors, despite their very high visual acuity, have very poor contrast abilities (poorer than humans). So, a coloured blade may be even better than a black one. So, a light (white) blade against a bright background is unlikely to be seen. But a black or coloured one is.

What is the evidence that it works?

Black-blade mitigation was field-tested by May et al. (2020) at the Smøla wind farm in 2013 in Norway over 3.5 years. On Smøla, White-tailed Eagles *Haliaeetus albicilla* are being killed at a very high rate by collision with the turbine blades. Four turbines were painted with a single black-painted blade in summer 2013. The black-painted turbines killed (i) 71% fewer total birds and (ii) 100% fewer eagles relative to unpainted blades.

Even more exciting in 2020 still no eagles have been killed at the coloured-blade turbines since 2013. In other words, no more eagles were killed in the 11-year experiment (starting 7.5 years before painting (2006-2013) and in situ 3.5 years after painting (2013-2016) (May et al.

2020). This despite 45-50 territorial pairs present on the island of Smøla (Dahl et al. 2012). The white-bladed turbines, however, are still killing birds at an average of 6 eagles per year (B. Iuell in litt.).

We see little reason why coloured blade – in the form of **Signal-red**, approved by Civil Aviation, would not work as well. This is because raptors see well in the colour spectrum (i.e. with the cones in the retina as opposed to the rods which see in black and white).

What are the visual impacts?

Discussions with wind farm managers in South Africa and Kenya suggest that visual effects are among the possible negative perceptions. We, therefore, requested the Smøla managers to supply us with images and videos of the turning blades to determine the effects.

Figure 1: The black-blade set up on a cloudy day in Norway is shown left. The black-blade (far turbine) is little different to the shadow cast by the all-white blades in the foreground © Bjorn Iuell.

The effect can be seen in the video kindly provided by Arild Soleim at www.birds-and-bats.com/specialist-studies. This shows little to no visual flicker or intrusion on the landscape from a single coloured-blade, and this concern is largely negated for all but the most sensitive human observer. It also has the effect of making the blade appear slower as one follows the black blade itself.

We argue that the benefits (no eagles killed) far outweigh the costs (initial costs to produce the coloured-blades). And once the blades are installed there will be no further costs as there are with competing mitigations (DT bird, or observer-operated shut-downs).

Black blade and Civil Aviation – white blades are not the most conspicuous

South African Civil Aviation state that white is "to provide the maximum daytime conspicuousness" However this statement was tested by McIsaac (2003) and he found that white is NOT the most conspicuous colour for either a moving blade or a stationary one

Embedded in the experiments undertaken by McIsaac's (2003) on kestrels is this very revealing graphic showing how human observers perceive the same patterns (including pure white).

Raptor Acuity and Wind-Turbine Blade Conspicuity

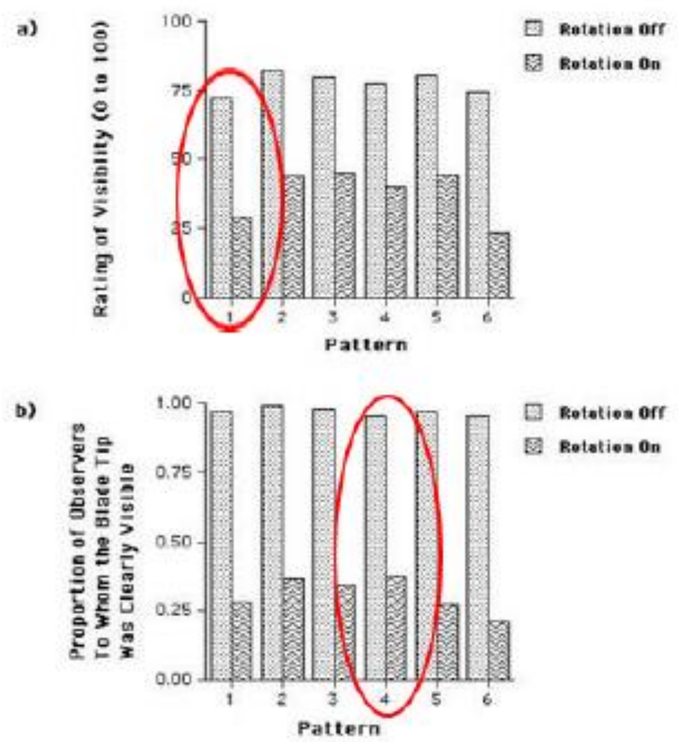

FIGURE 10. Human-perceived blade-pattern conspicuity: two-factor interactions of pattern and rotation. *These diagrams show the relationship between blade-pattern conspicuity and the effects of rotation. Illustrations of the blade patterns are presented in Fig. 9. Both blade pattern and rotation significantly affected conspicuity. Two ratings of pattern conspicuity are presented, a) full-blade visibility ratings, b) blade-tip visibility ratings.*

- **The pure white blade [pattern 1] was perceived as <u>less visible</u> by human observers than 5 of the other 6 patterns used whether the blades were spinning or not (top graph)**
- The <u>tip</u> of the pure white blade [pattern 1] was also perceived as less visible by human observers than 4 of the other 6 patterns used whether the blades were spinning or not (bottom graph)
- Like the Kestrels being tested, human observers saw patterned blades (patterns 2,3,4,5,6) better than pure white [pattern 1].

So, the CAA assumption that white is the most conspicuous colour for humans is not supported by experimentation with either raptorial birds or humans.

Patterned blades are better for both humans and raptors.

It is very important the South African Civil Aviation Authority is aware of these findings. Why? Because their guiding documents on painting of tall structures (**139.01.30 OBSTACLE LIMITATIONS AND MARKINGS OUTSIDE AERODROME OR HELIPORT (effective 1 August 2012)**) makes the following statement under section in **1.14. Wind turbine generators (Windfarms)**

- (4) Windfarm Markings (page 12 of 16)
  Wind turbines shall be painted bright white to provide the maximum daytime conspicuousness. The colours grey, blue and darker shades of white should be avoided altogether. If such colours have been used, the wind turbines shall be supplemented with daytime lighting, as required.

While this assumption that "bright white" would be most obvious to pilots and others, the experiments of McIsaac (2001) indicate that this is a false assumption. The pure white blade performed very poorly in the experiments of McIsaac (2001) and the patterned blade (No. 4 below) performed best of all.

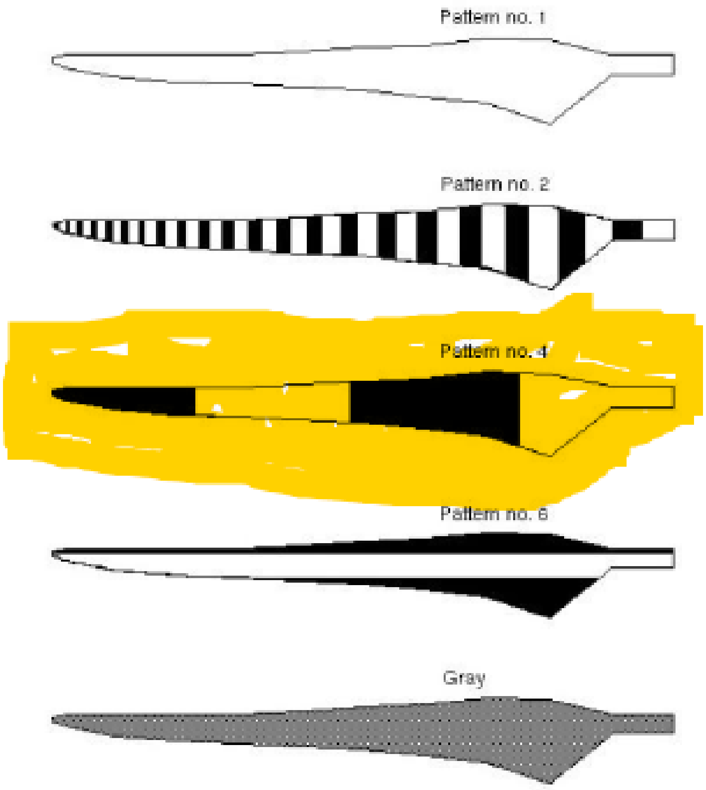

FIGURE 12. Kestrel-perceived blade-pattern conspicuity: stimulus blade patterns. *Depicted are the four black-and-white test patterns and the gray control pattern that were used to determine pattern conspicuity as perceived by a kestrel.*

Can it be applied in an African setting?

Given that eagles and raptors the world over probably see the landscape in similar ways there is a high probability that African eagles will see coloured-blades similarly well. Recent research on other raptors shows that despite their high visual acuity they see contrast more poorly than do humans (Potier, Milbus & Kelber 2019). This nicely explains why raptors take no avoiding action and are struck by white blades in the first place, and second why painting a blade black (increasing the contrast) increases the avoidance of those blades by eagles.

It also breaks up the "motion smear" researched by Hodos (2003) because he predicted a single black or coloured blade would increase the ability of birds to see movement in a set of fast-moving blade (the same effect can be seen by pilots of prop-driven planes, where one blade is painted differently). In an African setting the same can be seen on farmers' metal windmills where a blade is missing or painted on the rapidly spinning blades. Both increase the visual contrast and effect of movement.

The coloured-blade mitigation has yet to be rolled out in Africa – where it is urgently needed, given that we have over 100 species of raptors – more than any other continent (Clark and Davies 2018). Red blade tips have, however, already been used at the Ysterfontein Wind farm in the Western Cape, setting a precedent for their use elsewhere in South Africa.

Figure 2: Red-tipped turbine-blades on turbines at the Ysterfontein wind farm north west of Clanwilliam in the Western Cape (S 32° 9'23.42" E 18°49'7.10"). While these mitigations are not used in the correct single-blade configuration used by the Norwegians, they set a precedent for turbine blades to be red-painted in South Africa © RE Simmons

We have been informed that this mitigation is indeed being rolled out at the Kobe wind farm site in Japan. And there are plans for testing it in the Netherlands (Arjen Schultinga of Innogy, to Iuell Bjorn, Senior Environmental Advisor at Smøla Wind farm.)

This suggests that General Electric Renewables (GE), a manufacture of wind turbine blades, are already in the market for coloured blades. Attempts to engage with GE Renewables through the internet have proven unsuccessful despite contact with officials there.

We as avian specialist recommend the coloured-blade version of the black blade mitigation because (i) it is likely to be seen even more clearly by raptors than black, (ii) South African Civil Aviation (Lizell Stroh) in correspondence with Birdlife SA and Birds & Bats Unlimited have suggested that "signal red" would be preferable to black as it already used for marking structures such as towers, and is approved by them and (iii) the red paint may heat up less than a black blade in an African environment.

Four more aspects to consider from experience at the Smøla wind farm:

(i) It will cost a fraction to paint while the rotor blades are still on the ground instead of installed at the hub. At Smøla the painting was done with the blades up on the tower in situ and proved quite costly. The cost of painting one blade (with the crane lift and specialised personnel) was K55,000 ($5900). For all four blades and all fees and disbursements included over 2 weeks (due mainly to inclement weather) the total cost was c. K750 000 ($79 000). This would have been negligible had the blades been painted on the ground or come pre-painted (B. Iuell pers comm).

(ii) Although not an issue at Smøla, potentially a black blade may increase the blade temperature with potential consequences for blade quality and operation. We noticed that the temperature in the turbine tower at ground level with a painted tower base was high in summer (Stokke et al. 2020); there the surface area is large and more localized, and, of course, is not moving. No such effect was noticed for the black-painted turbine blades and there was no effect of any imbalance of the blades from differential heating of the black blade.

(iii) Smøla wind farm was not allowed to paint turbines which were constructed in the second construction stage due to insurance issues. Thus, guarantees with the blade manufacturers must be secured before the painting takes places – and preferably come pre-manufactured with a blade already painted red or black.

(iv) Each blade weighed 9 tonnes and the blade were painted with Carboline Windmastic TopCoat HSX. Two coats were applied and weighed approximately 60 kg. This is about 0.66% the weight of the blade and no mechanical effects were apparent. On inspection of the paint there was no wear or cracking apparent (B Iuell pers comm).

It is for influential players such as those in the South African Wind Energy Association and other wind farm developers, their governing bodies and avian conservation organisations to lobby the main players such as General Electric and Siemens to roll out this form of mitigation to reduce to a minimum the thousands of raptors deaths likely in future years. Without black or coloured blades on Africa's turbines we will continue to see the high fatality rates already apparent at some wind farms in South Africa (Simmons and Martins 2018, Perold et al. 2020).

With black-blade mitigation now shown to be highly effective in reducing eagle deaths in Norway, there is a great incentive for wind farm developers elsewhere to enact the coloured blade mitigation to reduce raptor deaths, particularly since it has no operational costs once installed.

Acknowledgments

Grateful thanks to Bjorn Iuell (Environmental Advisor to Smøla wind farm) for answering our numerous questions and providing extra information and photographs on Smøla's black blade project. Also to Arild Soleim at Smøla for the video clip of the moving blades, and to Lizell Stroh of SA Civil Aviation for valuable inputs.

Figure 3: A 4-year old Martial Eagle, struck by a white-bladed turbine, plummets to the earth at an Eastern Cape wind farm. Deaths like this could be reduced or avoided with black/coloured blade mitigation . © RE Simmons

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APPENDIX 9: MODELLING METHODOLOGY

1 Methodology used for the modelling of high-risk flight activity

1.1 Environmental variables

The aim of the avian risk modelling was to assess if any associations existed between observed risky flight behaviour (i.e. flights within rotor sweep height) and underlying environmental and habitat conditions. A range of variables were therefore generated to characterise the environment within the area of interest. Subsequently, predictor variables were generated related to various aspects of topography, hydrology/drainage, vegetation (type and state). The processes used to characterise the underlying environment related to topography, vegetation and hydrology followed the approaches used successfully in assessing habitat associations and suitability in previous avian studies (Colyn et al. 2020a; Colyn et al. 2020b; Colyn et al. 2020c).

Topographical variables characterised slope, aspect, elevational change, solar radiation, and ruggedness (Riley et al. 1999). Drainage specifically characterized the presence and magnitude of drainage lines using a hydrology workflow (Djokic et al. 2011). Habitat and vegetation were characterized using a range of remote sensing indices generated from Sentinel-2 imagery (Copernicus 2023). Indices included seasonal (winter and summer) and annual averages (2020-2023) of respective indices, as well as dynamic habitat variables (cumulative productivity, variation in productivity, and minimum productivity). Lastly, if any nest, colony and/or roost sites were identified by observers for any of the species being assessed, these were used to create an additional predictor variable, namely distance (m) to nest/colony/roost site.

1.2 Multi-scale data processing

Johnson (1980) established the conceptual hierarchical framework of multi-scale habitat selection analysis, whereby scales were tiered from the landscape scale through to the local patch selected for resources (McGarigal et al. 2016). We implemented a multi-scale approach within this study using four hierarchal tiers ranging from the discrete observation (0m, local habitat patch) through to a macro level scale (1km, landscape). Multi-scale analysis is noted to represent the dynamic process of habitat selection and response by species more efficiently.

1.3 Data analysis

Avian risk modelling was conducted in the statistical platform R (R Core Team 2021) using a classification machine learning approach. Data used to train models were derived from vantage point surveys collected across the area of interest across four iterations of monitoring. Flight data recorded by observers included species, number of birds, duration of flight, flight height, flight behaviour/type, flight track ID, date, and time. In addition to these data being recorded in-situ by observers, associated flight tracks were mapped and digitized. Flight tracks and associated data were analysed and joined using Python and R workflows. The primary aim of this assessment was to assess the environmental factors that influenced risky flight behaviour, i.e., flights recorded within the rotor swept area. Subsequently, a training dataset was generated from the vantage point observational dataset by filtering by species and flight height (those flight tracks within rotor sweep height).

Variable importance was calculated and plotted in R, which together with an associated stepwise variable selection process facilitated predictor variable selection. The stepwise selection process measures which variables are used more numerously and contribute more to predictive performance. This process, together with assessing the correlation coefficients within the resulting predictor variables, accounted for spatial autocorrelation across predictor variables by dropping highly correlated variables. Depending on the dataset size, our workflow utilises an Artificial Neural Network (ANN) or alternatively a decision tree algorithm. Both algorithms are noted as being well suited and capable of capturing non-linear relationships between input features and output labels, making them suitable for complex classification problems. More specifically, the ANN algorithm was noted to outperform alternative approaches in predicting habitat selection and association (Ozesmi and Qzesmi 1999; Lin et al. 2021). Models were trained on an 80% data partition, with 20% maintained as an independent test dataset used to test model performance.

Model performance was assessed using the Receiver-operating characteristic (ROC) and associated area under the curve (AUC-ROC) value (Freeman and Moisen 2008). ROC plots compare the true positive and false positive rates and are commonly used as a metric of model performance in classification studies (Jimenez-Valverde 2012; Sofaer et al. 2018). Threshold selection assesses the relationship between the predicted and observed values to generate thresholds that can be used to convert model outputs from a continuous format to a binary one. We classed the continuous probabilistic model output into classes using threshold selection processes. Classed outputs were then compared to that of actual observed vantage point data to determine the quantity of risky flights encompassed by each respective class.

2 Results

2.1 Grey Crowned Crane

Grey Crowned Crane represented the smallest flight tack dataset of the species' assessed. Modelled results suggested that the presence of agricultural fields with a certain productivity score (mean productivity index = 0.5) and within a certain distance of areas of drainage (wetlands, pans, etc.) with low terrain ruggedness increased the probability of risky flights (Figure 1). ROC plot analysis yielded a final AUC model evaluation score of 0.93, suggesting good model fit given the limited dataset size. Given this flight risk was strongly associated with agricultural fields which fluctuate in productivity seasonally, the respective risk could be assumed to fluctuate seasonally based on the productivity/state of these agricultural habitats.

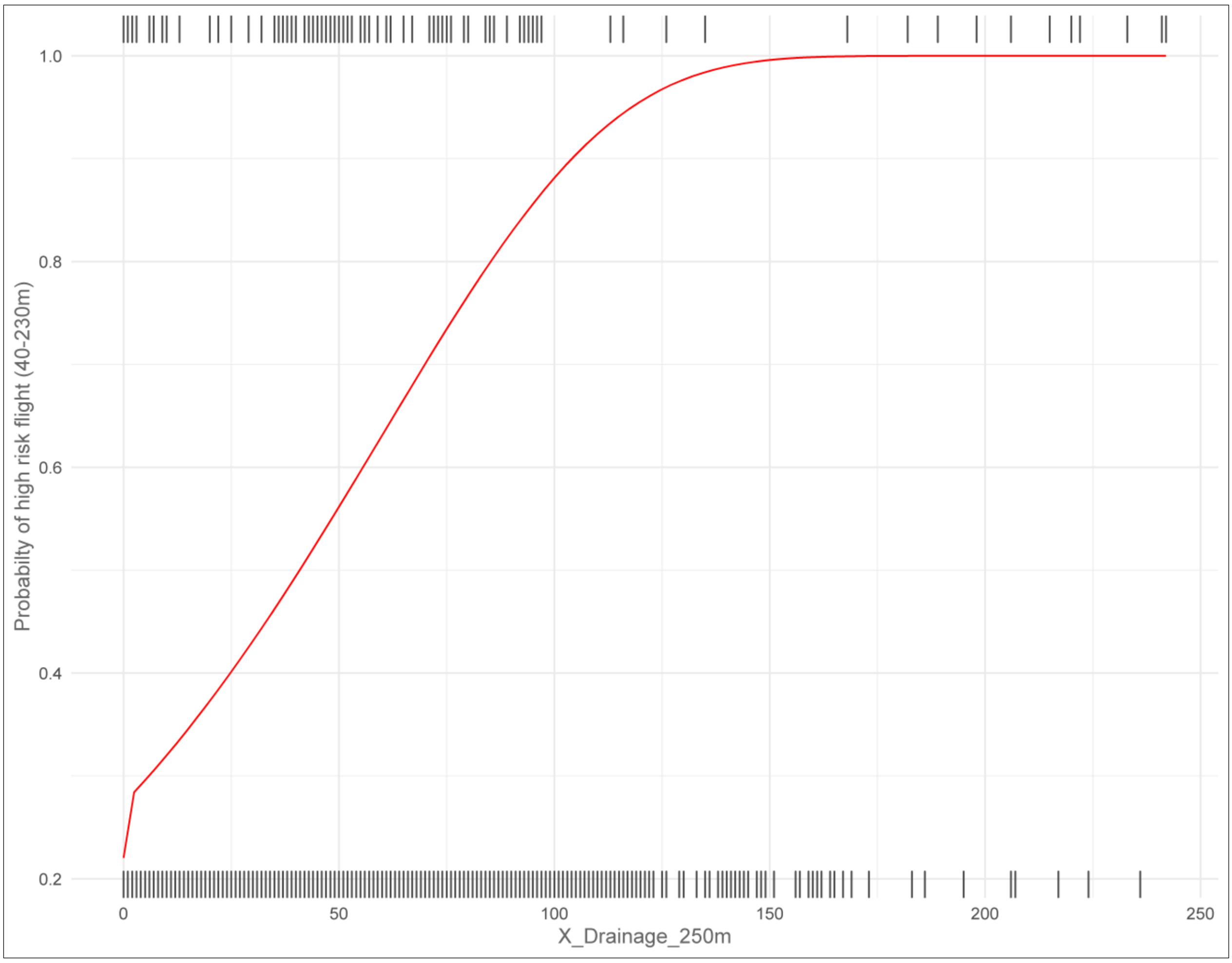

Figure 13: The partial dependence plot for Grey Crowned Crane displaying the influence that drainage (on a 250m spatial scale) had on the probability of high-risk flight.

2.2 Secretarybird

The final Secretarybird flight dataset included 23.3 bird minutes within the high-risk flight height class. Variable importance from the final trained model suggested that distance (m) to known nest site was the strongest variable influencing predictive performance. Modelled results suggested that flight risk was highest within 1.5 km from a nest site (Figure 2) where terrain was more rugged, with more pronounced slopes that were dominated by productive grassland habitat (mean productivity index = 2.4). An AUC score of 0.89 was generated from the independent test dataset for the final trained model, suggesting good model fit.

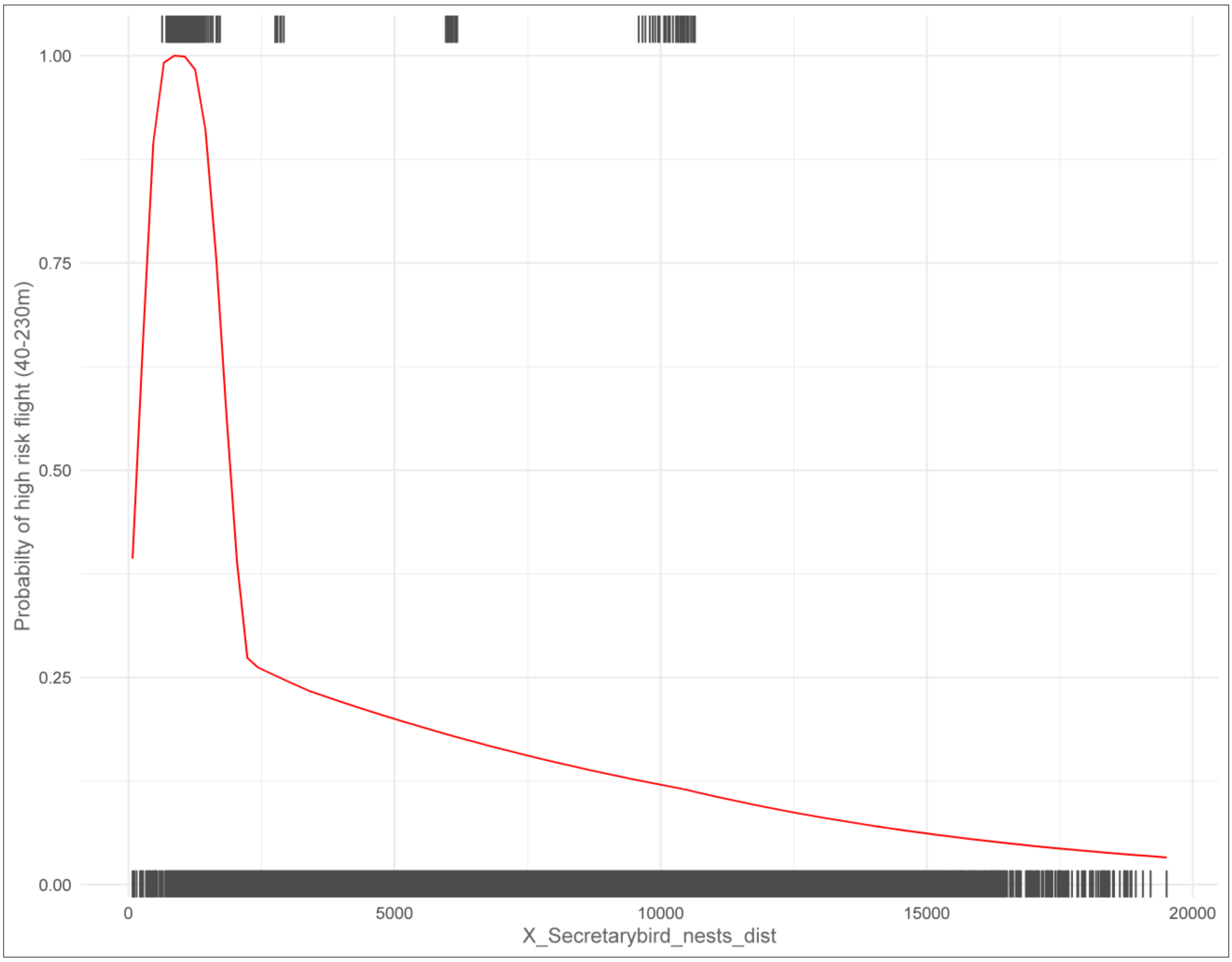

Figure 14: The partial dependence plot for Secretarybird displaying the influence that distance from known nest site had on the probability of high-risk flight.

The final Secretarybrid model was classed into 9 discrete classes using threshold selection processes (Figure 3).

Of the total 23 bird minutes recorded for Secretarybird, only a portion were observed surrounding known nest sites, with multiple flights being recorded on the periphery of the area of interest. These disjunct flight tracks could potentially represent flights of resident pairs outside the area of interest or alternatively represent floating/transient individuals. Subsequently, selecting all high-risk flight tracks within 5km of all known/observed nests sites based on the noted average inter-nest distance within grasslands (10km; Kemp 1999), yielded a total of 10 bird minutes (43%) surrounding known nests sites. These high-risk flight data associated with known nest sites was then compared to the classed modelled output to understand how varied classes accommodated known/recorded high-risk flights surrounding known nest sites. Subsequently, medium sensitivity was defined as classes incorporating 99% of known high-risk flights recorded, which corresponded to class 5 and higher for Secretarybird. Similarly, high sensitivity was classified as the core 96% (class $\geq$ 7) of high-risk flights recorded for Secretarybird. This high sensitivity class directly incorporated the areas deemed most probably of influencing high risk flights and such included those flights closest to known nest sites (generally within 1.5km). Two observed flight tracks that incorporated extended flight durations (minutes) were recorded at extensive distances from known nest sites and as such were not accommodated by the higher modelled classes in our final model given the high importance that distance to nest site yielded on predicted flight risk. If new nest sites are found, particularly in areas containing these disjunct flight tracks, the predicted flight risk surrounding these areas will change/increase.

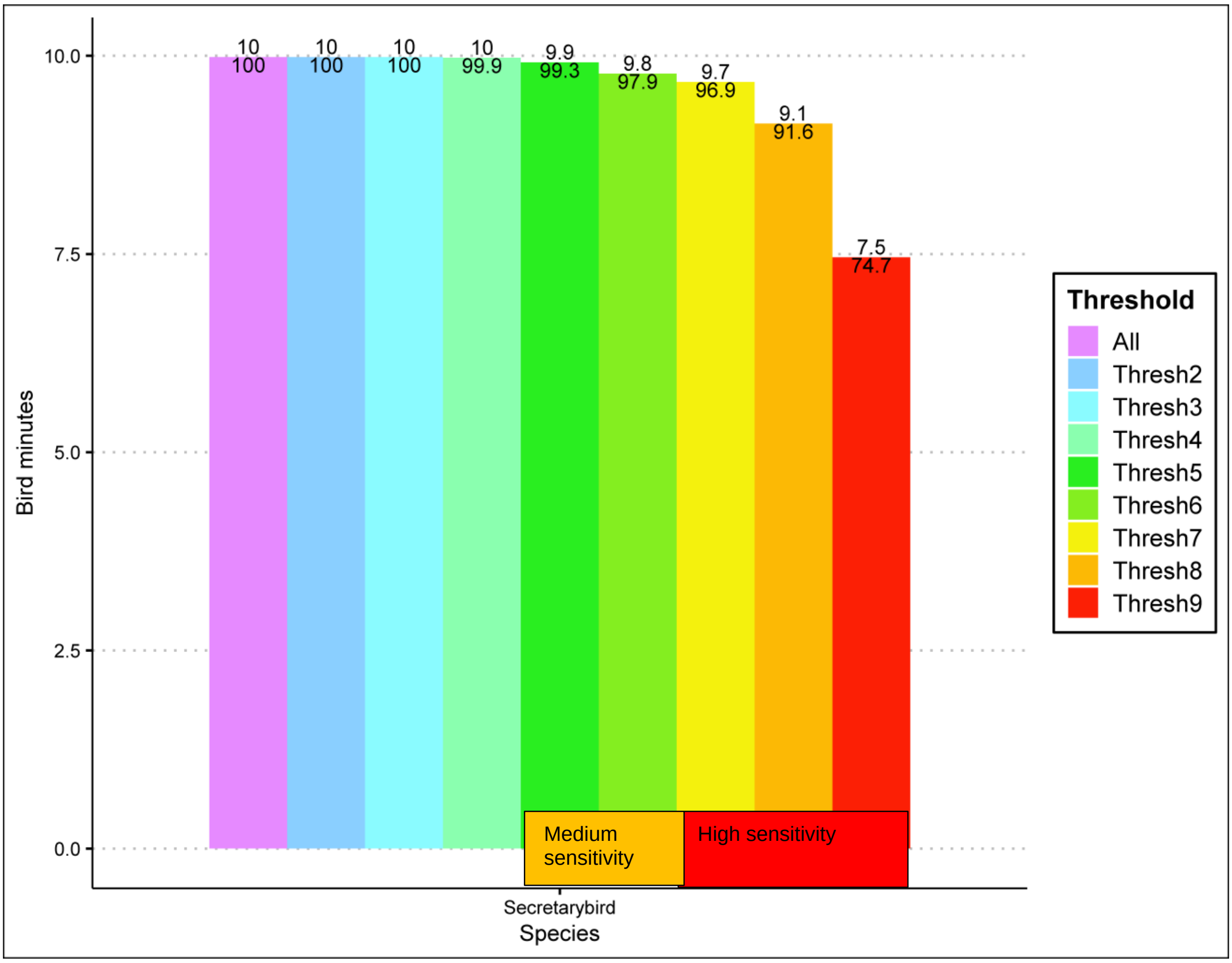

Figure 15: The final Secretarybird model classed into 9 classes, with associated known risky flight data surrounding nest sites represented across the respective classes. Each class incorporates a certain proportion of the overall risky bird minutes recorded. Total bird minutes incorporated by a respective class is annotated above bars, whilst the associated percentage (bird minutes incorporated/total bird minutes recorded) is annotated below bars.

2.3 Southern Bald Ibis

The final Southern Bald Ibis flight dataset included 847.5 bird minutes within the risky flight height class. Variable importance from the trained model suggested that distance to known colony and roost sites was the strongest variable influencing model predictive performance. Modelled results suggested that flight risk was highest within 2 km from a nest site, but could extend beyond this across certain habitat and topographical conditions. Areas of greater elevational drop-off and terrain ruggedness increased the probability of risky flight, particularly across habitats with higher seasonal variation in annual productivity, including grasslands and certain agricultural land cover types (pastures, livestock fodder/green crops, etc.). An AUC score of 0.92 was generated from the independent test dataset for the final trained model, suggesting good model fit.

The final Southern Bald Ibis model was classed into 9 discrete classes using threshold selection processes (Figure 5). All recorded risky flight data was then compared to this output to understand how varied classes accommodated known/recorded risky flights. Medium sensitivity was defined as classes incorporating 87% of known risk flights recorded, which corresponded to class 4 and higher for Southern Bald Ibis. Similarly, high sensitivity was classified as the core 75% of high-risk flights recorded for Southern Bald Ibis. The high sensitivity class directly incorporated the areas deemed most probably of influencing high risk flights and such included those flights closest to know colony and roost sites with a certain array of underlying habitat types (high productivity grasslands and certain agricultural habitats).

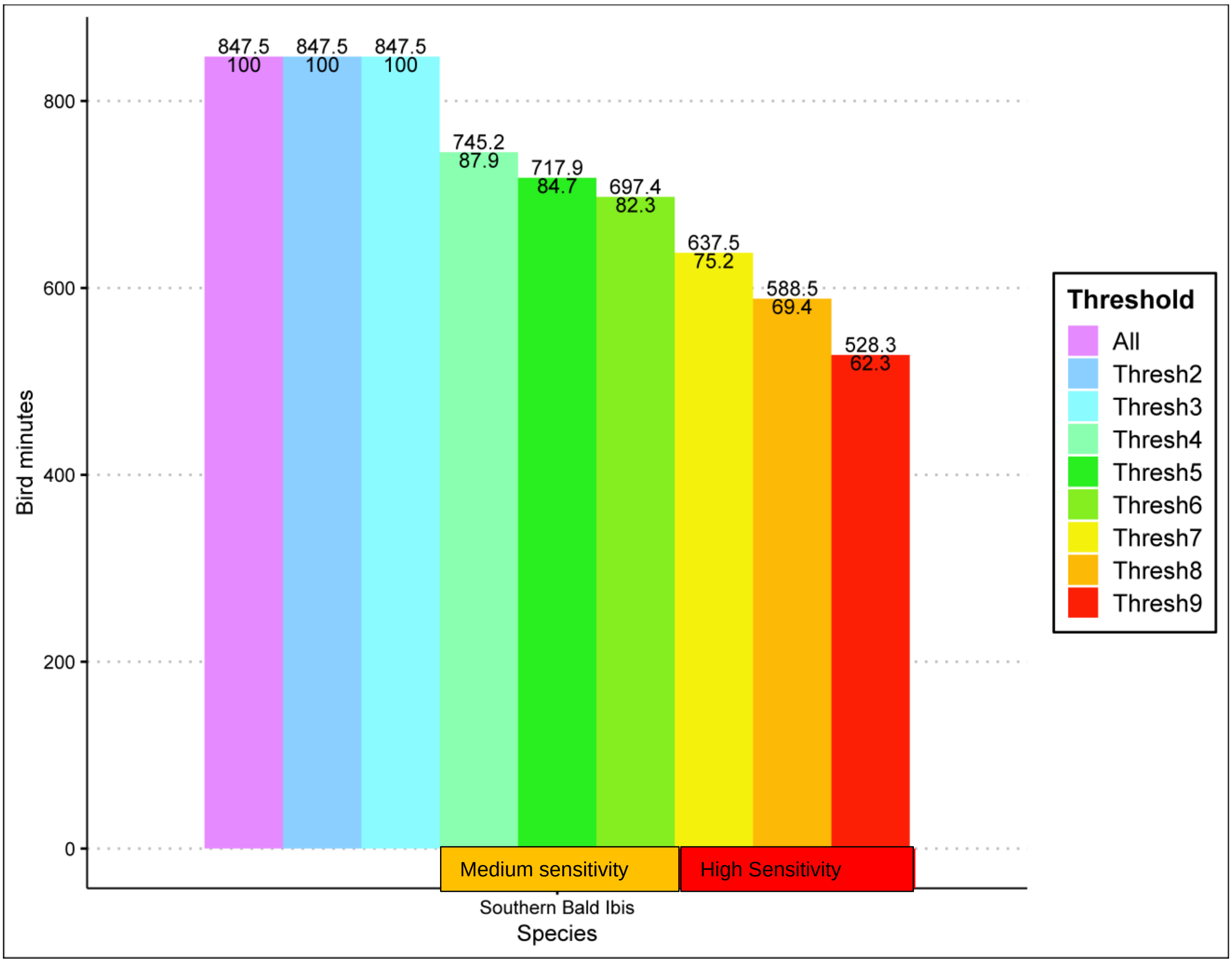

Figure 16: The final Southern Bald Ibis model classed into 9 classes, with associated known risky flight data represented across the respective classes. Each class incorporates a certain proportion of the overall risky bird minutes recorded. Total bird minutes incorporated by a respective class is annotated above bars, whilst the associated percentage (bird minutes incorporated/total bird minutes recorded) is annotated below bars.

3 Methodology used for the modelling of Rudd's Lark and Yellow-breasted Pipit habitat

An R workflow was used to prepare, pre-process and analyse remote sensing data acquired by the Sentinel 2 satellite platform (Copernicus 2023). A classification modelling framework, which included the use of an ensemble model, was used to assess habitat suitability for target species. An ensemble modelling approach incorporates the use of more than one classification algorithm, drawing on the strengths of each and resisting any inherent bias that could be present in a single model. This general modelling process has been previously used in multiple peer-reviewed avian habitat suitability studies (Colyn et al. 2020a; Colyn et al. 2020b; Colyn et al. 2020c). A stepwise variable selection technique was used to conduct a data driven process of variable selection. Variable selection includes the removal of highly correlated variables, thereby preventing autocorrelation and improving the interpretation of final model results (Vignali et al. 2020).

The occurrence datasets represent all recent (post 2010) presence localities recorded for Rudd's Lark (*Heteromirafra ruddi*), Botha's Lark (*Spizocorys fringillaris*), and Yellow-breasted Pipit (*Anthus chloris*) recorded across the mesic highland grasslands that incorporate their distributions. The modelling workflow included data partitioning, model training, variable selection, model testing, model optimization through hyperparameter tuning and final model predictions. The occurrence data largely included presence data with absence data being limited geographically to certain areas of greater survey coverage. Subsequently, to supplement existing absence data additional pseudo-absence data was generated across the area of interest using the Dismo R package (Hijmans et al. 2022). We partitioned the overall occurrence and pseudo-absence dataset into training (80%) and testing (20%) subsets. Subsequently, we trained the primary models using the MaxEnt, Random Forest and ANN algorithms, followed by hyperparameter tuning and model optimization using the genetic algorithm (Vignali et al. 2020). Variable importance and partial dependence plots were generated for the final set of variables selected following initial model training and optimization. A final global model was trained using the entire training occurrence dataset for each species, and this model was then used to make predictions of habitat suitability within the local area of interest (i.e. proposed development footprint).

Model performance was assessed using the Receiver-operating characteristic (ROC) and associated area under the curve (AUC-ROC) value (Freeman and Moisen 2008). ROC plots compare the true positive and false positive rates and are commonly used as a metric of model performance in classification studies (Jimenez-Valverde 2012; Sofaer et al. 2018). The package PresenceAbsence (Freeman and Moisen 2008) was used to create ROC-AUC plots and generate threshold selection statistics. Threshold selection assesses the relationship between the predicted and observed values to generate thresholds that can be used to convert model outputs from a continuous format to a binary one.

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