BIOTHERM MARALLA EAST AND WEST WIND PROJECTS

BIRD IMPACT ASSESSMENT STUDY: AVIFAUNA

MARALLA WEST

Compiled by

AFRIMAGE Photography (Pty) Ltd t/a:

Chris van Rooyen Consulting

VAT#: 4580238113

email: vanrooyen.chris@gmail.com

Tel: +27 (0)82 4549570 cell

for

WSP | PARSONS BRINCKERHOFF

APRIL 2016

EXECUTIVE SUMMARY

BioTherm Energy (BioTherm) is proposing to develop three wind energy facilities (WEFs) in the vicinity of Sutherland, in the Western Cape and Northern Cape. The planned sites are called Maralla East and West (2 x sites) and Esizayo (1 x site). The localities are located in the proposed Komsberg Renewable Energy Development Zone (REDZ).

This report deals with the potential impacts on avifauna of the proposed Maralla West WEF.

The proposed Maralla West WEF will have several potential impacts on avifauna at a site and regional level. These impacts are summarised in the table below:

Environmental parameter	Impact	Rating prior to mitigation	Rating post mitigation
Avifauna	Displacement of priority species due to disturbance during construction operations	-48 Medium	-40 Medium
	Priority species mortality due to collision with the turbines	-64 High	-48 Medium
	Displacement of priority species due to habitat transformation	-44 Medium	-27 Low
	Priority species mortality due to collision with the on-site powerlines	-64 High	-48 Medium
	Priority species mortality due to electrocution on the on-site powerlines	-48 Medium	-16 Low
	Displacement of priority species due to disturbance during decommissioning operations	-24 Low	-18 Low
	Cumulative impacts by renewable energy projects on birds within a 70km radius are temporary displacement due to disturbance associated with the construction of the facility and associated infrastructure, collisions with solar panels and wind	-75 High	-45 Medium

	turbines, permanent displacement due to habitat transformation, entrapment in perimeter fences and collisions with the associated power lines.		

A total of 163 species could potentially occur in the study area. Of these, 19 are classified as priority species. The results of the pre-construction monitoring have indicated areas of high flight activity which are frequented by Red Data Martial Eagles, Verreaux's Eagles and Black Harriers. Several turbine exclusion zones have been identified from the flight data gathered during 288 hours of VP watches. These exclusion zones focused on the recorded flight patterns of Martial Eagle, Verreaux's Eagle and Black Harrier. The flight patterns were interpreted taking into account relevant landscape features e.g. slopes and ridges, as well as confirmed roosts of Martial Eagle, to guide the delineation of no-turbine zones.

The greatest potential concern in the 70km radius around Komsberg Substation is for the large raptor species, particularly Verreaux's Eagle and Martial Eagle, due to their low numbers and vulnerability to turbine collisions. The total estimated area that could potentially be affected by renewable projects are approximately 233 503 ha, which is approximately 15% of the land surface within the 75km radius, although the actual footprint is likely to be smaller, as this figure is based largely on land parcel size, and not the actual infrastructure footprint. Nonetheless, the combined cumulative impact of renewable developments on priority species, and particularly wind energy developments on Red Data Verreaux's Eagle and Martial Eagle within the 70km radius around the Komsberg Substation, is potentially significant at a local or even regional scale, even with the application of mitigation measures such as buffer zones around nests, should all of these projects eventually get to be constructed. The impact should be less severe at a national level, due to the large distribution ranges of the species, but should nonetheless be carefully monitored.

From an avifaunal impact perspective, the proposed Maralla West WEF development could go ahead, provided the proposed mitigation measures, and especially the no-turbine zones and modifications to the wind mast, are strictly implemented.

TABLE OF CONTENTS

1. INTRODUCTION

1.1. SCOPE OF WORK

The terms of reference for this impact assessment report are as follows:

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts for the Maralla West facility and associated infrastructure on avifauna;
- Assess and evaluate the potential impacts; and
- Recommend mitigation measures to reduce the impact of the expected impacts on avifauna.

1.2. OBJECTIVES OF THE REPORT

The objectives of the report are to investigate the potential impact of the proposed Maralla West site on avifauna in order to assess whether the project is fatally flawed from an avifaunal impact perspective and, if not, what mitigation measures should be implemented to reduce the potential impacts.

1.3. LEGISLATIVE FRAMEWORK

There is no legislation pertaining specifically to the impact of wind facilities on avifauna. There are best practice guidelines available which were compiled under the auspices of Birdlife South Africa (BLSA) and the Endangered Wildlife Trust (EWT) i.e. *Jenkins A R; Van Rooyen C S; Smallie J J; Anderson M D & Smit H A. 2011. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Endangered Wildlife Trust and Birdlife South Africa.* These guidelines have been updated on several occasions, with the latest version released in 2015.

1.3.1 AGREEMENTS AND CONVENTIONS

Table 1 below lists international agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna[1].

Table 1: 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:	Global

[1] (BirdLife International (2016) Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south_africa. Checked: 2016-04-02).

	• The conservation of biological diversity • The sustainable use of the components of biological diversity • 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

1.3.2 NATIONAL LEGISLATION

1.3.2.1 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.

1.3.2.2 The National Environmental Management Act 107 of 1998 (NEMA)

The National Environmental Management Act 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 a number of 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.

1.3.2.3 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.

1.4. STUDY APPROACH AND METHODOLOGY

The following approach was followed in compiling the report:

- Bird distribution data of the Southern African Bird Atlas Project2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed wind facility is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. In order to get a more representative impression of the birdlife, a consolidated data set was obtained for the 12 pentads which overlap substantially with the proposed Maralla East and Maralla West development sites (see **Figure 1**). A total of 70 full protocol lists have been completed to date for the 12 pentads where the study area is located (i.e. lists surveys lasting a minimum of two hours each). The SABAP2 data was therefore regarded as a reliable snapshot of the avifauna, especially when supplemented by actual data collected during surveys and through general knowledge of the area.

- A classification of the vegetation types in the study area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).

- 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, Lesotho and Swaziland (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 latest (2016.2) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).

- The BirdLife South Africa (BLSA) was consulted on Important Bird Areas of Southern Africa for information on relevant Important Bird Areas (IBAs) (http://www.birdlife.org.za/conservation/important-bird-areas) (Marnewick *et al*. 2015).

- Satellite imagery from Google Earth was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.

- Information on bird diversity and abundance at the sites was obtained through a 12-months monitoring programme. Data was collected through transect counts, incidental sightings, inspection of potential focal points and the recording of flight behaviour from vantage points (see **APPENDIX 1** for an explanation of the methodology employed).

- Information on the dominant wind direction at all the sites was obtained from BioTherm (2016).
- Information on existing raptor nests were obtained from avifaunal specialists Dr. Andrew Jenkins (Avisense Consulting) and Andrew Pearson (Arcus), as well as from the staff of the Komsberg Nature Reserve. Various landowners were also interviewed to obtain information on nests and roosting sites.

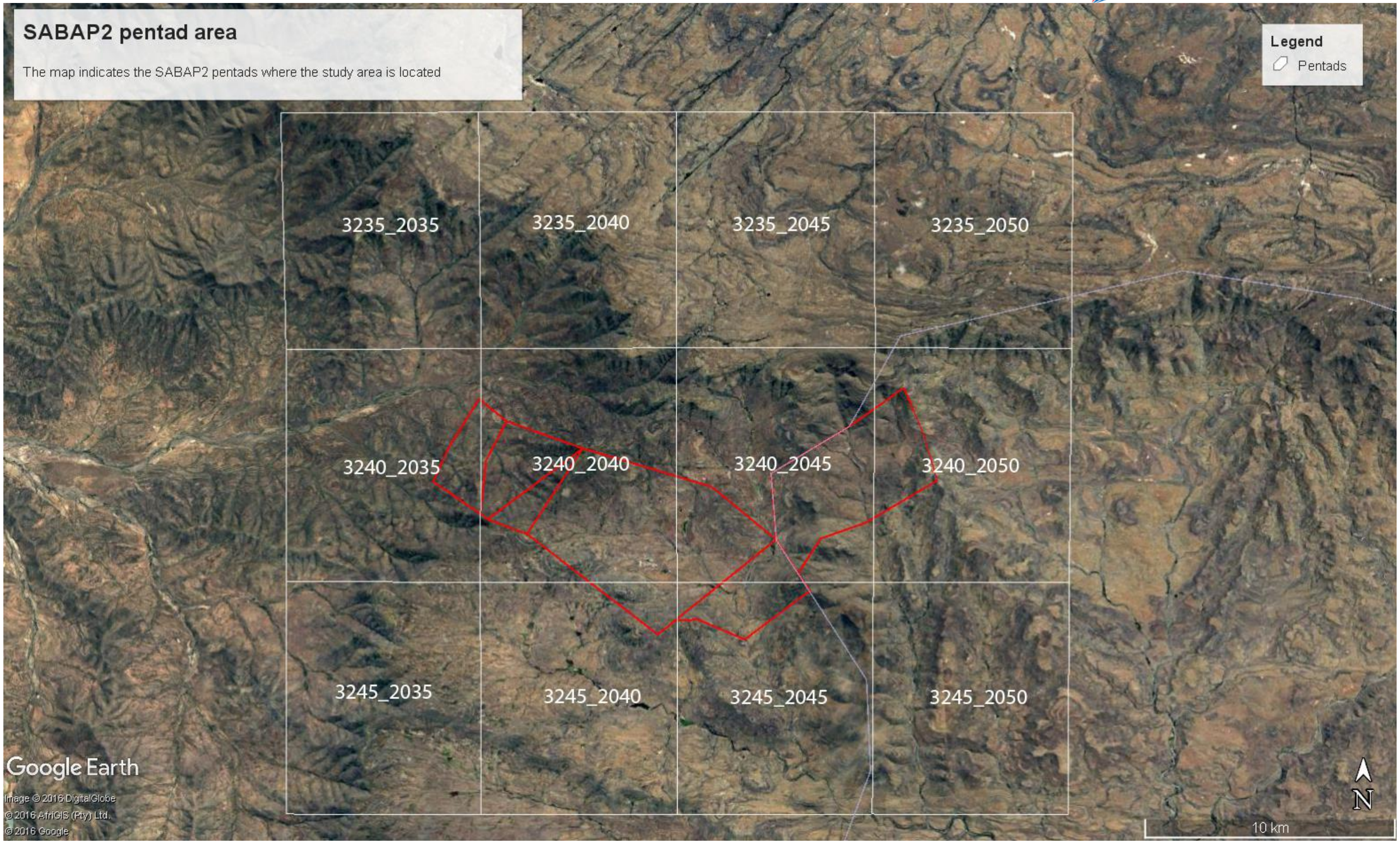


Figure 1: The 12 pentads where the proposed Maralla WEFs are located.

1.5. ASSUMPTIONS AND LIMITATIONS

- A total of 70 full protocol lists have been completed to date to date for the 12 pentads for the Maralla study area (i.e. lists surveys lasting a minimum of two hours or more each). This is a fairly comprehensive dataset which provides a reasonably accurate snapshot of the avifauna which could occur in the study area. For purposes of completeness, the list of species that could be encountered was supplemented with personal observations, general knowledge of the area, SABAP1 records (Harrison *et al.* 1997), and data from the pre-construction bird monitoring.

- Conclusions in this study are based on experience of these and similar species in different parts of South Africa. Bird behaviour can never be entirely reduced to formulas that will be valid under all circumstances, especially for a relatively new field such as wind energy. However, power line and substation impacts can be predicted with a fair amount of certainty, based on a robust body of research stretching back over thirty years (see References Section 9).

- To date no peer-reviewed, scientific papers are available on the impacts of wind farms on birds in South Africa. 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 (http://www.unep.org). 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."

- Predicted mortality rates are often inaccurate, indicating that this is still a fledgling science in many respects, even in developed countries like Spain with an established wind industry (Ferrer *et al.* 2012). Mortality data from post-construction monitoring programmes currently implemented at wind farms in South Africa was used to assist with the priority species risk assessments (Ralston, M. *in litt.* 2016).

- Priority species were taken from the updated list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012).

- The study area was defined as the area which comprise the two Maralla sites and the immediate environs. The development area was defined as the area taken up by the proposed Maralla West WEF only (see Figures 5 and 6).

1.6. DECLARATION OF INDEPENDENCE

Chris van Rooyen

Chris has 20 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (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 worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and several renewable energy projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently (2016) accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman

Albert has an M. Sc. in Conservation Biology from the University of Cape Town, and started his career in the natural sciences as a Geographic Information Systems (GIS) specialist at Council for Scientific and Industrial Research (CSIR). In 1998, he joined the Endangered Wildlife Trust where he headed up the Airports Company South Africa – EWT Strategic Partnership, a position he held until he resigned in 2008 to work as a private ornithological consultant. Albert's specialist field is the management of wildlife, especially bird related hazards at airports. His expertise is recognized internationally; in 2005 he was elected as Vice Chairman of the International Bird Strike Committee. Since 2010, Albert has worked closely with Chris van Rooyen in developing a protocol for pre-construction monitoring at wind energy facilities, and he is currently jointly coordinating pre-construction monitoring programmes at several wind farm facilities. Albert also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Nico Laubscher

Nico holds a D.Sc. from the University of Potchefstroom and was head of the Statistics Division, National Research Institute for Mathematical Sciences of the CSIR from 1959 – 1975. He retired in 1989 as head of the Centre for Statistical Consultation at the University of Stellenbosch. Nico held several offices, including President of the South African Statistical Association, and editor of the South African Statistical Journal. Nico has five decades' experience in statistical analysis and data science applications, including specialisation in model building with massive data sets, designing of experiments for process improvement and analysis of data so obtained, and statistical process control. He also has published peer reviewed papers in several leading statistical journals, including Annals of Mathematical Statistics, American Statistical Journal, Technometrics and The American Statistician. He currently operates as a private statistical consultant to industry and academia.

SPECIALIST DECLARATION

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which WSP was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed Maralla wind facilities.

Signed: Chris van Rooyen
Tel: 0824549570
Email: vanrooyen.chris@gmail.com

See **APPENDIX 2** for Chris van Rooyen's CV.

2. DESCRIPTION OF THE PROJECT

The proposed infrastructure will consist of the following:

- Generation capacity of potentially up to 250MW;

- Up to 56 Wind Turbines Generators[2]. Turbines will have a generating capacity of between 2 and 4MW each. The turbines will have a hub height of up to 120m and rotor diameter of up to 150m;
- Concrete foundation to support the turbines;
- Onsite IPP 132kV Substation, with the transformers for voltage step up from medium voltage to high voltage. Substation will occupy an area of 150mx 150m;
- A power line of up to 132kV that will run from the onsite IPP substation to the onsite Eskom Substation;
- The medium voltage collector system will comprise of cables (11kV up to and including 33kV) that will be run underground, expect where a technical assessment suggest that overhead lines are applicable, in the facility connecting the turbines to the onsite substation;
- A laydown area for the temporary storage of materials during the construction activities. The laydown area will be a maximum of 4ha in size;
- Temporary site compound for contractors;
- Permanent turbine crane platforms;
- Septic tanks;
- Access roads and internal roads;
- Construction of a car park and fencing;
- Administration, control and warehouse buildings;
- Operations and Maintenance compound area including O&M building, car park and storage area.

See **Figure 2** for the proposed lay-out of the Maralla West WEF.

[2] The number of turbines was reduced from 125 to 70 and finally to 56.

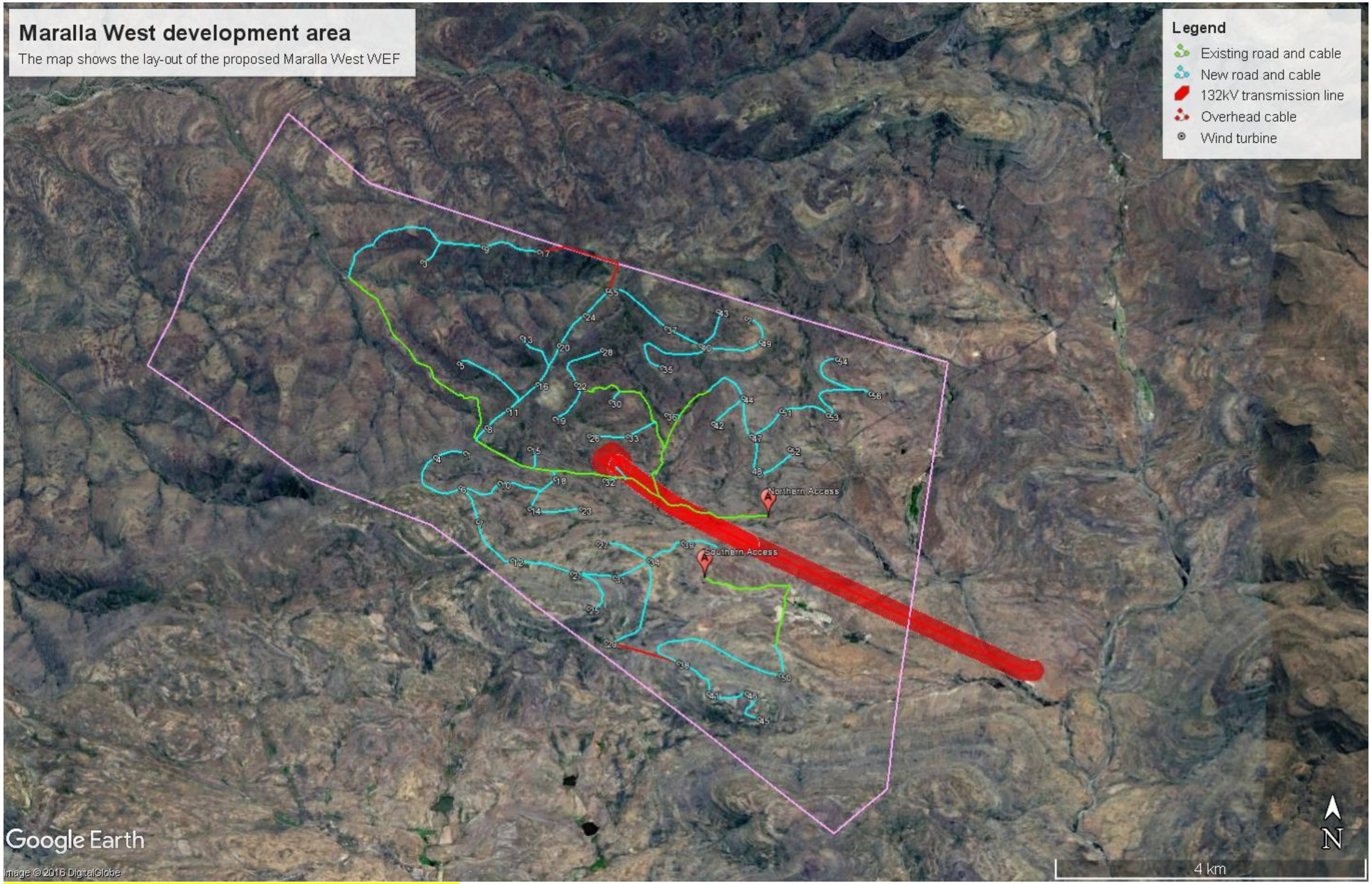


Figure 2: Lay-out proposed for the Maralla West WEF.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. STUDY AREA IN GENERAL

3.1.1. BIRD HABITATS

The study area is situated approximately 33km south of the town of Sutherland, in the Karoo Hoogland Local Municipality of the Northern Cape Province. The area is situated in the proposed Komsberg Renewable Energy Zone (REDZ) and the proposed Central Corridor of the national Electricity Grid Infrastructure (EGI) (DEA 2015). The study area straddles the slopes of the Klein Roggeveld Mountains below the escarpment, and is bisected by numerous ephemeral rivers, the largest being the Komsberg River and the Venter's River. The habitat in the study area is extremely rugged, consisting of rolling hills with boulder-strewn slopes and exposed ridge lines. The two highest points in the study area is Graskop (1430m a.s.l) and Perdekop (1478m a.s.l.). The study area contains a number of man-made dams used for the irrigation of a few crops (mostly pastures), which is grown as supplementary fodder for small stock farming. Sheep farming is the main economic activity. Maralla East is traversed by the Laingsburg / Roggeveld 1 66kV distribution power line, and Eskom's Droërivier-Muldersvlei and Bachus-Droërivier 400kV transmission lines pass about 10km to the south of the study area.

The natural vegetation in the study area is dominated by Central Mountain Shale Renosterveld which exists in a transitional zone between the Fynbos and Succulent Karoo Biomes (Mucina & Rutherford 2006). The vegetation type is found on slopes and broad ridges of low mountains and escarpments. It consists of tall shrubland dominated by renosterbos and large suites of mainly non-succulent karoo shrubs with a rich geophytic flora in the undergrowth or in more open, wetter or rocky habitats (Mucina & Rutherford 2006). In the extreme west of the Maralla West site, Tanqua Escarpment Shrubland is found on steep slopes. In the south closer to Komsberg Main Transmission Substation (MTS) the Central Mountain Shale Renosterveld is replaced by Koedoesberge – Moordenaars Karoo which is found on slightly undulating to hilly landscapes consisting of low succulent scrub and dotted by scattered tall shrubs and patches of "white" grass (Mucina & Rutherford 2006).

The climate is arid to semi-arid with a mean average precipitation of 228mm, with relatively even rainfall with a slight peak in autumn and winter. Mean daily maximum and minimum temperatures in Sutherland range between 27°C and -3°C for January and July[3].

While the development area is large, and the altitude range it encompasses considerable, the habitat in the study area from an avian perspective is relatively uniform, dominated by open, rocky, undulating or montane renosterbos, with steep, rocky slopes, ridges and low cliffs, denser, woody vegetation along the bigger drainage lines (and stands of alien trees), and both natural and artificial wetlands - river courses, vleis and dams. The larger artificial impoundments in the area probably support good numbers of waterbirds in wet years, and the Eskom power pylons are used as roosting, hunting and/or nesting habitat by certain species (e.g. raptors and corvids).

The site is not located within 50 km of any of the currently registered national Important Bird Areas (Marnewick *et al*. 2015).

See APPENDIX 3 for a photographic record of the habitat at the development area.

[3] http://www.worldweatheronline.com/sutherland-weather-averages/northern-cape/za.aspx

3.1.2 AVIFAUNA

3.1.2.1 Species potentially occurring at the site

A total of 163 species could potentially occur in the study area. Of these, 19 are classified as priority species. **Table 2** below lists the priority species that could potentially occur in the study area, as well as the potential impact on the species in the study area.

See Appendix 4 for a list of all species that could potentially occur in the study area.

3.1.2.2 Results of the pre-construction monitoring

In order to get an accurate assessment of the abundance and variety of avifauna in the study area, a pre-construction monitoring programme was instituted which ran over four seasons[4]. Data was collected through drive and walk transect counts, incidental sightings, the recording of flight behaviour from vantage points, inspection of potential focal points and nest searches (see **APPENDIX 1** for a comprehensive exposition of the methodology followed).

Table 3 lists all priority species which were recorded during the course of the pre-construction monitoring in the study area, and the manner in which they were recorded.

[4] The pre-construction monitoring covered both Maralla sites, a control area and the immediate environs.

Table 2: Priority species that could potentially occur in the study area. **EN = Endangered VU = Vulnerable NT = Near threatened LC = Least concern**

		Status					Abundance		Site		Impact			
Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (12 pentad)	SABAP1 reporting rate %	Maralla West	Recorded during pre-construction monitoring	Collisions with associated power line	Collisions with turbines	Displacement through disturbance	Displacement through habitat transformation
Bustard, Ludwig's	*Neotis ludwigii*	x	EN	EN		Near-endemic	5.71	✓ 10.42	x	x	x		x	
Buzzard, Jackal	*Buteo rufofuscus*	x			Near endemic	Endemic	42.86	✓ 22.22	x	x		x		
Buzzard, Steppe	*Buteo vulpinus*	x					7.14	✓ 17.65	x	x		x		
Eagle, Booted	*Aquila pennatus*	x					4.29	✓ 10.71	x	x		x		
Eagle, Martial	*Polemaetus bellicosus*	x	VU	EN			14.29	✓ 10.42	x	x		x		
Eagle, Verreaux's	*Aquila verreauxii*	x	LC	VU			11.43	✓ 16.67	x	x		x		
Eagle-owl, Spotted	*Bubo africanus*	x					7.14	✓ 5.88	x	x		x		
Falcon, Lanner	*Falco biarmicus*	x	LC	VU			0	0	x	x		x		
Flamingo, Greater	*Phoenicopterus ruber*	x	LC	NT			0	✓ 18.18	x	x	x	x		
Francolin, Grey-winged	*Scleroptila africanus*	x			Endemic (SA, Lesotho, Swaziland)	Endemic	31.43	✓ 8.33	x	x			x	x
Goshawk, Southern Pale Chanting	*Melierax canorus*	x				Near-endemic	28.57	✓ 30.00	x	x		x		
Harrier, Black	*Circus maurus*	x	VU	EN	Near endemic	Endemic	1.43	✓ 12.00	x	x		x		
Kestrel, Lesser	*Falco naumanni*	x					1.43	✗ 0.00	x	x			x	
Kite, Black-shouldered	*Elanus caeruleus*	x					1.43	✓ 29.41	x			x		
Korhaan, Karoo	*Eupodotis vigorsii*	x	LC	NT		Endemic	17.14	✓ 15.00	x		x		x	x
Korhaan, Southern Black	*Afrotis afra*	x	VU	VU	Endemic	Endemic	18.57	✓ 16.00	x	x	x	x	x	x
Snake-eagle, Black-chested	*Circaetus pectoralis*	x					1.43	✓ 16.67	x	x		x		
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	x					1.43	✗ 0.00	x	x		x		
Stork, Black	*Ciconia nigra*	x	LC	VU			0	✓ 5.88	x			x		
Harrier-hawk, African	*Polyboroides typus*	x	LC				0	0	x	x		x		
African Fish-Eagle	*Haliaeetus vocifer*	x	LC				0	0	x	x		x		
Sclater's Lark	*Spizocorys sclateri*	x	NT	NT	Endemic	Endemic	0	0				x		

Table 3: Species recorded during the pre-construction monitoring in the study area.

Priority Species	Scientific Name	Turbine	Control	VP	Ctrl VP	Incidental	Focal point
African Fish-Eagle	*Haliaeetus vocifer*			*			
African Harrier-Hawk	*Polyboroides typus*	*					
Black Harrier	*Circus maurus*	*		*		*	
Black-chested Snake-Eagle	*Circaetus pectoralis*		*		*	*	
Booted Eagle	*Aquila pennatus*			*			
Greater Flamingo	*Phoenicopterus ruber*		*	*			
Grey-winged Francolin	*Scleroptila africanus*	*	*			*	
Jackal Buzzard	*Buteo rufofuscus*	*	*	*	*	*	
Lanner Falcon	*Falco biarmicus*		*				
Lesser Kestrel	*Falco naumanni*			*			
Ludwig's Bustard	*Neotis ludwigii*			*			
Martial Eagle	*Polemaetus bellicosus*		*	*		*	
Rufous-chested Sparrowhawk	*Accipiter rufiventris*	*					
Sclater's Lark	*Spizocorys sclateri*		*				
Southern Black Korhaan	*Afrotis afra*	*		*		*	
Southern Pale Chanting Goshawk	*Melierax canorus*	*	*	*		*	
Spotted Eagle-Owl	*Bubo africanus*					*	
Steppe Buzzard	*Buteo vulpinus*	*		*		*	
Verreaux's Eagle	*Aquila verreauxii*	*	*	*	*	*	
19	**Total:**	**9**	**9**	**12**	**3**	**10**	**0**

Figures 3 and **4** below gives an indication of the relative abundance of priority species, as recorded through transect counts during the pre-construction monitoring at the study area. Abundance is expressed in terms of birds/km.

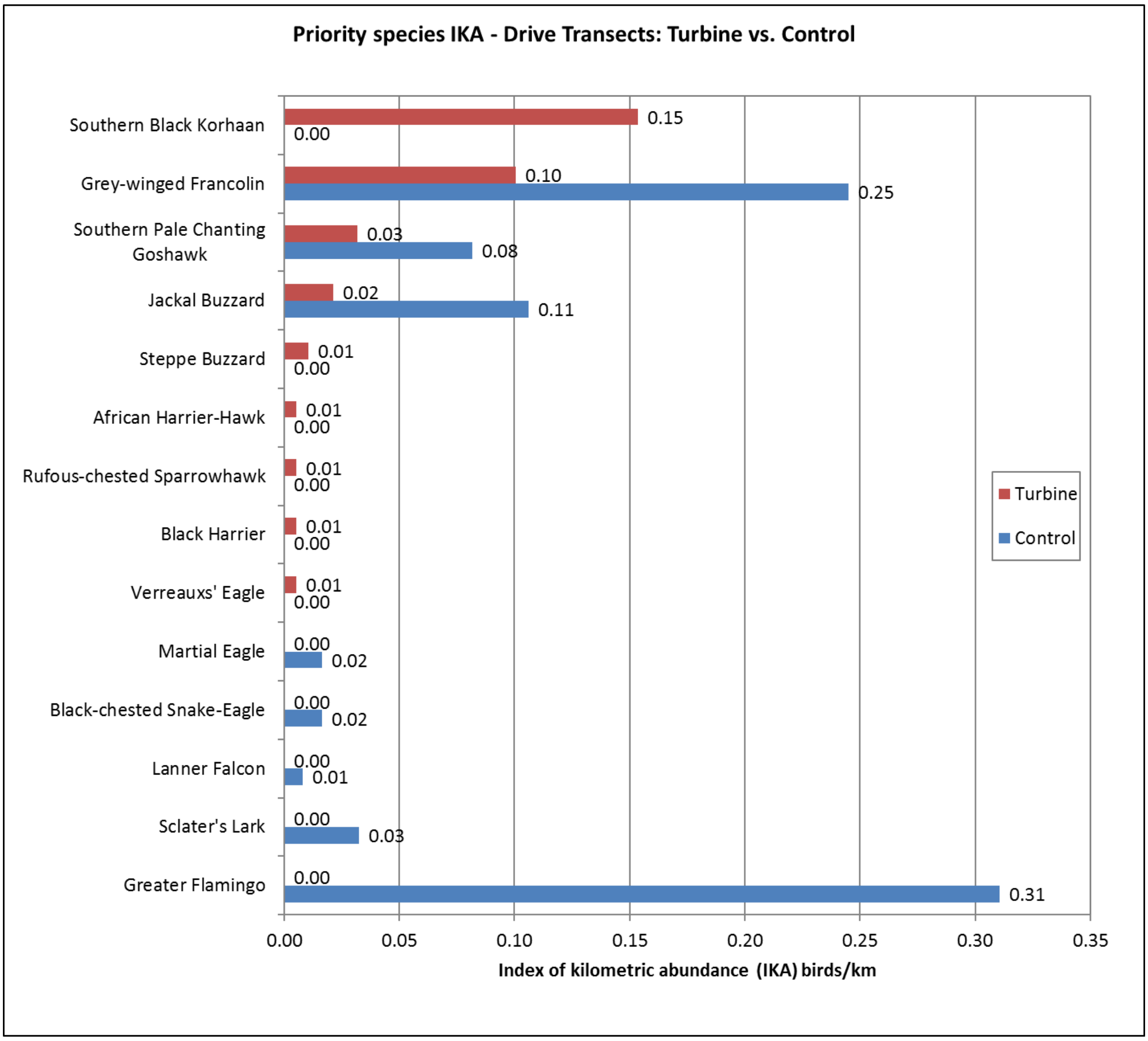


Figure 3: IKA for priority species recorded via drive transect counts at the study area.

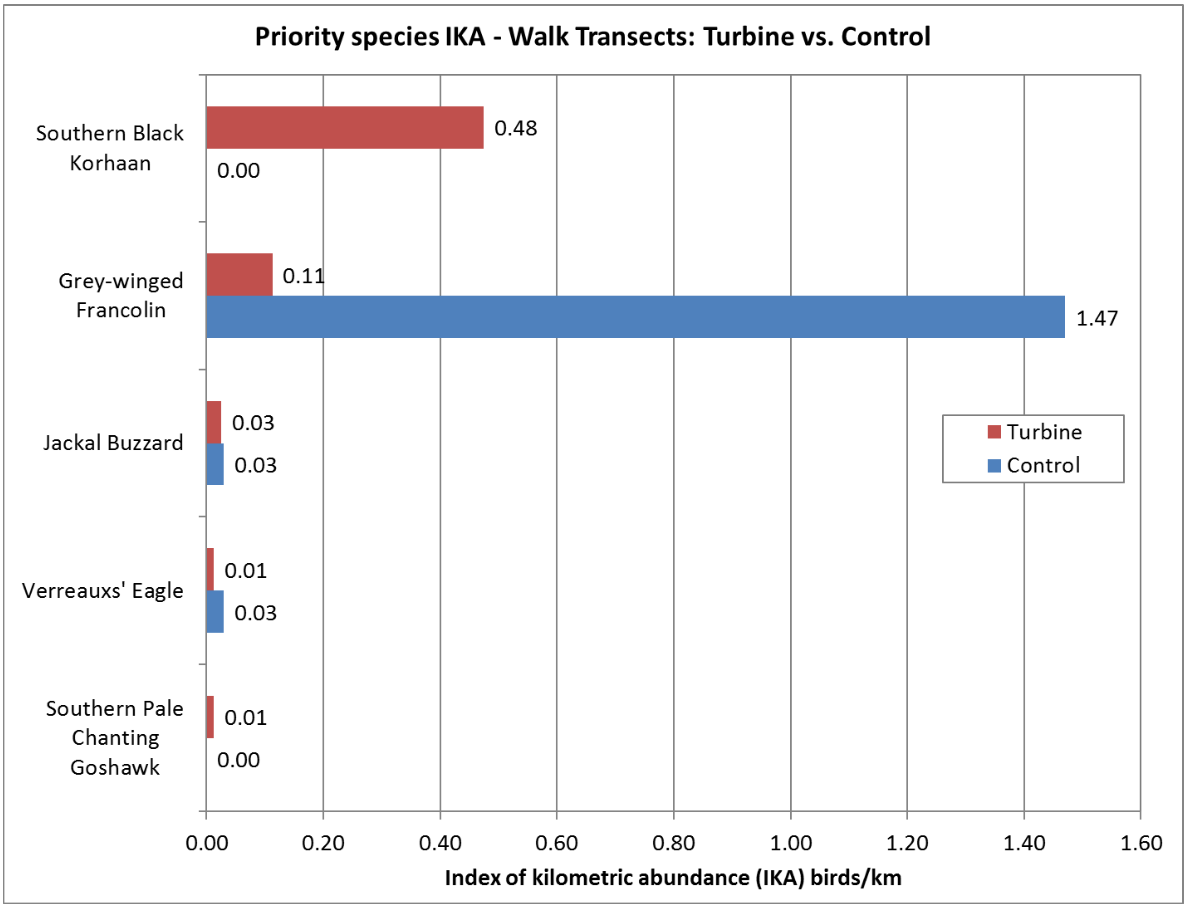


Figure 4: IKA for priority species recorded via walk transect counts at the study area.

Figure 5 shows the spatial distribution of transect recorded priority species in the study area.

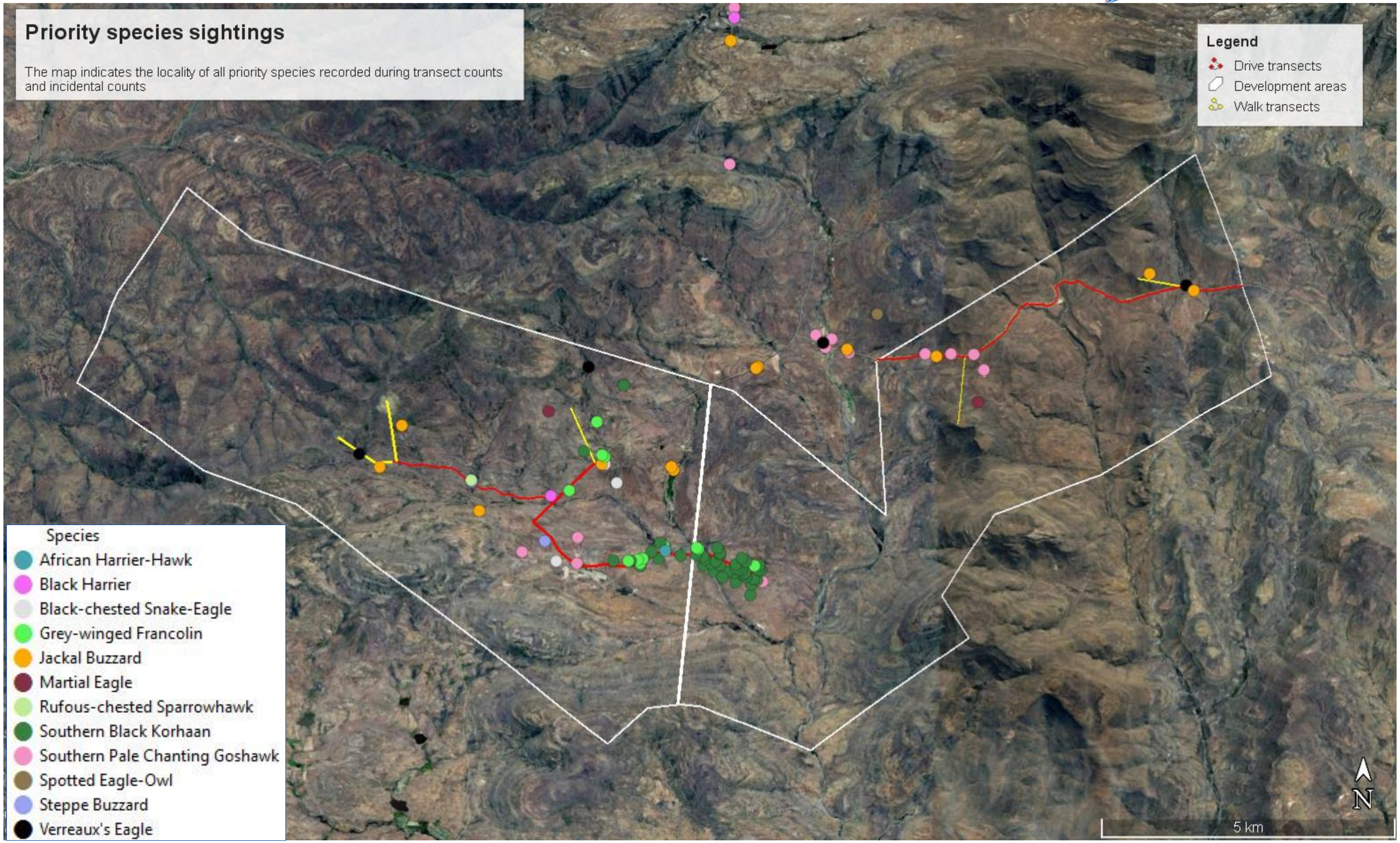


Figure 5: The spatial distribution of transect recorded individuals of priority species at the study area.

A total of 288 hours of vantage point watches were completed at six vantage points at the study area in order to record flight patterns of priority species. In the four sampling periods, priority species were recorded flying for a total of 10 hours, 44 minutes and 50 seconds. A total of 584 individual flights were recorded. Of these, 210 (36%) flights were at high altitude (>220m), 281 (48%) were at medium altitude (i.e. between 30m and 220m) and 93 (16%) were at low altitude (<30m).

The passage rate for priority species recorded at the development area (all flight heights) was 0.86 birds/hour[5]. See **Figure 6** below for the duration of flights for each species, at each height class[6].

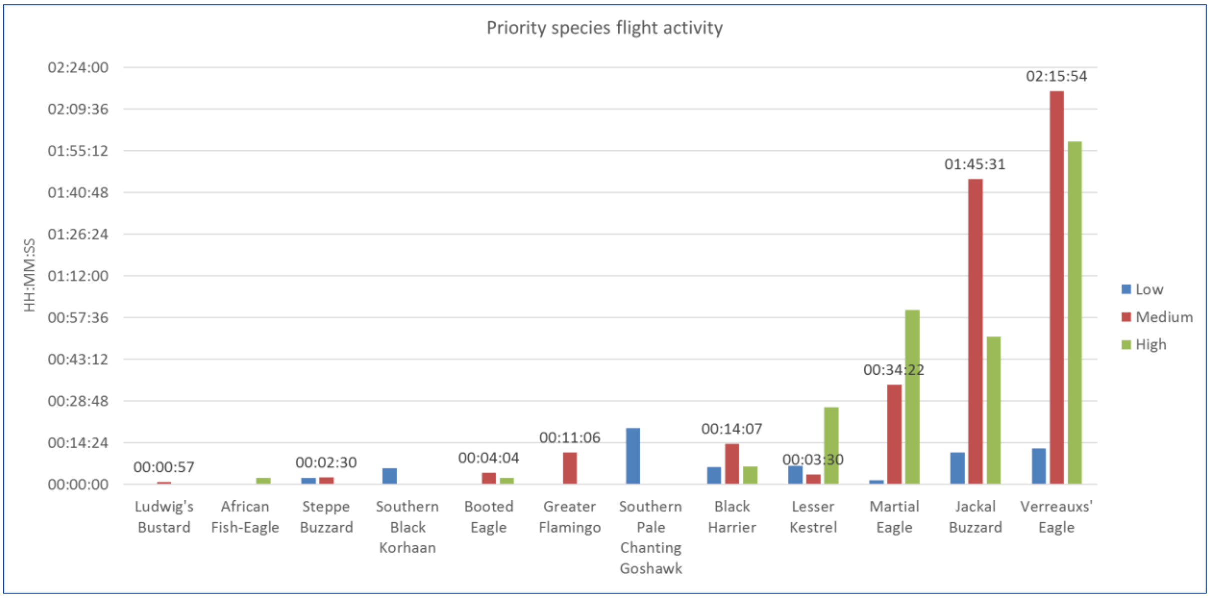


Figure 6: Flight times and heights recorded for priority species at the development area.

A site-specific collisions risk rating for each priority species recorded during VP watches was calculated to give an indication of the likelihood of an individual of the specific species to collide with the turbines at these sites. This was calculated taking into account the following factors:

- The duration of rotor height flights;
- the susceptibility to collisions, based on morphology (size) and behaviour (soaring, predatory, ranging behaviour, flocking behaviour, night flying, aerial display and habitat preference) using the ratings for priority species in the Avian Wind Farm Sensitivity Map of South Africa (Retief *et al*. 2012); and
- the planned number of turbines.

[5] A distinction was drawn between passages and flights. A passage may consist of several flights e.g. every time an individual bird changes height or mode of flight, this was recorded as an individual flight, although it still forms part of the same passage.

[6] Flight duration was calculated by multiplying the flight time with the number of individuals in the flight e.g. if the flight time was 30 seconds and it contained two individuals, the flight duration was 30 seconds x 2 = 60 seconds.

This was done in order to gain some understanding of which species are likely to be most at risk of collision at these specific sites. The formula used is as follows[7]:

Duration of medium height flights (decimal hours) x collision susceptibility calculated as the sum of morphology and behaviour ratings x number of planned turbines[8] ÷100.

The results are displayed in Table 4 and Figure 7 below.

Table 4: Site specific collision risk rating for all priority species recorded during VP watches.

Species	Duration of flights (hr)	Collision rating	# turbines	Risk rating
African Fish-Eagle	0.00	110	112	0.00
Southern Pale Chanting Goshawk	0.00	65	112	0.00
Southern Black Korhaan	0.00	55	112	0.00
Ludwig's Bustard	0.02	80	112	1.42
Steppe Buzzard	0.04	70	112	3.27
Lesser Kestrel	0.06	72	112	4.70
Booted Eagle	0.07	80	112	6.07
Greater Flamingo	0.19	85	112	17.61
Black Harrier	0.24	85	112	22.40
Martial Eagle	0.57	90	112	57.74
Jackal Buzzard	1.76	95	112	187.12
Verreauxs' Eagle	2.27	110	112	279.05
Average	**0.43**	**83.08**	**112**	**48.28**

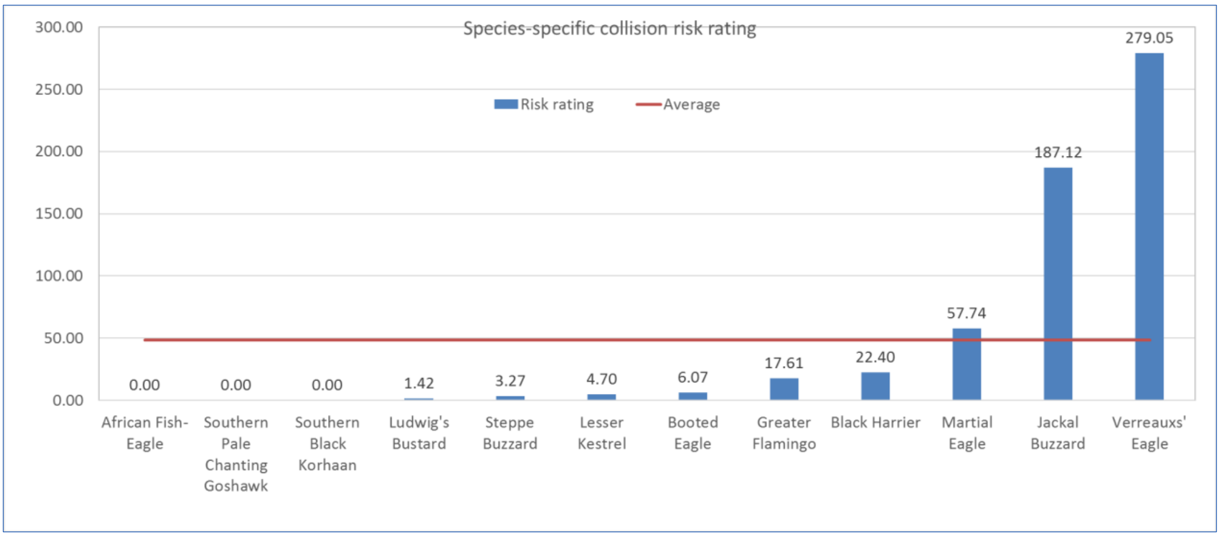


Figure 7: Site specific collision risk rating for priority species at the study area.

[7] It is important to note that the formula does not incorporate avoidance behaviour. 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 also important to note that there is not necessarily a direct correlation between time spent at rotor height, and the likelihood of collision.

[8] As at the time of the report compilation.

The spatial distribution of the flight activity of the four priority species with the highest risk ratings is presented below.

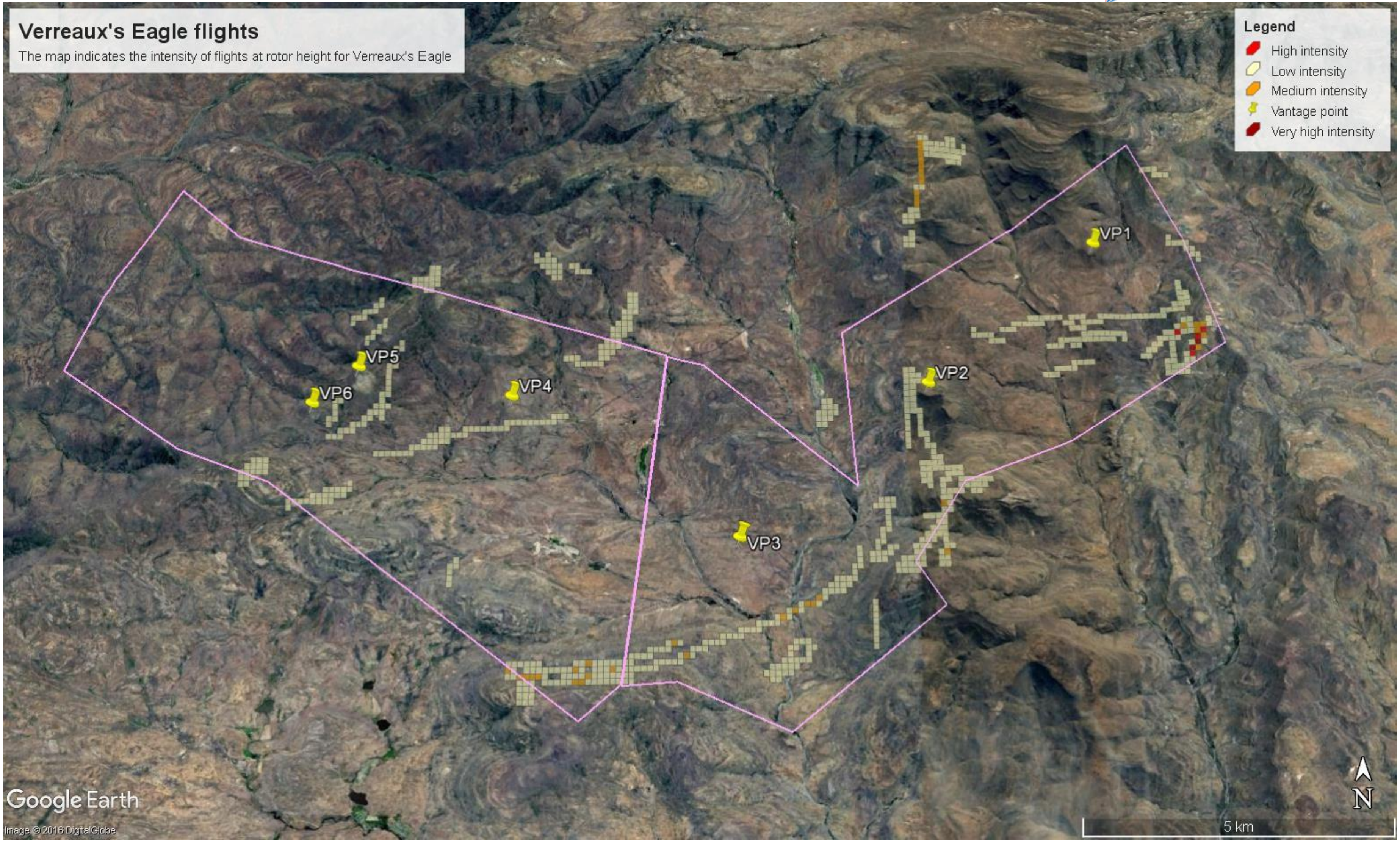


Figure 8: Distribution of flight activity of Verreaux's Eagle.

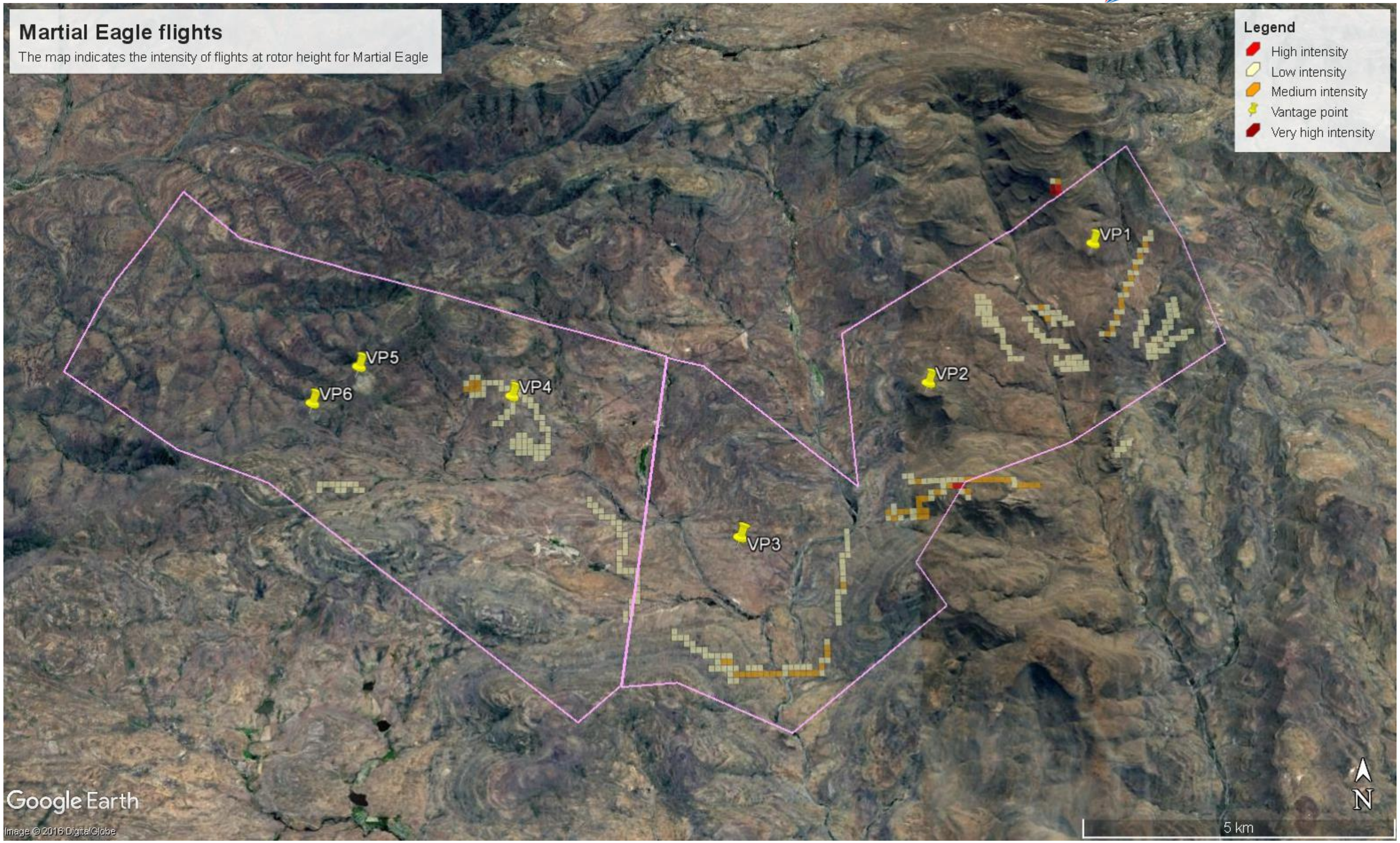


Figure 9: Distribution of flight activity of Martial Eagle.

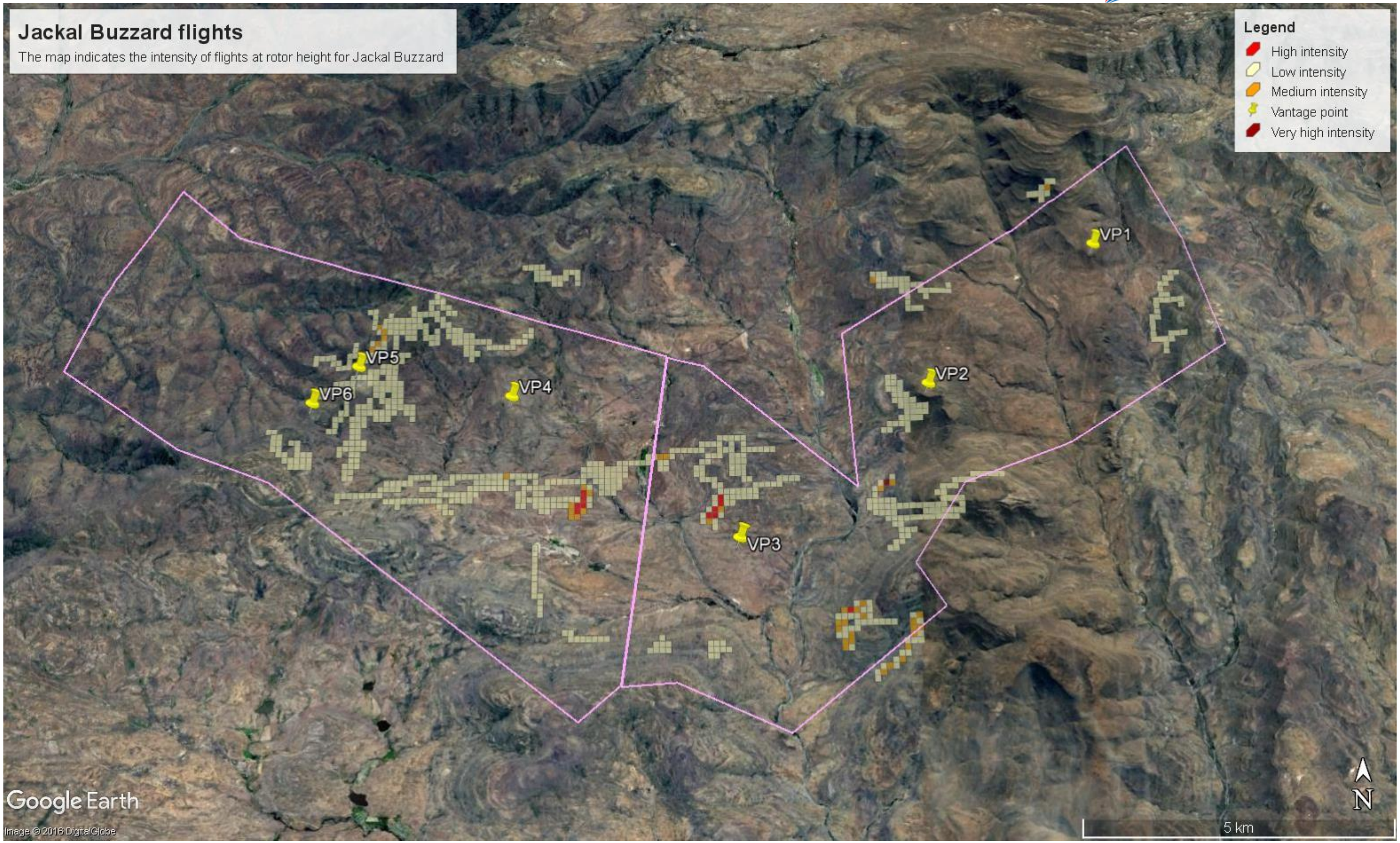


Figure 10: Distribution of flight activity of Jackal Buzzard flights.

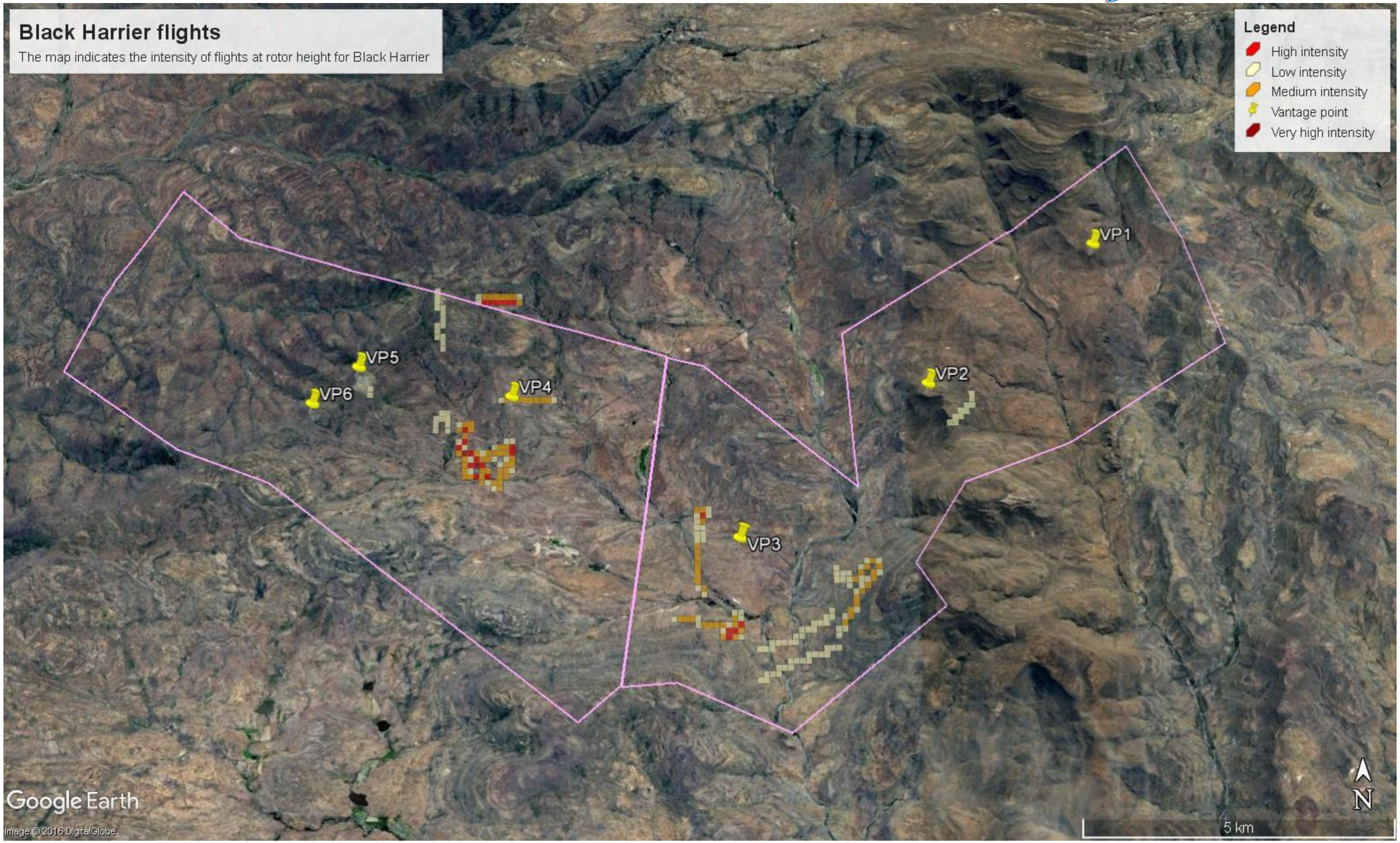


Figure 11: Distribution of flight activity of Jackal Buzzard flights.

A total of 10 potential focal points of bird activity were identified and inspected during each of the four surveys at the two Maralla development areas, i.e. five sites with potential habitat for cliff-nesting raptors and five dams:

- FPM 1: Steep valley with rocky ridges
- FPM 2: West-facing cliffs
- FPM 3: East-facing slope with ridge
- FPM 4: Deep valley with ridges
- FPM 5: Deep valley with west-facing ridge
- FPM 6: Dam
- FPM 7: Dam
- FPM 8: Dam
- FPM 9: Dam
- FPM 10: Dam

Dedicated searches were also conducted to investigate potential nesting and roosting sites in trees and powerlines in the study area and beyond. In addition, a total of 7 areas were identified immediately adjacent to the development areas consisting of cliffs and ridges along the escarpment which were meticulously searched by an observer with binoculars and a scope for nests. Nest searches were conducted in 2016 in January, April, June and November/December.

The seven potential cliff nesting areas comprise the following:

- FP 1: Deep north-south kloof with cliffs on both sides
- FP 2: Deep north-south kloof with cliffs on both sides
- FP 3: South-facing cliffs
- FP 4: Deep north-south kloof
- FP 5: South-facing cliffs
- FP 6: South-facing cliffs
- FP 7: South facing cliffs

Five dams at the control site were also identified as focal points and counts of waterbirds were conducted during each survey iteration.

Additional information on the location of raptor nests were also obtained from Dr. Andrew Jenkins from Avisense Consulting, Andrew Pearson from ARCUS and the staff of the Komsberg Nature Reserve.

Figure 12 indicates the position of the focal points. Figure 13 indicates the locality of all nests and roosts recorded and/or confirmed during the pre-construction monitoring.

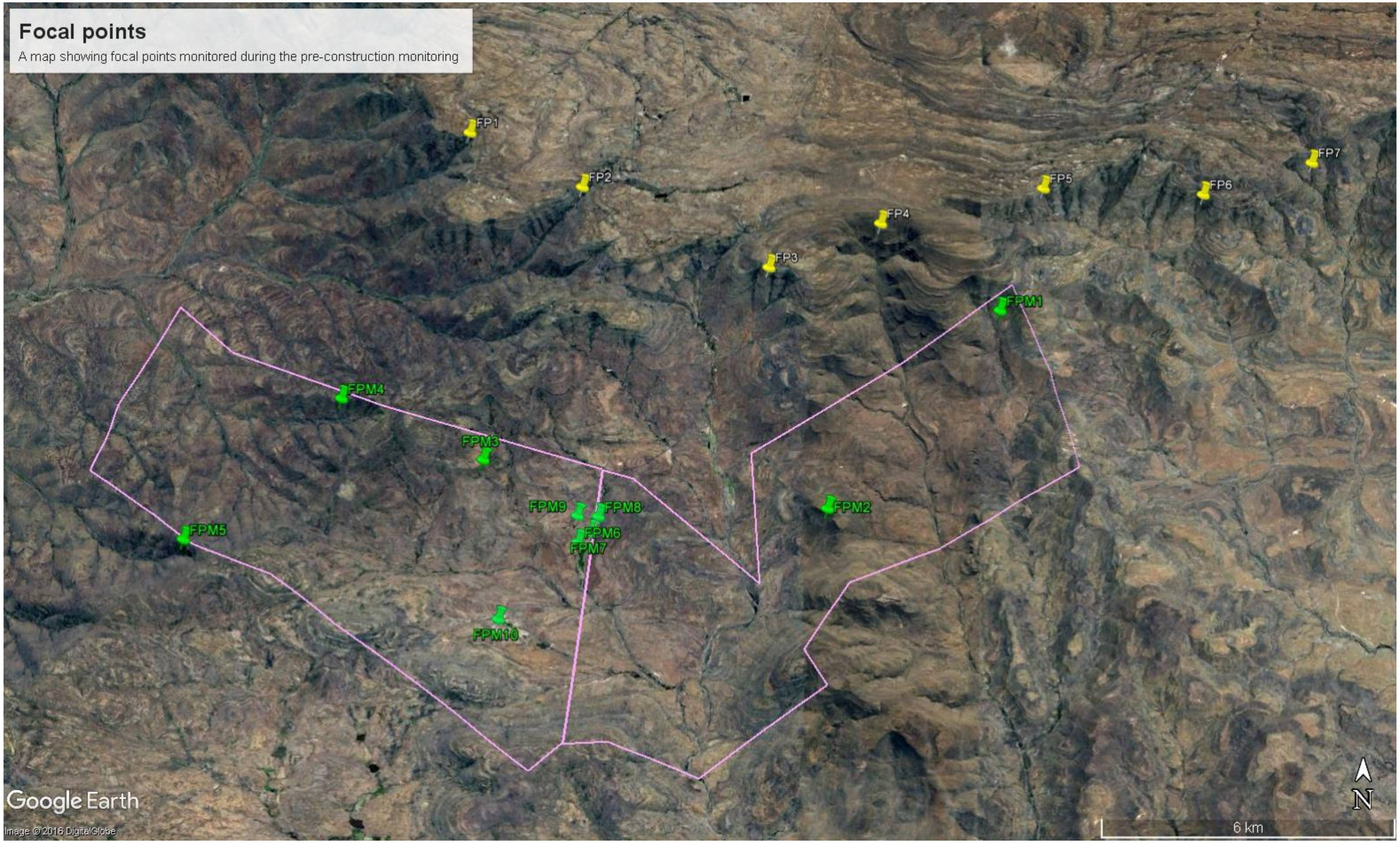


Figure 12: The location of focal points monitored during the pre-construction monitoring.

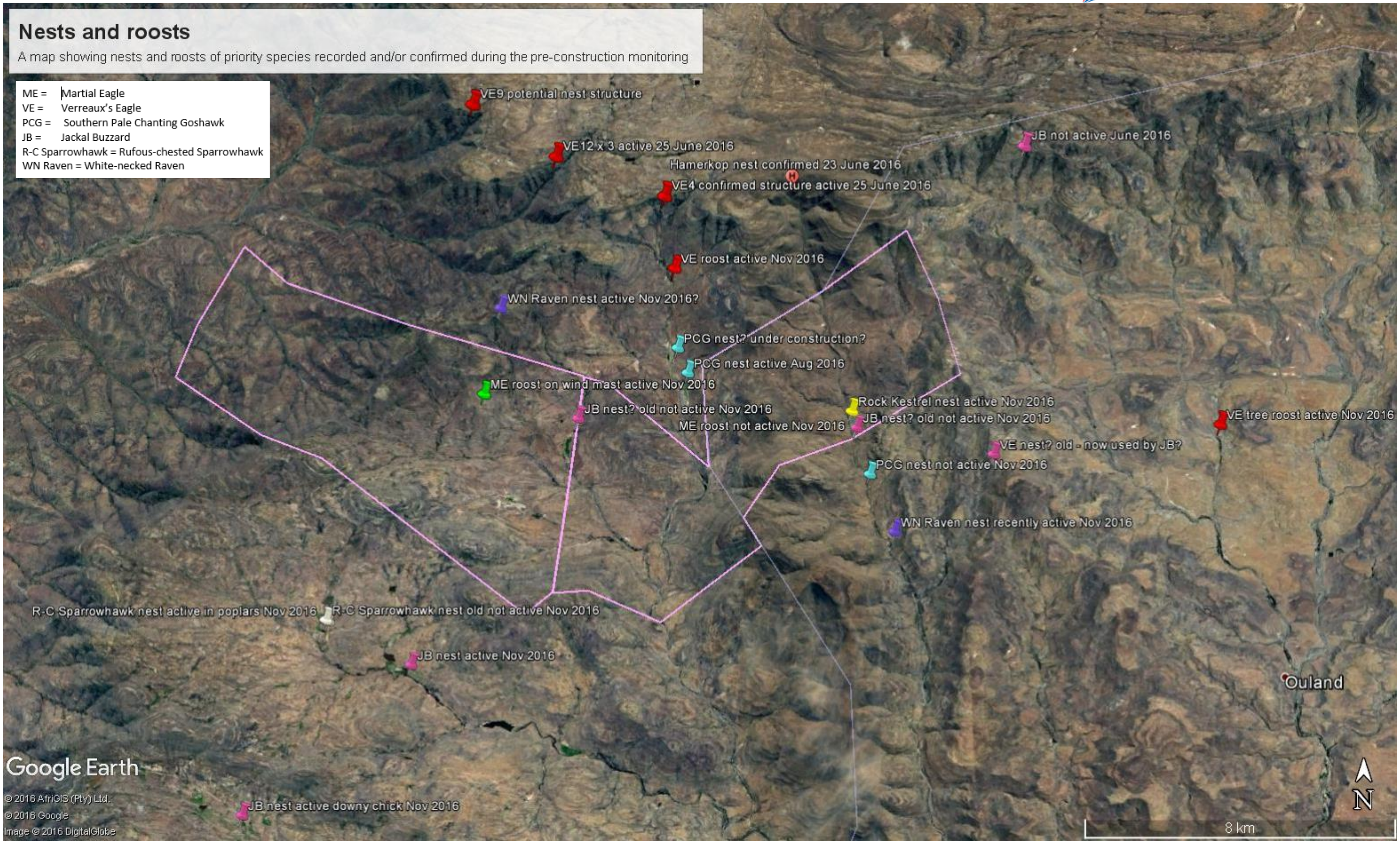


Figure 13: The location of roots and nests recorded and/or confirmed during the pre-construction monitoring.

3.1.2.3 Sample size and representativeness of the pre-construction monitoring data

The computations and the outcome of the data exhibited in the tables and graphs in the statistical analysis (see **APPENDIX 5**) illustrate that the pre-construction survey may be taken to be statistically representative of the flight activity of the soaring and terrestrial priority species of birds recorded during the survey periods. It has also been demonstrated that more samples would not yield a meaningful improvement in the accuracy and precision of the results.

See **APPENDIX 5** for a detailed explanation of the statistical methods.

4. FINDINGS

4.1 GENERAL DESCRIPTION OF EXPECTED IMPACTS

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):

- Collision mortality on the wind turbines;
- Displacement due to disturbance during construction and operation of the wind farm;
- Displacement due to habitat change and loss; and
- Collisions with the internal powerline connections.

It is important to note that the assessment is made on the status quo as it is currently in the study area. The possible change in land use in the broader development area is not taken into account because the extent and nature of future developments are unknown at this stage. It is however highly unlikely that the land use will change in the foreseeable future.

4.2 COLLISION MORTALITY ON WIND TURBINES[9]

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 of wind energy (Drewitt and Langston, 2006).

Collisions with wind turbines appear to kill fewer birds than collisions with other man-made infrastructures, 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;

---

[9] This section is adapted from a recent (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

Huso and Dalthorp 2014). Additionally, 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 in-depth 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.

4.2.1 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. The most likely reason for this is that large birds often need to use thermal and orographic updrafts to gain altitude, particularly for long distance flights. Thermal updrafts (thermals) are masses of hot, rising wind that form over heated surfaces, such as plains. Being dependent on solar radiation, they occur at certain times of the year or the day. Conversely, orographic lift (slope updraft), is formed when wind is deflected by an obstacle, such as mountains, slopes or tall buildings. Soaring birds use these two types of lift to gain altitude (Duerr *et al.* 2012). 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.

<u>Maralla West</u>
Priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are Southern Black Korhaan, Grey-winged Francolin, Greater Flamingo and Ludwig's Bustard. It is noted though that no Ludwig's Bustard mortalities have as yet been reported at wind farms in South Africa, despite initial concerns that the species might be vulnerable in this respect (Ralston, M. *in litt.* 2016).

- 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 and Shaw, 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 and Shaw, 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 and Shaw, 2010; Martin, 2011). For example, the visual fields of vultures (*Gyps sp.*) include extensive blind areas above, below and behind the head and enlarged supra-orbital ridges (Martin *et al.* 2012). This, combined with their tendency to angle their head toward the ground in flight, might make it difficult for them to see wind turbines ahead, which might at least partially explain their high collision rates with wind turbines (Martin, 2012).

Currently, there is little information on whether noise from wind turbines can play a role in bird collisions with wind turbines. Nevertheless, wind turbines with whistling blades are expected to experience fewer avian collisions than silent ones, with birds hearing the blades in noisy (windy) conditions. However, the hypothesis that louder blade noises (to birds) result in fewer fatalities has not been tested so far (Dooling, 2002).

<u>Maralla West</u>
Many of the priority species at the proposed wind farm probably have high resolution vision areas found in the lateral fields of view, rather than frontally, e.g., the bustards, korhaans and passerines. The possible exceptions to this are the 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. The major concern at the site is collision mortality of large raptors, namely Verreaux's Eagle, Martial Eagle, Jackal Buzzard and Black Harrier. All of these have been recorded as collision victims at wind farms in South Africa (Ralston, M. *in litt*. 2016), despite their wide binocular fields.

- Phenology

It has been suggested that resident birds would be less prone to collision, due to their familiarity with the presence of the structures (Drewitt and Langston, 2008). However, 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. Also, Johnston *et al.* (2014) found that during migration when visibility is good Golden Eagles can adjust their flight altitudes and avoid the wind turbines.

At two wind farms in the Strait of Gibraltar, the majority of Griffon Vulture deaths occurred in the winter. This probably happened because thermals are scarcer in the winter, and resident vultures in that season probably relied more on slope updrafts to gain lift (Barrios and Rodríguez, 2004). The strength of these updrafts may not have been sufficient to lift the vultures above the turbine blades, thereby exposing them to a higher collision risk. Additionally, migrating vultures did not seem to follow routes that crossed these two wind farms, so the number of collisions did not increase during migratory periods. Finally, at Smøla, collision risk modelling showed that White-tailed Eagles are most prone to collide during the breeding season, when there is increased flight activity in rotor swept zones (Dahl *et al.* 2013).

The case seems to be different for passerines, with several studies documenting high collision rates for migrating passerines at certain wind farms, particularly at coastal or offshore sites. However, comparable data on collision rates for resident birds is lacking. This lack of information may result from fewer studies, lower detection rates and rapid scavenger removal (Johnson *et al.* 2002; Lekuona and Ursua, 2007). One of the few studies reporting passerine collision rates (from Navarra, northern Spain) documents higher collision rates in the autumn migration period, but it is unclear if this is due to migratory behaviour or due to an increase in the number of individuals because of recently fledged juveniles (Lekuona and Ursua, 2007).

Maralla West
Migratory priority species that could be encountered at the wind development site are Steppe Buzzard, Booted Eagle and Lesser Kestrel. Ludwig's Bustard is regarded as a partial migrant (Shaw 2013), while Black Harriers wander widely (Hockey *et al.* 2005). However, judging from the flight data, the species most at risk are the resident Martial Eagles, Verreaux's Eagles, Black Harriers and Jackal Buzzards.

- Bird behaviour

Flight type seems to play an important role in collision risk, especially when associated with hunting and foraging strategies. Kiting flight, 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). 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). 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).

Collision risk may also be influenced by behaviour associated with a specific sex or age. In Belgium, only adult Common Terns (*Sterna hirundo*) were impacted by a wind farm (Everaert and Stienen, 2007) and the high fatality rate was sex-biased (Stienen *et al.* 2008). In this case, the wind farm is located in the foraging flight path of an important breeding colony, and the differences between fatality of males and females can be explained by the different foraging activity during egg-laying and incubation (Stienen *et al.* 2008). Another example comes from Portugal, where recent findings showed that the mortality of the Skylark (*Alauda arvensis*) is sex and age biased, and affecting mainly adult males. This was related with the characteristic breeding male song-flights that make them more vulnerable to collision with wind turbines (Morinha *et al.* 2014). It seems this may also be responsible for mortalities of Red-capped Lark (*Calandrella cinerea*) at a wind farm in South Africa (Ralston, M. in litt. 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). The same may be true for Blue Crane, as preliminary indications are that the species are not particularly vulnerable to turbine collisions (Ralston, M. in litt. 2016), despite being highly vulnerable to powerlines collisions.

Several collision risk models incorporate other variables related to bird behaviour. Flight altitude is widely considered important in determining the risk of bird collisions with offshore and onshore wind turbines, as birds that tend to fly at the height of rotor swept zones are more likely to collide (e.g. Band *et al.* 2007; Furness *et al.* 2013; Garthe and Hüppop, 2004).

Maralla West
All the priority species recorded at the study area (except flamingos) can be classified as either terrestrial species or soaring species. Terrestrial species spend most of the time foraging on the ground. They do not fly often and then generally short distances at low to medium altitude, usually powered flight. At the wind farm site, korhaans and bustards are included in this category. Some larger species undertake longer distance flights at higher altitudes (specifically Ludwig's Bustard). 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 wind farm site, the raptor and stork species are included in this class. Based on the potential time spent potentially flying at rotor height, soaring species are likely to be at greater risk of collision, especially Verreaux's Eagle, Martial Eagle and Jackal Buzzard, and to

a lesser extent Black Harrier, all of which are vulnerable to turbine collisions (Ralston, M. *in litt*. 2016). However, specific behaviour of some terrestrial species might put them at risk of collision, e.g. display flights of Southern Black Korhaan might place them within the rotor swept zone.

- Avoidance behaviours

Collision fatalities are also related to displacement and avoidance behaviours, as birds that do not exhibit either of these behaviours are more likely to collide with wind turbines. The lack of avoidance behaviour has been highlighted as a factor explaining the high fatality of White-tailed Eagles at Smøla wind farm, as no significant differences were found in the total amount of flight activity within and outside the wind farm area (Dahl *et al.* 2013). However, the birds using the Smøla wind farm are mainly sub-adults, indicating that adult eagles are being displaced by the wind farm (Dahl *et al.* 2013).

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 also important to note that there is not necessarily a direct correlation between time spent at rotor height, and the likelihood of collision.

Displacement due to wind farms, which can be defined as reduced bird breeding density within a short distance of a wind turbines, has been described for some species (Pearce-Higgins *et al.* 2009). Birds exhibiting this type of displacement behaviour when defining breeding territories are less vulnerable to collisions, not because of morphological or site-specific factors, but because of altered behaviour (see also section 6.2 below).

<u>Maralla West</u>
It is anticipated that the birds at the proposed wind farm will successfully avoid the wind turbines most of the time. However, risky situations may develop with raptors (especially Verreaux's' Eagle, Martial Eagle, Jackal Buzzard and Black Harrier) engaged in hunting which might serve to distract them and place them at risk of collision, or birds engaged in display behaviour, e.g. Southern Black Korhaan (see earlier point). Raptors engaged in territorial defence involving conspecifics, or being mobbed by crows or other raptors are at particular risk as they are distracted during such activities (Simmons 2016).

Despite being potential collision candidates based on morphology and flight behaviour, bustards do not seem to be particularly vulnerable to wind turbine collisions, indicating a high avoidance rate (A. Camiña 2012a). To date, no Ludwig's Bustard collisions have been recorded at operational South African wind farms (Ralston, M. *in litt.* 2016). Obviously it is too early to make conclusive statements about the vulnerability of the species to wind turbine collisions, but these early indications are promising.

- 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; Smallie 2015). 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).

Maralla West
The abundance of priority species at the proposed wind farm site will fluctuate depending on season of the year, and particularly in response to rainfall. This is a common phenomenon in arid ecosystems, where stochastic rainfall events can trigger irruptions of insect populations which in turn attract large numbers of birds, e.g. Ludwig' Bustard. In general, higher populations of priority species are likely to be present when the veld conditions are good, especially in the rainy season. The overall abundance of priority species in the study area was low, but this is to be expected for apex predators such as Verreaux's and Martial Eagles.

4.2.2 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 (see previous section). 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.

Maralla West
Landscape features are likely to play an important role at the site. The site basically consists of rolling hills and low mountains with steep slopes, exposed ridge lines and low cliffs. These landscape features at the site provide ample opportunities for slope soaring for large raptors using declivity currents and orographic lift.

- Flight paths

Although the abundance of a species per se may not contribute to a higher collision rate with wind turbines, as previous discussed, areas with a high concentration of birds seem to be particularly at risk of collisions (Drewitt and Langston, 2006), and therefore several guidelines on wind farm construction advise special attention to areas located in migratory paths (e.g. Atienza *et al.* 2012; CEC, 2007; USFWS, 2012). As an example, Johnson *et al.* (2002) noted that over two-thirds of the carcasses found at a wind farm in Minnesota were of migrating birds. At certain times of the year, nocturnally migrating passerines are the most abundant species at wind farm, particularly during spring and fall migrations, and are also the most common fatalities (Strickland *et al.* 2011).

For territorial raptors like Golden Eagles, foraging areas are preferably located near to the nest, when compared to the rest of their home range. For example, in Scotland 98% of 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 closed 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). In Spain, on the other hand, a study spanning 7 provinces with an estimated Golden Eagle population of 384 individuals, with a combined total of 46 years of post-construction monitoring, involving 5 858 turbines, collisions did not occur at the nearest wind farm to the nest site but occurred in hunting areas with high prey availability far from the breeding territories, or randomly. A subset of data was used to investigate, inter alia, the relationship between collision mortality and proximity to wind turbines. Data was gathered for over a 12-year period. Analysis revealed that collisions are not related with the distance from the nest to the nearest turbine (Camiña 2014).

Wind farms located within flight paths can increase collision rates, as seen for the wind farm located close to a seabird breeding colony in Belgium (Everaert and Stienen, 2008). In this case, wind turbines were placed along feeding routes, and several species of gulls and terns were found to fly between wind turbines on their way to marine feeding grounds. Additionally, breeding adults flew closer to the structures when making frequent flights to feed chicks, which potentially increased the collision risk.

Maralla West
The study area is not located on any known migration route. The flight data collected during the 288 hours of vantage point watches provides some indication of the areas most frequented by large soaring species.

- 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 opportunistic foraging due to availability of food (Smallie 2015).

Maralla West
In semi-arid zones such as where this proposed wind farm is located, food availability is often linked to rainfall. It is a well-known fact that insect outbreaks may occur after rainfall events, which could draw in various priority species such as Ludwig's Bustard, and possibly Lesser Kestrel. This in turn could heighten the risk of collisions. Rock piles left after construction of the wind farm can become a micro habitat for rock hyrax which could attract large eagles.

- Weather

Certain weather conditions, such as strong winds that affect the ability to control flight manoeuvrability or reduce visibility, seem to increase the occurrence of bird collisions with artificial structures (Longcore *et al.* 2013). Some high bird fatality events at wind farms have been reported during instances of poor weather. For example, at an offshore research platform in Helgoland, Germany, over half of the bird strikes occurred on just two nights that were characterized by very poor visibility (Hüppop *et al.* 2006). Elsewhere, 14 bird carcasses were found at two adjacent wind turbines after a severe thunderstorm at a North American wind farm (Erickson *et al.* 2001). However, in these cases, there may be a cumulative effect of bad weather and increased attraction to artificial light. Besides impairing visibility, low altitude clouds can in turn lower bird flight height, and therefore increasing their collision risk with tall obstacles (Langston and Pullan, 2003). For wind farms located along migratory routes, the collision risk may not be the same throughout a 24-h period, as the flight altitudes of birds seem to vary. The migration altitudes of soaring birds have been shown to follow a typically diurnal pattern, increasing during the morning hours, peaking toward noon, and decreasing again in the afternoon, in accordance with general patterns of daily temperature and thermal convection (Kerlinger, 2010; Shamoun-Baranes *et al.* 2003).

Collision risk of raptors is particularly affected by wind. For example, Golden Eagles migrating over a wind farm in Rocky Mountain showed variable collision risk according to wind conditions, which decreased when the wind speed raised and increased under head- and tailwinds when compared to western crosswinds (Johnston *et al.* 2014).

Maralla West
Weather conditions at the proposed wind farm are likely to influence flight behaviour in much the same manner as has been recorded elsewhere at wind farms. Most soaring flight activity of priority raptors was recorded during light to gentle breezes with a north-westerly orientation (see **APPENDIX 5**).

4.2.3 WIND FARM-SPECIFIC FACTORS

- Turbine and wind mast features

Turbine features may play a role in collision risk. Older lattice-type towers have been associated with high collision risk, as some species exhibiting high fatality rates used the turbine poles as roosts or perches when hunting (Osborn *et al.* 1998; Thelander and Rugge, 2000). However, in more recent studies, tower structure did not influence the number of bird collisions, as it was not higher than expected according to their availability when compared to collisions with tubular turbines (Barrios and Rodríguez, 2004).

Turbine size has also been highlighted as an important feature, as higher towers have a larger rotor swept zone and, consequently, a larger collision risk area. While this makes intuitive sense, the majority of published scientific studies indicate that an increase in rotor swept area do not automatically translate into a larger collision risk. Turbine dimensions seem to play an insignificant role in the magnitude of the collision risk in general, relative to other factors such as topography, turbine location, morphology and a species' inherent ability to avoid the turbines, and may only be relevant in combination with other factors, particularly wind strength and topography (see Howell 1997, Barrios & Rodriguez 2004; Barclay *et al.* 2007, Krijgsveld *et al.* 2009, Smallwood 2013; Everaert 2014). Only two studies so far found a correlation between turbine hub height and mortality (De Lucas *et al.* 2008; Loss *et al.* 2013).

Rotor speed (revolutions per minute) also seems to be relevant, as faster rotors are responsible for higher fatality rates (Thelander *et al.* 2003). However, caution is needed when analysing rotor speed alone, as it is usually correlated with other features that may influence collision risk as turbine size, tower height and rotor diameter (Thelander *et al.* 2003), and because rotor speed is not proportional to the blade speed. In fact, fast spinning rotors have fast moving blades, but rotors with lower resolutions per minute may drive higher blade tip speeds.

Wind masts could act as a magnet for large raptors, as the booms supporting the anemometers provide an ideal roosting platform. This could draw the birds into an area where they could be exposed to a collision risk.

<u>Maralla West</u>
Due to the fact that the turbine dimensions are constantly changing as newer models are introduced, it is best to take a pre-cautionary approach in order to anticipate any future potential changes in the turbine dimensions. The pre-construction monitoring programme worked with a potential rotor swept area of 30m – 220m to incorporate a wide range of models.

The temporary wind mast at the site is currently acting as a roost for a pair of Martial Eagles. Both birds have been observed roosting on the booms supporting the anemometers. This creates a collision risk as the birds will frequent the area due to the presence of the roost, a fact which is supported by the flight data gathered during VP watches. The booms on the wind mast need to be modified in order to prevent the birds from being able to roost on them, which will force the birds to roost elsewhere e.g. in the grove of poplar trees at Maralla East. It is likely that unless the issue of the booms is addressed, that the birds will always be at risk as they will always be drawn to the wind mast as a potential roost, irrespective of where the permanent wind mast will be located. This would necessitate the implementation of a substantial no-turbine zone. However, the issue was raised with BioTherm and they have undertaken to implement the necessary modifications to the booms, in consultation with the avifaunal specialist, which will eliminate the need for a buffer zone.

- Blade visibility

When turbine blades spin at high speeds, a motion smear (or motion blur) effect occurs, making wind turbines less conspicuous. This effect occurs both in the old small turbines that have high rotor speed and in the newer high turbines that despite having slower rotor speeds, achieve high blade tip speeds. Motion smear effect happens when an object is moving too fast for the brain to process the images and, as a consequence, the moving object appears blurred or even transparent to the observer. The effect is dependent on the velocity of the moving object and the distance between the object and the observer. The retinal-image velocity of spinning blades increases as birds get closer to them, until it eventually surpasses the physiological limit of the avian retina to process temporally changing stimuli. As a consequence, the blades may appear transparent and perhaps the rotor swept zone appears to be a safe place to fly (Hodos, 2003). For example, McIsaac (2001) showed that American Kestrels were not always able to distinguish moving turbine blades within a range of light conditions.

Maralla West
Motion smear is inherent to all wind turbines and will therefore also be a potential risk factor at the proposed wind farm.

- Wind farm configuration

Wind farm lay-out can also have a critical influence on bird collision risk. For example, it has been demonstrated that wind farms arranged perpendicularly to the main flight path may be responsible for a higher collision risk (Everaert *et al.* 2002 & Isselbacher and Isselbacher, 2001 in Hötker *et al.* 2006). At APWRA, wind farms located at the ends of rows, next to gaps in rows, and at the edge of local clusters were found to kill disproportionately more birds (Smallwood and Thellander, 2004). In this wind farm, serially arranged wind turbines that form wind walls are safer for birds (suggesting that birds recognize wind turbines and towers as obstacles and attempt to avoid them while flying), and fatalities mostly occur at single wind turbines or wind turbines situated at the edges of clusters (Smallwood and Thellander, 2004). However, this may be a specificity of APWRA. For instance, De Lucas *et al.* (2012a) found that the positions of the wind turbines within a row did not influence the turbine fatality rate of Griffon Vultures at Tarifa. Additionally, engineering features of the newest wind turbines require a larger minimum distance between adjacent wind turbines and in new wind farms it is less likely that birds perceive rows of turbines as impenetrable walls. In fact, in Greece it was found that the longer the distance between wind turbines, the higher is the probability that raptors will attempt to cross the space between them (Cárcamo *et al.* 2011).

Maralla West
The results of the pre-construction monitoring have indicated areas of high flight activity which are frequented by Red Data Martial Eagles, Verreaux's Eagles and Black Harriers. These areas necessitated buffer zones which were considered in the final lay-out and the number of turbines was reduced from 125 to 70 and finally to 56.

4.3 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 operational 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. Onshore, disturbance distances (in other words the distance from wind farms up to which birds are absent or less abundant than expected) up to 800 m (including zero) have been recorded for wintering waterfowl (Pedersen & Poulsen 1991 as cited by Drewitt & Langston 2006), though 600 m is widely accepted as the maximum reliably recorded distance (Drewitt & Langston 2006). The variability of displacement distances is illustrated by one study which found lower post-construction densities of feeding European White-fronted Geese *Anser albifrons* within 600 m of the turbines at a wind farm in Rheiderland, Germany (Kruckenberg & Jaene 1999 as cited by Drewitt & Langston 2006), while another showed displacement of Pink-footed Geese *Anser brachyrhynchus* up to only 100–200 m from turbines at a wind farm in Denmark (Larsen & Madsen 2000 as cited by Drewitt & Langston 2006). 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). 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 seem to be little evidence for a persistent decline in passerine populations at wind farm sites in the UK (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).

The effect of birds altering their migration flyways or local flight paths to avoid a wind farm is also a form of displacement. This effect is of concern because of the possibility of increased energy expenditure when birds have to fly further, as a result of avoiding a large array of turbines, and the potential disruption of linkages between distant feeding, roosting, moulting and breeding areas otherwise unaffected by the wind farm. The effect depends on species, type of bird movement, flight height, distance to turbines, the layout and operational status of turbines, time of day and wind force and direction, and can be highly variable, ranging from a slight 'check' in flight direction, height or speed, through to significant diversions which may reduce the numbers of birds using areas beyond the wind farm (Drewitt & Langston 2006). A review of the literature suggests that none of the barrier effects identified so far have significant impacts on populations (Drewitt & Langston 2006). However, there are circumstances where the barrier effect might lead indirectly to population level impacts; for example where a wind farm effectively blocks a regularly used flight line between nesting and foraging areas, or where several wind farms interact cumulatively to create an extensive barrier which could lead to diversions of many tens of kilometres, thereby incurring increased energy costs.

<u>Maralla West</u>
None of the priority species are likely to be permanently displaced due to disturbance, although displacement in the short term during the construction phase is very likely. The risk of permanent displacement is greater for large species such as Ludwig's Bustard, although displacement of the closely related Denham's Bustard (*Neotis denhami*) is evidently not happening at existing wind farms in the Eastern Cape (M. Langlands 2016 pers. comm, Rossouw 2016 pers. comm). If the wind farm follows the modern trend of fewer, larger turbines, the risk of displacement is also lower. However, this will only be established through a post-construction monitoring programme.

No active raptor nests were recorded on the site (see Figure 16).

4.4 DISPLACEMENT DUE TO HABITAT LOSS

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 area (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 subtler, 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 were 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. 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 (Alan *et al.* 1997).

<u>Maralla West</u>
The direct habitat transformation at the proposed wind farm is likely to be fairly minimal. The indirect habitat transformation (habitat fragmentation) is likely to have a bigger impact on priority species. It is expected that the densities of most priority species will decrease due to this impact, but complete displacement is unlikely. Indications are that bustards continue to use the wind farm areas (M. Langlands 2016 pers. comm, Rossouw 2016 pers. comm.).

4.5 MORTALITY ON INTERNAL POWERLINE INFRASTRUCTURE

Negative impacts on birds by electricity infrastructure generally take two forms namely electrocution and collisions (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs and Ledger 1986a; Hobbs & Ledger 1986b; Ledger, Hobbs & Smith, 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000; Van Rooyen 2004; Jenkins *et al.* 2010). Birds also impact on the infrastructure through nesting and streamers, which can cause interruptions in the electricity supply (Van Rooyen *et al.* 2002).

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 2004). The electrocution risk is largely determined by the pole/tower design. In the case of the proposed Maralla wind facilities, no electrocution risk is envisaged because the design of the steel mono-pole 132kV lines will not pose an electrocution threat to any of the priority species which are likely to occur at the site. The medium voltage collector system will comprise of cables (11kV up to and including 33kV) that will be run underground, expect where a technical assessment suggest that overhead lines are applicable. This will greatly reduce the threat of electrocution.

Collisions are probably the bigger threat posed by transmission lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. 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). In a recent PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with transmission lines:

"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).

The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin et al. 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown et al. 1987, Henderson et al. 1996).

Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 2012).

The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e. the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins et al. 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Alonso et al. 1994a, Bevanger 1994)."

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 14 below - Jenkins *et al.* 2010).

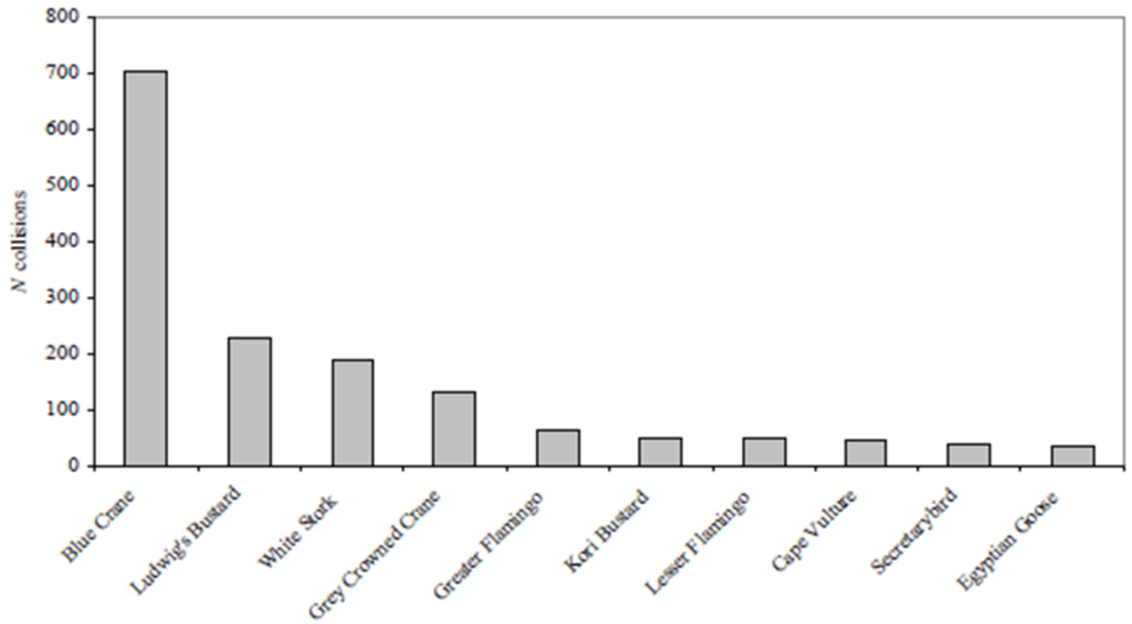


Figure 14: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

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 a recent 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 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).

Several factors are thought to influence avian collisions, including the manoeuvrability of the bird, topography, weather conditions and power line configuration. An important additional factor that previously has received little attention is the visual capacity of birds; i.e. whether they are able to see obstacles such as power lines, and whether they are looking ahead to see obstacles with enough time to avoid a collision. In addition to helping explain the susceptibility of some species to collision, this factor is key to planning effective mitigation measures. Recent research provides the first evidence that birds can render themselves blind in the direction of travel during flight through voluntary head movements (Martin & Shaw 2010). Visual fields were determined in three bird species representative of families known to be subject to high levels of mortality associated with power lines i.e. Kori Bustards, Blue Cranes *Anthropoides paradiseus* and White Storks *Ciconia ciconia*. In all species the frontal visual fields showed narrow and vertically long binocular fields typical of birds that take food items directly in the bill under visual guidance. However, these species differed markedly in the vertical extent of their binocular fields and in the extent of the blind areas which project above and below the binocular fields in the forward facing hemisphere. The importance of these blind areas is that when in flight, head movements in the vertical plane (pitching the head to look downwards) will render the bird blind in the direction of travel. Such movements may frequently occur when birds are scanning below them (for foraging or roost sites, or for conspecifics). In bustards and cranes pitch movements of only 25° and 35°, respectively, are sufficient to render the birds blind in the direction of travel; in storks, head movements of 55° are necessary. That flying birds can render themselves blind in the direction of travel has not been previously recognised and has important implications for the effective mitigation of collisions with human artefacts including wind turbines and power lines. These findings have applicability to species outside of these families especially raptors (*Accipitridae*) which are known to have small binocular fields and large blind areas similar to those of bustards and cranes, and are also known to be vulnerable to power line collisions.

Despite doubts about the efficacy of line marking to reduce the collision risk for bustards (Jenkins *et al.* 2010; Martin *et al.* 2010), there are numerous studies which prove that marking a line with PVC spiral type Bird Flight Diverters (BFDs) generally reduce mortality rates (e.g. Barrientos *et al.* 2011; Jenkins *et al.* 2010; Alonso & Alonso 1999; Koops & De Jong 1982), including to some extent for bustards (Barrientos *et al.* 2012; Hoogstad 2015 pers.comm). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. Barrientos *et al.* (2011) reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease of 55–94% in bird mortalities. Koops and De Jong (1982) found that the spacing of the BFDs was critical in reducing the mortality rates - mortality rates are reduced up to 86% with a spacing of 5m, whereas using the same devices at 10m intervals only reduces the mortality by 57%. Barrientos *et al.* (2012) found that larger BFDs were more effective in reducing Great Bustard collisions than smaller ones. Line markers should be as large as possible, and highly contrasting with the background. Colour is probably less important as during the day the background will be brighter than the obstacle with the reverse true at lower light levels (e.g. at twilight, or during overcast conditions). Black and white interspersed patterns are likely to maximise the probability of detection (Martin *et al.* 2010).

<u>Maralla West</u>
The internal powerline could pose a collision risk to some priority species. Species most at risk are Ludwig's Bustard, Southern Black Korhaan, Greater Flamingo, Martial Eagle and Verreaux's Eagle.

5 DETAILED DESCRIPTION OF IMPACTS PER PHASE

5.1 DISPLACEMENT OF PRIORITY SPECIES DUE TO DISTURBANCE (CONSTRUCTION AND DE-COMMISSIONING)

The construction (and de-commissioning) of the wind farm and associated infrastructure, including the on-site powerline and road network, will result in a significant amount of movement and noise, which will lead to temporary displacement of avifauna from the site. It is highly likely that most priority species listed in Table 2 will vacate the area for the duration of these activities. None of the priority species are likely to be permanently displaced due to disturbance, although displacement in the short term during the construction and de-commissioning phases is very likely. The risk of permanent displacement is larger for large species such as Ludwig's Bustard, although displacement of the closely related Denham's Bustard (*Neotis denhami*) is evidently not happening at existing wind farms in the Eastern Cape (M. Langlands 2016 pers. comm, Rossouw 2016 pers. comm). If the wind farm follows the modern trend of fewer, larger turbines, the risk of displacement is also lower. However, this will only be established through a post-construction monitoring programme.

5.2 PRIORITY SPECIES MORTALITY DUE TO COLLISION WITH THE TURBINES (OPERATION)

Priority species that could potentially be vulnerable to wind turbine collisions are listed in Table 2.

- Priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are Southern Black Korhaan, Grey-winged Francolin, Greater Flamingo and Ludwig's Bustard. It is noted though that no Ludwig's Bustard mortalities have as yet been reported at wind farms in South Africa, despite initial concerns that the species might be vulnerable in this respect (Ralston, M. *in litt.* 2016).

- Many of the priority species at the proposed wind farm probably have high resolution vision areas found in the lateral fields of view, rather than frontally, e.g., the bustards, korhaans and passerines. The possible exceptions to this are the 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. The major concern at the site is collision mortality of raptors, namely Verreaux's Eagle, Martial Eagle, Jackal Buzzard and Black Harrier. All of these have been recorded as collision victims at wind farms in South Africa (Ralston, M*. in litt*. 2016), despite their wide binocular fields.
- Soaring species are likely to be at greater risk of collision than terrestrial species, especially Verreaux's Eagle, Martial Eagle and Jackal Buzzard, and to a lesser extent Black Harrier, all of which are vulnerable to turbine collisions (Ralston, M. *in litt*. 2016). However, specific behaviour of some terrestrial species might put them at risk of collision, e.g. display flights of Southern Black Korhaan might place them within the rotor swept zone.
- It is anticipated that the birds at the proposed wind farm will successfully avoid the wind turbines most of the time. However, risky situations may develop with raptors (especially Verreaux's' Eagle, Martial Eagle, Jackal Buzzard and Black Harrier) engaged in hunting which might serve to distract them and place them at risk of collision, or birds engaged in display behaviour, e.g. Southern Black Korhaan (see earlier point). Raptors engaged in territorial defence involving conspecifics, or being mobbed by crows or other raptors are at particular risk as they are distracted during such activities (Simmons 2016). The temporary wind mast at the site is currently acting as a roost for a pair of Martial Eagles. Both birds have been observed roosting on the booms supporting the anemometers. This creates a collision risk as the birds will frequent the area due to the presence of the roost, a fact which is supported by the flight data gathered during VP watches. The booms on the wind mast need to be modified in order to prevent the birds from being able to roost on them, which will force the birds to roost elsewhere e.g. in the grove of poplar trees at Maralla East. It is likely that unless the issue of the booms is addressed, that the birds will always be at risk as they will always be drawn to the wind mast as a potential roost, irrespective of where the permanent wind mast will be located. This would necessitate the implementation of a substantial no-turbine zone. However, the issue was raised with BioTherm and they have undertaken to implement the necessary modifications to the booms, in consultation with the avifaunal specialist, which will eliminate the need for a buffer zone.
- Despite being potential collision candidates based on morphology and flight behaviour, bustards do not seem to be particularly vulnerable to wind turbine collisions, indicating a high avoidance rate (A. Camiña 2012a). To date, no Ludwig's Bustard collisions have been recorded at operational South African wind farms (Ralston, M. in litt. 2016). Obviously it is too early to make conclusive statements about the vulnerability of the species to wind turbine collisions, but these early indications are promising
- Landscape features are likely to play an important role at the site. The site basically consists of rolling hills and low mountains with steep slopes, exposed ridge lines and low cliffs. These landscape features at the site provide ample opportunities for slope soaring for large raptors using declivity currents and orographic lift which could them at risk of collisions.
- The study area is not located on any known migration route. The flight data collected during the 288 hours of vantage point watches provides some clues to the areas most frequented by large soaring species. The results of the pre-construction monitoring have indicated areas of high flight activity which are frequented by Red Data Martial Eagles, Verreaux's Eagles and Black Harriers. These areas were considered in the final lay-out.
- In semi-arid zones such as where this proposed wind farm is located, food availability is often linked to rainfall. It is a well-known fact that insect outbreaks may occur after rainfall events, which could draw in various priority species such as Ludwig's Bustard, and possibly Lesser Kestrel. This in turn could heighten the risk of collisions. Rock piles left after construction of the wind farm can become a micro habitat for rock hyrax which could draw in large eagles.

5.3 DISPLACEMENT OF PRIORITY SPECIES DUE TO HABITAT TRANSFORMATION (OPERATION)

Priority species that could potentially be vulnerable to displacement due to habitat transformation are listed in Table 2. The direct habitat transformation at the proposed wind farm is likely to be fairly minimal. The indirect habitat transformation (habitat fragmentation) is likely to have a bigger impact on priority species. It is expected that the densities of some terrestrial priority species (e.g. Southern Black Korhaan and Grey-winged Francolin) will decrease due to this impact, but complete displacement is unlikely. Raptors are unlikely to be affected. Indications are that bustards continue to use the wind farm areas (M. Langlands 2016 pers. comm, Rossouw 2016 pers. comm).

5.4 MORTALITY OF PRIORITY SPECIES DUE TO COLLISIONS WITH THE 132KV ON-SITE POWERLINE (OPERATION)

Priority species that could potentially be vulnerable to powerline collision mortality with the internal 132kV powerline are listed in Table 2. The most likely priority species candidates for collision mortality on the proposed 132kV power lines are medium to large terrestrial species i.e. Southern Black Korhaan and particularly Ludwig's Bustard. Greater Flamingo could also be at risk. The combination of IPP A and Common Substation 1 is strongly preferred due to its short length.

5.5 MORTALITY OF PRIORITY SPECIES DUE TO ELECTROCUTIONS WITH THE ON-SITE MEDIUM VOLTAGE NETWORK (OPERATION)

The medium voltage collector system will comprise of cables (11kV up to and including 33kV) that will be run underground, expect where a technical assessment suggest that overhead lines are applicable. This will greatly reduce the threat of electrocution. However, in those areas where overhead lines will be required, large raptors could be exposed to electrocution risks on the reticulation poles, unless bird-friendly structures are used.

5.6 NO-GO AREAS

Several turbine exclusion zones have been identified from the flight data gathered during 288 hours of VP watches. These exclusion zones focused on the recorded flight patterns of Martial Eagle, Verreaux's Eagle and Black Harrier. The flight patterns were interpreted taking into account relevant landscape features e.g. slopes and ridges to guide the delineation[10]. Anticipated areas of high avifaunal activity such as dams were also considered, taking into account the fact that numbers of waterbirds can vary greatly seasonally and annually, depending on dam levels.

See Figure 15 below for a map of the proposed exclusion zones.

[10] BioTherm undertook to modify the wind mast design to prevent large raptors from perching on the mast (see Table 5), prior to the construction of the wind turbines. No buffer-zone is therefore recommended around the wind mast as it will not attract perching or roosting large raptors once the modification has been implemented.

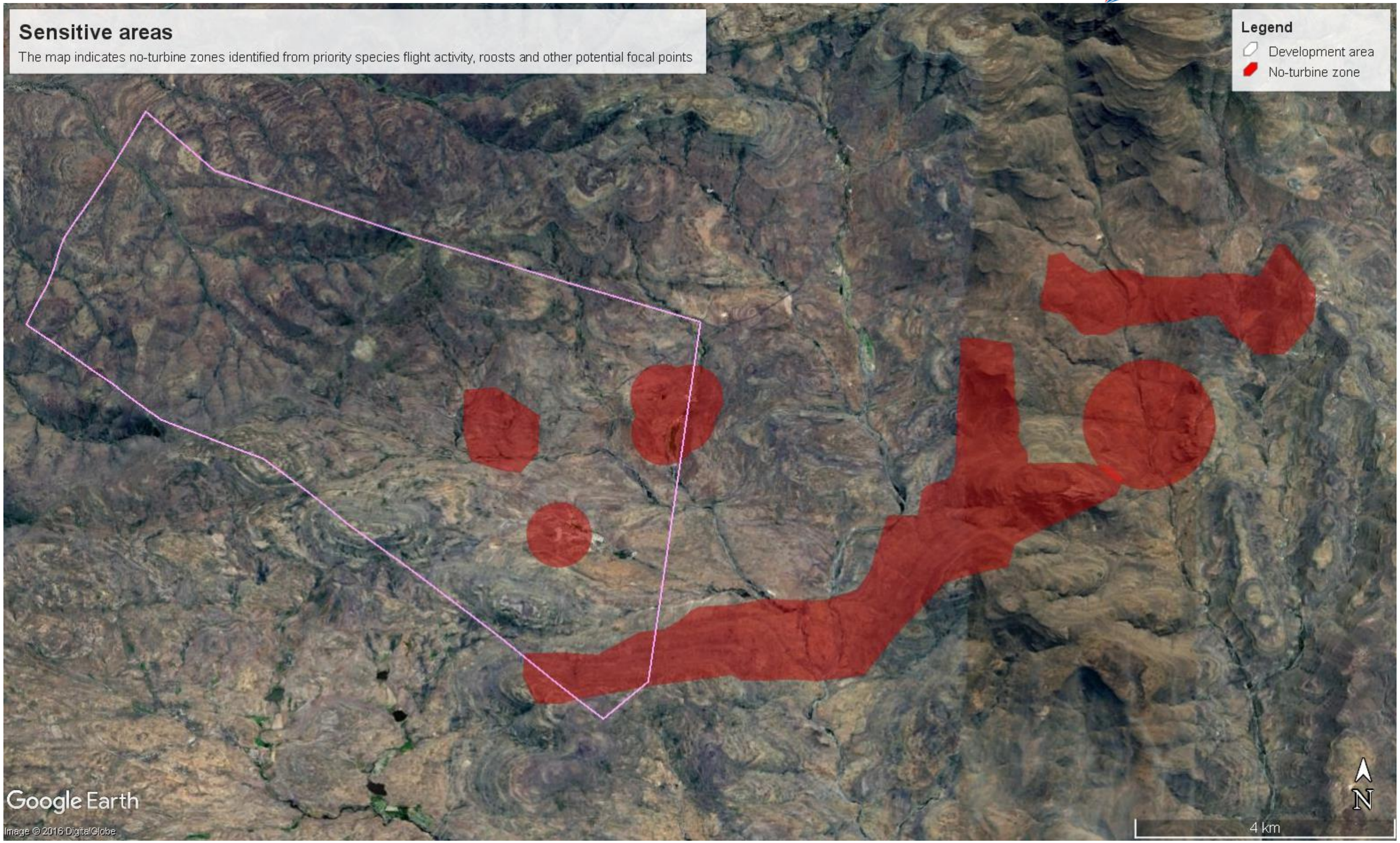


Figure 15: Proposed no turbine exclusion zones

5.7 PREFERRED ALTERNATIVE: INTERNAL POWERLINES AND SUBSTATION

The combination of IPP A and Common Substation 1 is strongly preferred due to its short length.

5.8 CUMULATIVE IMPACTS

The renewable energy project applications currently registered with DEA within a 45km radius around the proposed developments are listed in APPENDIX 6[11]. Possible impacts by renewable energy projects on birds within this area are temporary displacement due to disturbance associated with the construction of the facility and associated infrastructure, collisions with solar panels and wind turbines, permanent displacement due to habitat transformation, entrapment in perimeter fences and collisions with the associated power lines.

Apart from renewable energy developments, several other threats are currently facing avifauna within the Karoo habitat (Marnewick *et al.* 2015):

- Overgrazing

This results in a depletion of palatable plant species, erosion, and encroachment by Karoo shrubs. The result is loss of suitable habitat and a decrease in the availability of food for large terrestrial birds. Centre-pivot irrigated croplands using underground water are increasing and agriculture is intensifying.

- Poisoning

Strychnine poison was used extensively in the past to control damage-causing predators, such as Black-backed Jackal *Canis mesomelas* and Caracal *Caracal caracal*, and reduced scavenging raptor populations. The use of poison may be continuing, and the potential impacts on threatened raptor species has not been confirmed or quantified.

- Road-kills

Many birds are commonly killed on roads, especially nocturnal species such as Spotted Eagle-Owl.

- Powerlines

Numerous existing and new power lines are significant threats to some priority species. Power lines kill substantial numbers of all large terrestrial bird species in the Karoo, including threatened species (Jenkins *et al*. 2010; Shaw, J. 2013) There is currently no completely effective mitigation method to prevent collisions.

- Climate change

Climate change scenarios for the region predict slightly higher summer rainfall by 2050, and increased rainfall variability. Droughts are expected to become more severe. The climate change is predicted to have both positive and negative consequences for priority species. Increased summer rainfall could improve survival, and conversely drought years can lower long-term average survival. Large, mainly resident species dependent on rainfall are also more vulnerable to climate change. This would include the slow-breeding Verreaux's Eagle, Tawny Eagle and Martial Eagle, which also exhibit extended parental care. Severe hailstorms kill many priority species and could become more frequent.

- Shale gas fracking

[11] This information was provided by WSP Parsons Brinckerhoff and is assumed to be accurate. Additional information was sourced from the internet, where available.

There is a potential threat of shale gas fracking throughout the Karoo. Populations of bird species may be locally reduced through disturbance caused by lights, vibration, vehicles and dust, and may be affected by pollutants in ponds containing contaminated water produced by returned fracking fluids.

- Persecution

Although it is difficult to prove, the direct persecution of raptors such as Verreaux's Eagle and Martial Eagle for stock predation is still taking place (R. Visagie pers. comm).

The greatest potential concern in the 70km radius around Komsberg Substation is for the large raptor species, particularly Verreaux's Eagle and Martial Eagle, due to their low numbers and vulnerability to turbine collisions. The total estimated area that could potentially be affected by renewable projects are approximately 233 503 ha, which is approximately 15% of the land surface within the 70km radius, although the actual footprint is likely to be smaller, as this figure is based largely on land parcel size, and not the actual infrastructure footprint. Nonetheless, the combined cumulative impact of renewable developments on priority species, and particularly wind energy developments on Red Data Verreaux's Eagle and Martial Eagle within the 70km radius around the Komsberg Substation, is potentially significant at a local or even regional scale, even with the application of mitigation measures such as buffer zones around nests, should all of these projects eventually get to be constructed. The impact should be less severe at a national level, due to the large distribution ranges of the species, but should nonetheless be carefully monitored.

6. ASSESSMENT OF IMPACTS

The EIA uses a methodological framework developed by WSP | Parsons Brinckerhoff to meet the combined requirements of international best practice and NEMA, Environmental Impact Assessment Regulations, 2014 (GN No. 982) (the "EIA Regulations").

As required by the EIA Regulations (2014), the determination and assessment of impacts were based on the following criteria:

- Nature of the Impact
- Significance of the Impact
- Consequence of the Impact
- Extent of the impact
- Duration of the Impact
- Probability if the impact
- Degree to which the impact:
  - can be reversed;
  - may cause irreplaceable loss of resources; and
  - can be avoided, managed or mitigated.

Following international best practice, additional criteria have been included to determine the significant effects. These include the consideration of the following:

- Magnitude: to what extent environmental resources are going to be affected;
- Sensitivity of the resource or receptor (rated as high, medium and low) by considering the importance of the receiving environment (international, national, regional, district and local), rarity of the receiving environment, benefits or services provided by the environmental resources and perception of the resource or receptor); and
- Severity of the impact, measured by the importance of the consequences of change (high, medium, low, negligible) by considering inter alia magnitude, duration, intensity, likelihood, frequency and reversibility of the change.

It should be noted that the definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

6.1 METHODOLOGY

Impacts were assessed in terms of the following criteria:

- The **nature**, a description of what causes the effect, what will be affected and how it will be affected

Nature or Type of Impact	Definition
Beneficial / Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Adverse / Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that arise directly from activities that form an integral part of the Project (e.g. new infrastructure).
Indirect	Impacts that arise indirectly from activities not explicitly forming part of the Project (e.g. noise changes due to changes in road or rail traffic resulting from the operation of Project).
Secondary	Secondary or induced impacts caused by a change in the Project environment (e.g. employment opportunities created by the supply chain requirements).
Cumulative	Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.

- The physical **extent**, wherein it is indicated whether:

Score	Description
1	the impact will be limited to the site;
2	the impact will be limited to the local area;
3	the impact will be limited to the region;
4	the impact will be national; or
5	the impact will be international;

- The **duration**, wherein it is indicated whether the lifetime of the impact will be:

Score	Description
1	of a very short duration (0 to 1 years)
2	of a short duration (2 to 5 years)
3	medium term (5–15 years)
4	long term (> 15 years)
5	permanent

→ The **magnitude of impact on ecological processes**, quantified on a scale from 0-10, where a score is assigned:

Score	Description
0	small and will have no effect on the environment.
2	minor and will not result in an impact on processes.
4	low and will cause a slight impact on processes.
6	moderate and will result in processes continuing but in a modified way.
8	high (processes are altered to the extent that they temporarily cease).
10	very high and results in complete destruction of patterns and permanent cessation of processes.

→ The **probability of occurrence**, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale where:

Score	Description
1	very improbable (probably will not happen.
2	improbable (some possibility, but low likelihood).
3	probable (distinct possibility).

4 highly probable (most likely).

5 definite (impact will occur regardless of any prevention measures).

- the **significance**, which is determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high;
- the **status**, which is described as either positive, negative or neutral;
- the degree to which the impact can be reversed;
- the degree to which the impact may cause irreplaceable loss of resources; and
- the *degree* to which the impact can be mitigated.

The **significance** is determined by combining the criteria in the following formula:

$$S = (E+D+M)*P$$

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

Overall Score	Significance Rating	Description
< 30 points	**Low**	where this impact would not have a direct influence on the decision to develop in the area
31-60 points	**Medium**	where the impact could influence the decision to develop in the area unless it is effectively mitigated
> 60 points	**High**	where the impact must have an influence on the decision process to develop in the area

5.1 IMPACT ASSESSMENT TABLES

The impact assessment tables are attached as APPENDIX 7.

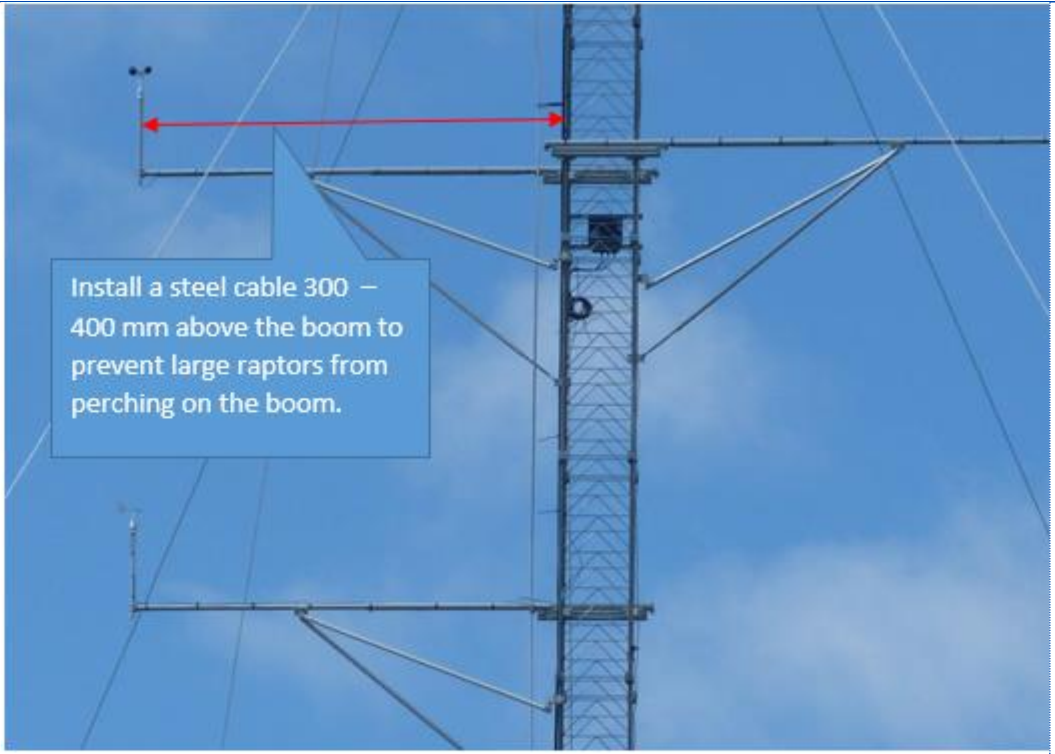
7. MITIGATION AND MANAGEMENT MEASURES

The proposed mitigation measures are set out below in **Table 5.**

Table 5: Mitigation and management

Activity	Mitigation and Management Measure	Responsible Person	Applicable Development Phase	Include as Condition of Authorisation	Monitoring requirements
Displacement of priority species due to disturbance during construction operations	1) A site-specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the CEMP and should apply good environmental practice during construction. 2) Environmental Control Officers to oversee activities and ensure that the site-specific construction environmental management plan (CEMP) is implemented and enforced; 3) The appointed Environmental Control Officer (ECO) must be trained by an avifaunal specialist to identify the potential priority species as well as the signs that indicate possible breeding by these species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of Red Data species, and such efforts may include the training of construction staff to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species. If any of the Red Data species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed. 4) Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding/roosting activity of priority species, as well as any additional sensitive habitats. The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise. 5) No turbines should be constructed in no-go areas, while associated infrastructure (roads, powerlines and substations) should be avoided where possible in these areas;	ECO and Avifaunal specialist	Construction	Yes	None

	6) During the construction phase, an avifaunal specialist must conduct surveys/exploration of the WEF site (particularly focussing on potential Martial Eagle and Verreaux's Eagle roost sites as well as suitable nesting habitat). This should be done during and after, the breeding season (i.e. approximately in July and again in September) of large Eagles (e.g. Martial and Verreaux's Eagle). The aim will be to locate nest sites, so that these may continue to be monitored during the construction and operation phase.				
Priority species mortality due to collision with the turbines	1) The results of the pre-construction monitoring must guide the lay-out of the turbines, especially as far as proposed no-turbine zones are concerned. No turbines must be constructed in the high-risk areas which were identified based on the results of the pre-construction monitoring, with a specific view to limiting the risk of collisions to Verreaux's Eagle, Martial Eagle, Black Harrier and Greater Flamingo. 2) Once the turbines have been constructed, post-construction monitoring should be implemented under the guidance of an avifaunal specialist to assess collision rates, in accordance with the latest version of the Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. 3) If collision rates indicate unacceptable mortality levels of priority species, curtailment of selective turbines should be implemented if sufficient evidence emerges to link mortality to specific turbines. 4) Care should be taken not to create habitat for prey species that could draw priority raptors into the area and expose them to collision risk. Rock piles must be removed from site or covered with topsoil to prevent them from becoming habitat for Rock Hyrax (Dassie). 5) The booms on the wind mast must be modified to prevent them from becoming roost sites for large raptors. It is recommended that a horizontal thick steel cable is installed 300 - 400mm above the boom to create a physical barrier to prevent large raptors from perching on the boom (see below).	Wind farm management and avifaunal specialist	Operational	Yes	Once the turbines have been constructed, post-construction monitoring should be implemented under the guidance of an avifaunal specialist to assess collision rates, in accordance with the latest version of the Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa.

					
Displacement of priority species due to habitat transformation	1) A site-specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction 2) Existing roads and farm tracks should be used where possible; 3) The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths; 4) No off-road driving;	ECO Avifaunal specialist Rehabilitation specialist	Operational	Yes	Environmental Control Officers to oversee activities and ensure that the site-specific construction environmental management plan (CEMP) is

	5) Environmental Control Officers to oversee activities and ensure that the site-specific construction environmental management plan (CEMP) is implemented and enforced; 6) Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist. 7) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a rehabilitation specialist and included within the Construction Environmental Management Plan (CEMP).				implemented and enforced;
Priority species mortality due to collision with the on-site powerlines	1)An avifaunal specialist must conduct a site walk through of final pylon positions prior to construction to determine if, and where, bird flight diverters (BFDs) are required. 2) Install bird flight diverters as per the instructions of the specialist following the site walkthrough, which may include the need for modified BFDs fitted with solar powered LED lights on certain spans. 3) The operational monitoring programme must include regular monitoring of the grid connection power line for collision mortalities.	Avifaunal specialist	Operational	Yes	The operational monitoring programme must also include regular monitoring of the grid connection power line for collision mortalities.
Priority species mortality due to electrocution on the on-site powerlines	1)An avifaunal specialist must certify that the pole structures to be used on the internal MV network is bird-friendly.	Avifaunal specialist	Design	Yes	None
Displacement of priority species due to	1) A site-specific Decommissioning Environmental Management Plan (DEMP) must be implemented, which gives appropriate and detailed description of how decommissioning activities must be conducted to reduce unnecessary destruction of	Site management	Decommissioning	Yes	None

disturbance during decommissioning operations	habitat. All contractors are to adhere to the DEMP and should apply good environmental practice during decommissioning. 2) Following decommissioning, rehabilitation of all areas disturbed must be undertaken and to this end a habitat restoration plan is to be developed by a rehabilitation specialist and included within the Decommissioning Environmental Management Plan (CEMP).	Rehabilitation specialist			

7. STAKEHOLDER CONSULTATION

7.1. STAKEHOLDER CONSULTATION PROCESS

Public participation is a requirement of the S&EIR process; it consists of a series of inclusive and culturally appropriate interactions aimed at providing stakeholders with opportunities to express their views, so that these can be considered and incorporated into the S&EIR decision-making process. Effective public participation requires the prior disclosure of relevant and adequate project information to enable stakeholders to understand the risks, impacts, and opportunities of the Proposed Project.

A comprehensive stakeholder consultation process was undertaken during the scoping phase. Stakeholders were identified through existing databases, site notices, newspaper adverts and meetings. All stakeholders identified to date have been registered on the project database. All concerns, comments, viewpoints and questions (collectively referred to as 'issues') received to date have been documented and responded to in a Comment and Response Report.

There will be ongoing communication between WSP | Parsons Brinckerhoff and stakeholders throughout the S&EIR process.

7.2. STAKEHOLDER COMMENTS AND RESPONSE

stakeholder Details	Comment	Specialist Response
DEA&DP	4.4.1 This Directorate supports the recommendation of the Avifaunal Specialist Study (Chris van Rooyen Consulting. April 2016) that all turbines should be excluded from the west-facing slopes (i.e. slopes facing the dominant wind direction). which have been identified as avifauna! no-go areas. 4.4.2 As per the Avifaunal Specialist Study, this Directorate does not support development of turbines within the Martial Eagle roosting area.	The exclusion zones have since been revised, based on the results of the pre-construction monitoring, which provided a more accurate indication of potential high-risk zones.
Cape Nature	There are nests of raptors either within or just outside the property (Esizayo) and a roost on the boundary of the property (Maralla). In terms of the Verreaux's Eagle and Martial Eagle, where the exclusion zones are sighted around the nest and roost respectively, CapeNature cautions that it is possible that the foraging areas for these birds may occur inside the properties and that these exclusion zones, may need to be adapted to cater for such instances. It is probable that the Avifaunal Specialist is aware of	The exclusion zones have since been revised, based on the results of the pre-construction monitoring, which provided a more accurate indication of potential high-risk zones.

	this as he made mention of collisions in the Eastern Cape as a direct result of this, and this will have to be accounted for in the pre-construction monitoring phase. 5.2. The current layout of the turbines on both properties is fairly evenly dispersed over the entire property. These windfarms are all in natural vegetation and there is a strong possibility of habitat loss for sensitive species. The threatened Southern Black Korhaan for example (of which there are fairly high number of sightings on the properties), depends on natural vegetation for its existence and has disappeared from areas where the natural vegetation has been replaced by agriculture. These species can be catered for by concentrating turbines so that larger areas of undisturbed areas are available for them. The monitoring needs to take this into account and identify areas where these species occur in higher numbers so that turbine placement can be effectively implemented. 5.3. The one aspect that is not dealt with is the accumulative impact. Both sites are surrounded by other windfarm developments either proposed or at the bidding stage. Considering the size of the area that will eventually be under windfarms, this aspect needs to be addressed. Currently the accumulative impact is a difficult subject to address as there are a number of stakeholders involved because of the different applications, but DEA needs to be made aware of this and be reminded on a regular basis as they will have to come up with a plan to address this issue. The other aspect is the accumulative impact of collisions that also need to be addressed. 5.4. CapeNature is looking forward to analysing the	The pre-construction monitoring revealed a concentration of Southern Black Korhaan in the east of the proposed Maralla West development site with very few sightings in the remainder of the study area. This could possibly be linked to the flat topography in this area. Only two turbines are located in this area, which means that displacement of the species from this area is highly unlikely. The issue of cumulative impacts are addressed under Section 5.8 of this report.

	avifaunal monitoring results and proposed mitigation measures in light thereof.	

8. CONCLUSIONS

The proposed Maralla West WEF will have several potential impacts on avifauna at a site and regional level. These impacts are summarised in the table below:

Environmental parameter	Impact	Rating prior to mitigation	Rating post mitigation
Avifauna	Displacement of priority species due to disturbance during construction operations	-48 Medium	-40 Medium
	Priority species mortality due to collision with the turbines	-64 High	-48 Medium
	Displacement of priority species due to habitat transformation	-44 Medium	-27 Low
	Priority species mortality due to collision with the on-site powerlines	-64 High	-48 Medium
	Priority species mortality due to electrocution on the on-site powerlines	-48 Medium	-16 Low
	Displacement of priority species due to disturbance during decommissioning operations	-24 Low	-18 Low
	Cumulative impacts by renewable energy projects on birds within a 45km radius are temporary displacement due to disturbance	-75 High	-45 Medium

	associated with the construction of the facility and associated infrastructure, collisions with solar panels and wind turbines, permanent displacement due to habitat transformation, entrapment in perimeter fences and collisions with the associated power lines.		

The greatest potential concern in the 70km radius around Komsberg Substation is for the large raptor species, particularly Verreaux's Eagle and Martial Eagle, due to their low numbers and vulnerability to turbine collisions. The total estimated area that could potentially be affected by renewable projects are approximately 233 503 ha, which is approximately 15% of the land surface within the 75km radius, although the actual footprint is likely to be smaller, as this figure is based largely on land parcel size, and not the actual infrastructure footprint. Nonetheless, the combined cumulative impact of renewable developments on priority species, and particularly wind energy developments on Red Data Verreaux's Eagle and Martial Eagle within the 70km radius around the Komsberg Substation, is potentially significant at a local or even regional scale, even with the application of mitigation measures such as buffer zones around nests, should all of these projects eventually get to be constructed. The impact should be less severe at a national level, due to the large distribution ranges of the species, but should nonetheless be carefully monitored.

From an avifaunal impact perspective, the proposed development could go ahead, provided the proposed mitigation measures, and especially the no-turbine zones and modifications to the wind mast, are strictly implemented.

9 REFERENCES

- ALLAN, D.G. 1994. The abundance and movements of Ludwig's Bustard *Neotis ludwigii*. Ostrich 65: 95-105
- ANIMAL DEMOGRAPHY UNIT. The southern African Bird Atlas Project 2. University of Cape Town. http://sabap2.adu.org.za. Accessed 15/04/2016.
- ATIENZA, J.C., FIERRO, I.M., INFANTE, O., VALLS, J., DOMINGUEZ, J., 2012. Directrices para la evaluación del impacto de los parques eólicos en aves y murciélagos (versión 3.0). SEO/BirdLife, Madrid.
- AVIAN POWER LINE INTERACTION COMMITTEE (APLIC). 2012. Mitigating Bird Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute. Washington D.C.
- BAND, W., MADDERS, M., WHITFIELD, D.P., 2007. Developing field and analytical methods to assess avian collision risk at wind farms. In: Lucas, M., Janss, G.F.E., Ferrer, M. (Eds.), Birds and Wind Farms: Risk Assessment and Mitigation. Quercus, Madrid, pp. 259–275.

- BARCLAY R.M.R, BAERWALD E.F AND GRUVER J.C. 2007. Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. Canadian Journal of Zoology. 85: 381 – 387.
- BARNES, K.N. (ed.) 1998. The Important Bird Areas of southern Africa. BirdLife South Africa: Johannesburg.
- BIOTHERM. 2016. Unpublished data from wind masts at the Maralla and Esizayo sites.
- BARRIENTOS R, PONCE C, PALACIN C, MARTÍN CA, MARTÍN B, ET AL. 2012. Wire marking results in a small but significant reduction in avian mortality at power lines: A BACI Designed Study. PLoS ONE 7(3): e32569. doi:10.1371/journal.pone.0032569.
- BARRIENTOS, R., ALONSO, J.C., PONCE, C., PALACÍN, C. 2011. Meta-Analysis of the effectiveness of marked wire in reducing avian collisions with power lines. Conservation Biology 25: 893-903.
- BARRIOS, L., RODRÍGUEZ, A., 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. J. Appl. Ecol. 41, 72–81.
- BEAULAURIER, D.L. 1981. Mitigation of bird collisions with transmission lines. Bonneville Power Administration. U.S. Dept. of Energy.
- BERNARDINO, J., BISPO, R., COSTA, H., MASCARENHAS, M., 2013. Estimating bird and bat fatality at wind farms: a practical overview of estimators, their assumptions and limitations. New Zeal. J. Zool. 40, 63–74.
- BEVANGER, K., 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. Ibis 136, 412–425.
- BRIGHT, J.A., LANGSTON, R.H.W., BULLMAN, R., EVANS, R.J., GARDNER, S., PEARCE-HIGGINS, J., WILSON, E., 2006. Bird Sensitivity Map to provide Locational Guidance for Onshore Wind Farms in Scotland. RSPB Research Report No. 20.
- CALVERT, A.M., BISHOP, C.A., ELLIOT, R.D., KREBS, E.A., KYDD, T.M., MACHTANS, C.S., ROBERTSON, G.J., 2013. A synthesis of human-related avian mortality in Canada. Avian Conserv. Ecol. 8 (2), 11.
- CAMIÑA A. 2013. Pre-Construction Monitoring of Bird Populations in Maanhaarberg WEF De Aar, Northern Cape. Report to Longyuan Mulilo De Aar Wind Power Pty (Ltd).
- CAMIÑA, A. 2012a. Email communication on 12 April 2012 to the author by Alvaro Camiña, Spanish ornithologist with 8 years' experience in avifaunal monitoring at wind farms in Spain.
- CAMIÑA, A. 2012b. Email communication on 17 November 2012 to the author by Alvaro Camiña, Spanish ornithologist with 8 years' experience in avifaunal monitoring at wind farms in Spain.
- CAMIÑA, A. 2014. Pre-Construction Monitoring of bird populations in Maanhaarberg WEF De Aar, Northern Cape. Unpublished report to Longyuan Mulilo De Aar Wind Power Pty (Ltd).
- CÁRCAMO, B., KRET, E., ZOGRAFOU, C., VASILAKIS, D., 2011. Assessing the Impact of Nine Established Wind Farms on Birds of Prey in Thrace, Greece. Technical Report. WWF Greece, Athens.
- CARRETE, M., SÁNCHEZ-ZAPATA, J.A., BENÍTEZ, J.R., LOBÓN, M., DONÁZAR, J.A., 2009. Large scale risk-assessment of wind-farms on population viability of a globally endangered long-lived raptor. Biol. Conserv. 142, 2954–2961.
- CEC, 2007. California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development. Commission Final Report. California Energy Commission, Renewables Committee, and Energy Facilities Siting Division, and California Department of Fish and Game, Resources Management and Policy Division.

- DAHL, E.L., MAY, R., HOEL, P.L., BEVANGER, K., PEDERSEN, H.C., RØSKAFT, E., STOKKE, B.G., 2013. White-tailed eagles (Haliaeetus albicilla) at the Smøla wind-power plant, Central Norway, lack behavioral flight responses to wind turbines. Wildl. Soc. Bull. 37, 66–74.
- DEA 2015. Department of Environmental Affairs, 2015. Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa. CSIR Report Number: CSIR/CAS/EMS/ER/2015/0001/B. Stellenbosch.
- DE LUCAS, M., FERRER, M., BECHARD, M.J., MUÑOZ, A.R., 2012a. Griffon vulture mortality at wind farms in southern Spain: distribution of fatalities and active mitigation measures. Biol. Conserv. 147, 184–189.
- DE LUCAS, M., JANSS, G.F.E., WHITFIELD, D.P., FERRER, M., 2008. Collision fatality of raptors in wind farms does not depend on raptor abundance. J. Appl. Ecol. 45, 1695–1703.
- DE LUCAS, M.; JANSS, G.; FERRER, M. 2004. The Effects of a Wind Farm on Birds in a Migration Point: The Strait of Gibraltar. Biodiversity & Conservation, 13(2), 395-407.
- DESHOLM, M., FOX, A.D., BEASLEY, P.D.L., KAHLERT, J., 2006. Remote techniques for counting and estimating the number of bird-wind turbine collisions at sea: a review. Ibis 148, 76–89.
- DOOLING, R., 2002. Avian Hearing and the Avoidance of Wind Turbines. National Renewable Energy Laboratory, Colorado.
- DREWITT, A.L., LANGSTON, R.H.W., 2006. Assessing the impacts of wind farms on birds. Ibis, 29–42.
- DREWITT, A.L., LANGSTON, R.H.W., 2008. Collision effects of wind-power generators and other obstacles on birds. Ann. N. Y. Acad. Sci. 1134, 233–266.
- DUERR, A.E., MILLER, T.A., LANZONE, M., BRANDES, D., COOPER, J., O'MALLEY, K., MAISONNEUVE, C., TREMBLAY, J., KATZNER, T., 2012. Testing an emerging paradigm in migration ecology shows surprising differences in efficiency between flight modes. PLoS ONE 7 (4), e35548.
- ERICKSON, W.P., JOHNSON, G.D., STRICKLAND, M.D., YOUNG, D.P., SERNKA, K.J., GOOD, R.E., 2001. Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States. RESOLVE, Inc., (US).
- ERICKSON, W.P., JOHNSON, G.D., YOUNG JR., D.P.Y., 2005. A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions. General Technical Reports. USDA Forest Service General Technical Report PSWGTR-191.
- EVERAERT, J., 2014. Collision risk and micro-avoidance rates of birds with wind turbines in Flanders. Bird Study 61, 220–230.
- EVERAERT, J., STIENEN, E.M., 2008. Impact of wind turbines on birds in Zeebrugge (Belgium). In: Hawksworth, D., Bull, A. (Eds.), Biodiversity and Conservation in Europe. Springer, Netherlands, pp. 103–117.
- EVERAERT, J., STIENEN, E.W.M., 2007. Impact of wind turbines on birds in Zeebrugge (Belgium). Biodivers. Conserv. 16, 3345–3359.
- FARFAN M.A., VARGAS J.M., DUARTE J. AND REAL R. (2009). What is the impact of wind farms on birds? A case study in southern Spain. Biodiversity Conservation. 18:3743-3758).
- FERRER, M., DE LUCAS, M., JANSS, G.F.E., CASADO, E., MUNOZ, A.R., BECHARD, M.J., CALABUIG,C.P. 2012. Weak relationship between risk assessment studies and recorded mortality on wind farms. Journal of Applied Ecology. 49. p38-46.
- FURNESS, R.W., WADE, H.M., MASDEN, E.A., 2013. Assessing vulnerability of marine bird populations to offshore wind farms. J. Environ. Manage. 119, 56–66.

- GARTHE, S., HÜPPOP, O., 2004. Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. J. Appl. Ecol. 41, 724–734.
- GOVE, B., LANGSTON, RHW., MCCLUSKIE, A., PULLAN, JD. & SCRASE, I. 2013. Wind Farms and Birds: An Updated Analysis Of The Effects Of Wind Farms On Birds, And Best Practice Guidance On Integrated Planning And Impact Assessment. T-PVS/Inf (2013) 15. Report prepared by BirdLife International on behalf of the Bern Convention.
- HALE, A.M, HATCHETT, S.E, MEYER, J.A, & BENNETT. V.J.2014. No evidence of displacement due to wind turbines in breeding grassland songbirds. Volume 116, 2014, pp. 472–482 DOI: 10.1650/CONDOR-14-41.1.
- HARRISON, J.A., ALLAN, D.G., UNDERHILL, L.G., HERREMANS, M., TREE, A.J., PARKER, V & BROWN, C.J. (eds). 1997. The atlas of southern African birds. Vol 1 & 2. BirdLife South Africa, Johannesburg.
- HERRERA-ALSINA, L., VILLEGAS-PATRACA, R., EGUIARTE, L.E., ARITA, H.T., 2013. Bird communities and wind farms: a phylogenetic and morphological approach. Biodivers. Conserv. 22, 2821–2836.
- HOBBS, J.C.A. & LEDGER J.A. 1986a. The Environmental Impact of Linear Developments; Power lines and Avifauna. Proceedings of the Third International Conference on Environmental Quality and Ecosystem Stability. Israel, June 1986.
- HOBBS, J.C.A. & LEDGER J.A. 1986b. Power lines, Birdlife and the Golden Mean. Fauna and Flora, 44:23-27.
- HOCKEY P.A.R., DEAN W.R.J., AND RYAN P.G. 2005. Robert's Birds of Southern Africa, seventh edition. Trustees of the John Voelcker Bird Book Fund, Cape Town.
- HODOS, W., 2003. Minimization of Motion Smear: Reducing Avian Collisions with Wind Turbines. Report NREL/SR-500-33249. Washington, DC.
- HOOVER, S.L., MORRISON, M.L., 2005. Behavior of red-tailed hawks in a wind turbine development. J. Wildl. Manage. 69, 150–159.
- HOOVER, S.L., MORRISON, M.L., 2005. Behavior of red-tailed hawks in a wind turbine development. J. Wildl. Manage. 69, 150–159.
- HÖTKER, H., THOMSEN, K.M., KÖSTER, H., 2006. Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats. Facts, Gaps in Knowledge, Demands for Further Research, and Ornithological Guidelines for the Development of Renewable Energy Exploitation. Michael-Otto-Institut im NABU, Bergenhusen.
- HOWELL, J.A. 1997. Avian Mortality at rotor swept area equivalents Altamont Pass and Montezuma Hills, California. Report for Kenetech Wind Power
- HULL, C.L., STARK, E.M., PERUZZO, S., SIMS, C.C., 2013. Avian collisions at two wind farms in Tasmania, Australia: taxonomic and ecological characteristics of colliders versus non-colliders. New Zeal. J. Zool. 40, 47–62.
- HÜPPOP, O., DIERSCHKE, J., EXO, K.-M., FREDRICH, E., HILL, R., 2006. Bird migration studies and potential collision risk with offshore wind turbines. Ibis 148, 90–109.
- HUSO, M.M.P., DALTHORP, D., 2014. Accounting for unsearched areas in estimating wind turbine-caused fatality. J. Wildl. Manage. 78, 347–358.
- IUCN 2015.4 IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- JANSS, G.F.E., 2000. Avian mortality from power lines: a morphologic approach of a species-specific mortality. Biol. Conserv. 95, 353–359.
- JENKINS, A. & SMALLIE, J. 2009. Terminal velocity: the end of the line for Ludwig's Bustard? Africa Birds and Birding. Vol 14, No 2.

- JENKINS, A., DE GOEDE, J.H. & VAN ROOYEN, C.S. 2006. Improving the products of the Eskom Electric Eagle Project. Unpublished report to Eskom. Endangered Wildife Trust.
- JENKINS, A.R., DE GOEDE, J.H., SEBELE, L. & DIAMOND, M. 2013. Brokering a settlement between eagles and industry: sustainable management of large raptors nesting on power infrastructure. Bird Conservation International 23: 232-246.
- JENKINS, A.R., SMALLIE, J.J. & DIAMOND, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 263-278.
- JOHNSON, G.D., ERICKSON, W.P., STRICKLAND, M.D., SHEPHERD, M.F., SHEPHERD, D.A., 2002. Collision mortality of local and migrant birds at a large-scale wind-power development on Buffalo Ridge, Minnesota. Wildl. Soc. Bull. 30, 879–887.
- JOHNSTON, N.N., BRADLEY, J.E., OTTER, K.A., 2014. Increased flight altitudes among migrating golden eagles suggest turbine avoidance at a Rocky Mountain wind installation. PLoS ONE 9, e93030.
- KATZNER, T.E., BRANDES, D., MILLER, T., LANZONE, M., MAISONNEUVE, C., TREMBLAY, J.A., MULVIHILL, R., MEROVICH, G.T., 2012. Topography drives migratory flight altitude of golden eagles: implications for on-shore wind energy development. J. Appl. Ecol. 49, 1178–1186.
- KERLINGER, P., GEHRING, J.L., ERICKSON, W.P., CURRY, R., JAIN, A., GUARNACCIA, J., 2010. Night migrant fatalities and obstruction lighting at wind turbines in North America. Wilson J. Ornithol. 122, 744–754.
- KITANO, M., SHIRAKI, S., 2013. Estimation of bird fatalities at wind farms with complex topography and vegetation in Hokkaido, Japan. Wildl. Soc. Bull. 37, 41–48.
- KOOPS, F.B.J. & DE JONG, J. 1982. Vermindering van draadslachtoffers door markering van hoogspanningsleidingen in de omgeving van Heerenveen. Electrotechniek 60 (12): 641 – 646.
- KRIJGSVELD, K.L., AKERSHOEK, K., SCHENK, F., DIJK, F., DIRKSEN, S., 2009. Collision risk of birds with modern large wind turbines. Ardea 97, 357–366.
- KRUGER, R. & VAN ROOYEN, C.S. 1998. Evaluating the risk that existing power lines pose to large raptors by using risk assessment methodology: The Molopo Case Study. Proceedings of the 5th World Conference on Birds of Prey and Owls. August 4-8,1998. Midrand, South Africa.
- KRUGER, R. 1999. Towards solving raptor electrocutions on Eskom Distribution Structures in South Africa. Bloemfontein (South Africa): University of the Orange Free State. (M. Phil. Mini-thesis)
- LANGGEMACH, T. 2008. Memorandum of Understanding for the Middle-European population of the Great Bustard, German National Report 2008. Landesumweltamt Brandenburg (Brandenburg State Office for Environment).
- LANGLANDS, M. 2015. Personal communication on 5 April 2016 to the author by a member of the St. Francis Bay Bird Club.
- LANGSTON, R.W., PULLAN, J.D., 2003. Windfarms and birds: an analysis of the effects of wind farms on birds, and guidance on environmental criteria and site selection issues. BirdLife International to the Council of Europe, Bern Convention. RSPB/ Birdlife in the UK.
- LEDDY, K.L., HIGGINS, K.F., NAUGLE, D.E., 1999. Effects of wind turbines on upland nesting birds in conservation reserve program grasslands. Wilson Bulletin 11, 100–104.
- LEDGER, J. 1983. Guidelines for Dealing with Bird Problems of Transmission Lines and Towers. Eskom Test and Research Division. (Technical Note TRR/N83/005).
- LEDGER, J.A. & ANNEGARN H.J. 1981. Electrocution Hazards to the Cape Vulture (Gyps coprotheres) in South Africa. Biological Conservation 20:15-24.

- LEDGER, J.A. 1984. Engineering Solutions to the Problem of Vulture Electrocutions on Electricity Towers. The Certificated Engineer, 57:92-95.
- LEDGER, J.A., J.C.A. HOBBS & SMITH T.V. 1992. Avian Interactions with Utility Structures: Southern African Experiences. Proceedings of the International Workshop on Avian Interactions with Utility Structures. Miami (Florida), Sept. 13-15, 1992. Electric Power Research Institute.
- LEKUONA, J.M., URSUA, C., 2007. Avian mortality in wind plants of Navarra (Northern Spain). In: deLucas, M., Janss, G., Ferrer, M. (Eds.), Birds and Wind Farms. Quercus Editions, Madrid, pp. 177–192.
- LONGCORE, T., RICH, C., MINEAU, P., MACDONALD, B., BERT, D.G., SULLIVAN, L.M., MUTRIE, E., GAUTHREAUX, S.A., AVERY, M.L., CRAWFORD, R.L., MANVILLE, A.M., TRAVIS, E.R., DRAKE, D., 2013. Avian mortality at communication towers in the United States and Canada: which species, how many, and where? Biol. Conserv. 158, 410–419.
- LOSS S.R., WILL, T., MARRA, P.P. Estimates of bird collision mortality at wind facilities in the contiguous United States. Biological Conservation 168 (2013) 201–209.
- LOSS, S.R., WILL, T., LOSS, S.S., & MARRA, P.P. 2014. Bird–building collisions in the United States: Estimates of annual mortality and species vulnerability. The Condor 116(1):8-23. 2014.
- MARNEWICK, M.D., RETIEF E.F., THERON N.T., WRIGHT D.R., ANDERSON T.A. 2015. Important Bird and Biodiversity Areas of South Africa. Johannesburg: Birdlife South Africa.
- MARTIN, G., SHAW, J., SMALLIE J. & DIAMOND, M. 2010. Bird's eye view – How birds see is key to avoiding power line collisions. Eskom Research Report. Report Nr: RES/RR/09/31613.
- MARTIN, G.R., 2011. Understanding bird collisions with man-made objects: a sensory ecology approach. Ibis 153, 239–254.
- MARTIN, G.R., 2012. Through birds' eyes: insights into avian sensory ecology. J. Ornithol. 153, 23–48.
- MARTIN, G.R., KATZIR, G., 1999. Visual fields in short-toed eagles, Circaetus gallicus (Accipitridae), and the function of binocularity in birds. Brain Behav. Evol. 53, 55–66.
- MARTIN, G.R., PORTUGAL, S.J., MURN, C.P., 2012. Visual fields, foraging and collision vulnerability in Gyps vultures. Ibis 154, 626–631.
- MAY, R., BEVANGER, K., VAN DIJK, J., PETRIN, Z., BRENDE, H., 2012a. Renewable Energy Respecting Nature. A Synthesis of Knowledge on Environmental Impacts of Renewable Energy financed by the Research Council of Norway, NINA Report. Trondheim.
- MAY, R., HAMRE, O., VANG, R., NYGARD, T., 2012b. Evaluation of the DTBird Videosystem at the Smøla Wind-Power Plant. Detection Capabilities for Capturing Near-turbine Avian Behaviour. NINA Report 910. Trondheim.
- MCGRADY, M.J., GRANT, J.R., BAINBRIDGE, I.P., MCLEOD, D.R.A., 2002. A model of golden eagle (Aquila crysaetos) ranging behavior. J. Raptor Res. 36, 62–69.
- McISAAC, H.P., 2001. Raptor acuity and wind turbine blade conspicuity. In: National Avian-Wind Power Planning Meeting IV. Resolve Inc., Washington, DC, pp. 59– 87.
- MCLEOD, D.R.A., WHITFIELD, D.P., MCGRADY, M.J., 2002. Improving prediction of golden eagle (Aquila chrysaetos) ranging in western Scotland using GIS and terrain modeling. J. Raptor Res. 36, 70–77.
- MORINHA, F., TRAVASSOS, P., SEIXAS, F., MARTINS, A., BASTOS, R., CARVALHO, D., MAGALHÃES, P., SANTOS, M., BASTOS, E., CABRAL, J.A., 2014. Differential mortality of birds killed at wind farms in Northern Portugal. Bird Study 61, 255–259.
- MUCINA. L. & RUTHERFORD, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

- O'ROURKE, C.T., HALL, M.I., PITLIK, T., FERNÁNDEZ-JURICIC, E., 2010. Hawk eyes I: diurnal raptors differ in visual fields and degree of eye movement. PLoS ONE 5, e12802.
- OSBORN, R.G., DIETER, C.D., HIGGINS, K.F., USGAARD, R.E., 1998. Bird flight characteristics near wind turbines in Minnesota. Am. Midl. Nat. 139, 29–38.
- PEARCE-HIGGINS, J.W., STEPHEN, L., DOUSE, A., & LANGSTON, R.H.W. 2012. Greater impacts on bird populations during construction than subsequent operation: result of multi-site and multi-species analysis. Journal of Applied Ecology 2012, 49, 396-394)
- PEARCE-HIGGINS, J.W., STEPHEN, L., LANGSTON, R.H.W., BAINBRIDGE, I.P., BULLMAN, R., 2009. The distribution of breeding birds around upland wind farms. J. Appl. Ecol. 46, 1323–1331.
- PLONCZKIER, P., SIMMS, I.C., 2012. Radar monitoring of migrating pink-footed geese: behavioural responses to offshore wind farm development. J. Appl. Ecol. 49, 1187–1194.
- RAAB, R., JULIUS, E., SPAKOVSZKY, P. & NAGY, S. 2009. Guidelines for best practice on mitigating impacts of infrastructure development and afforestation on the Great Bustard. Prepared for the Memorandum of Understanding on the conservation and management of the Middle-European population of the Great Bustard under the Convention on Migratory species (CMS). Birdlife International. European Dvision.
- RAAB, R., SPAKOVSZKY, P., JULIUS, E., SCHÜTZ, C. & SCHULZE, C. 2010. Effects of powerlines on flight behaviour of the West-Pannonian Great Bustard Otis tarda population. Bird Conservation International. Birdlife International.
- RALSTON, S. 2016. Avifaunal mortality at operational wind farms in South Africa. Birdlife South Africa, in litt. March 2016.
- RETIEF E.F., DIAMOND M, ANDERSON M.D., SMIT, H.A., JENKINS, A & M. BROOKS. 2012. Avian Wind Farm Sensitivity Map. Birdlife South Africahttp://www.birdlife.org.za/conservation/birds-and-wind-energy/windmap.
- ROSSOUW, W. 2016. Personal communication by experienced bird monitor and member of the St. Francis Bird Club to the author via text message on 20 March 2016.
- SAIDUR, R., RAHIM, N.A., ISLAM, M.R., SOLANGI, K.H., 2011. Environmental impact of wind energy. Renew. Sust. Energ. Rev. 15 (5), 2423–2430.
- SCOTTISH NATURAL HERITAGE. 2010. Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model. SNH Avoidance Rate Information & Guidance Note.
- SHAMOUN-BARANES, J., LESHEM, Y., YOM-TOV, Y., LIECHTI, O., 2003. Differential use of thermal convection by soaring birds over central Israel. Condor 105 (2), 208– 218.
- SHAW, J.M. 2013. Power line collisions in the Karoo: Conserving Ludwig's Bustard. Unpublished PhD thesis. Percy FitzPatrick Institute of African Ornithology, Department of Biological Sciences, Faculty of Science University of Cape Town May 2013.
- SIMMONS, R. Photographic record of a Martial Eagle killed at Jeffreys Bay wind farm. Short note. Birds & Bats Unlinmited. July 2016.
- SMALLIE, J. 2015. In litt. Verreaux's Eagle *Aquila verreauxii* wind turbine collision fatalities. Short note. Wild Skies Ecological Services.
- SMALLWOOD, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71:2781-2791.
- SMALLWOOD, K.S. 2013. Comparing bird and bat fatality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin 37: 19-33.
- SMALLWOOD, K.S., KARAS, B., 2009. Avian and bat fatality rates at old-generation and repowered wind turbines in California. J. Wildl. Manage. 73, 1062–1071.

- SMALLWOOD, K.S., RUGGE, L., HOOVER, S., THELANDER, M.L., CARL, M., 2001. Intra- and Inter-turbine string comparison of fatalities to animal burrow densities at Altamont Pass. In: Proceedings of the National Avian-Wind Power Planning Meeting IV. RESOLVE Inc., Washington, DC, Carmel, California, p. 183.
- SMALLWOOD, K.S., RUGGE, L., MORRISON, M.L., 2009. Influence of behavior on bird mortality in wind energy developments. J. Wildl. Manage. 73, 1082–1098
- SMALLWOOD, K.S., THELLANDER, C.G., 2004. Developing Methods to reduce Bird Mortality in the Altamont Pass Wind Resource Area. PIER Final Project Report. California Energy Commission.
- SOVACOOL, B.K., 2009. Contextualizing avian mortality: a preliminary appraisal of bird and bat fatalities from wind, fossil-fuel, and nuclear electricity. Energy Policy 37, 2241–2248.
- T. K. STEVENS, A. M. HALE, K. B. KARSTEN, V. J. BENNETT. An analysis of displacement from wind turbines in a wintering grassland bird community. Biodivers Conserv (2013) 22:1755–1767 DOI 10.1007/s10531-013-0510-8.
- TAYLOR, M.R. (ed.) 2015. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.

APPENDIX 1: PRE-CONSTRUCTION MONITORING METHODOLOGY

1. Objectives

The objective of the pre-construction monitoring at the proposed Maralla West and West Wind Energy Facilities 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 measure the potential collision risk with the turbines.

2. Methods

The monitoring protocol for the site was designed according to the latest version of *Jenkins A R; Van Rooyen C S; Smallie J J; Anderson M D & Smit H A. 2011. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Endangered Wildlife Trust and Birdlife South Africa.*

The monitoring was conducted in the following periods:

- 18 – 28 January 2016
- 4 April – 25 April 2016
- 1 June – 26 June 2016
- 27 September – 6 October 2016
- 29 November – 2 December 2016

Monitoring was conducted in the following manner:

- Two drive transect were identified totalling 15.74km on the development areas and one drive transect in a control area with a total length of 10.2km.
- Two observers travelling slowly (± 10km/h) in a vehicle recorded all species on both sides of the transect. The observers stopped at regular intervals (every 500 m) to scan the environment with binoculars. Drive transects were counted three times per sampling session.
- In addition, six walk transects of 1km each were identified at the development areas, and two at the control area, 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;
    - Distance from transect (0-50 m, 50-100 m, >100 m);
    - Wind direction;
    - Wind strength (1 – 7 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).

- Six vantage points (VPs) were identified from which the majority of the proposed development areas could 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. >220m; medium i.e. 30m – 220m; low i.e. <30m);
- Flight mode (soar; flap; glide; kite; hover); and
- Flight time (in 15 second-intervals).

The aim with drive transects was primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects were primarily aimed at recording small passerines. The objective of the transect monitoring was to gather baseline data on the use of the site by birds in order to measure potential displacement by the wind farm activities. The objective of vantage point counts was to assess the potential collision risk with the turbines. Priority species were identified using the November 2014 BLSA list of priority species for wind farms.

A total of 10 potential focal points of bird activity were identified and inspected during each of the four surveys at the two Maralla development areas, i.e. five sites with potential habitat for cliff-nesting raptors and five dams:

- FPM 1: Steep valley with rocky ridges
- FPM 2: West-facing cliffs
- FPM 3: East-facing slope with ridge
- FPM 4: Deep valley with ridges
- FPM 5: Deep valley with west-facing ridge
- FPM 6: Dam
- FPM 7: Dam
- FPM 8: Dam
- FPM 9: Dam
- FPM 10: Dam

Dedicated searches were also conducted to investigate potential nesting and roosting sites in trees and powerlines in the study area and beyond. In addition, a total of 7 areas were identified immediately adjacent to the development areas consisting of cliffs and ridges along the escarpment which were meticulously searched by an observer with binoculars and a scope for nests. Nest searches were conducted in 2016 in January, April, June and November/December.

The seven potential cliff nesting areas comprise the following:

- FP 1: Deep north-south kloof with cliffs on both sides
- FP 2: Deep north-south kloof with cliffs on both sides
- FP 3: South-facing cliffs
- FP 4: Deep north-south kloof
- FP 5: South-facing cliffs
- FP 6: South-facing cliffs
- FP 7: South facing cliffs

Five dams at the control site were also identified as focal points and counts of waterbirds were conducted during each survey iteration.

Additional information on the location of raptor nests were also obtained from Dr. Andrew Jenkins from Avisense Consulting, Andrew Pearson from ARCUS and the staff of the Komsberg Nature Reserve.

Figure 1 below indicates the proposed Maralla development areas where monitoring was performed.

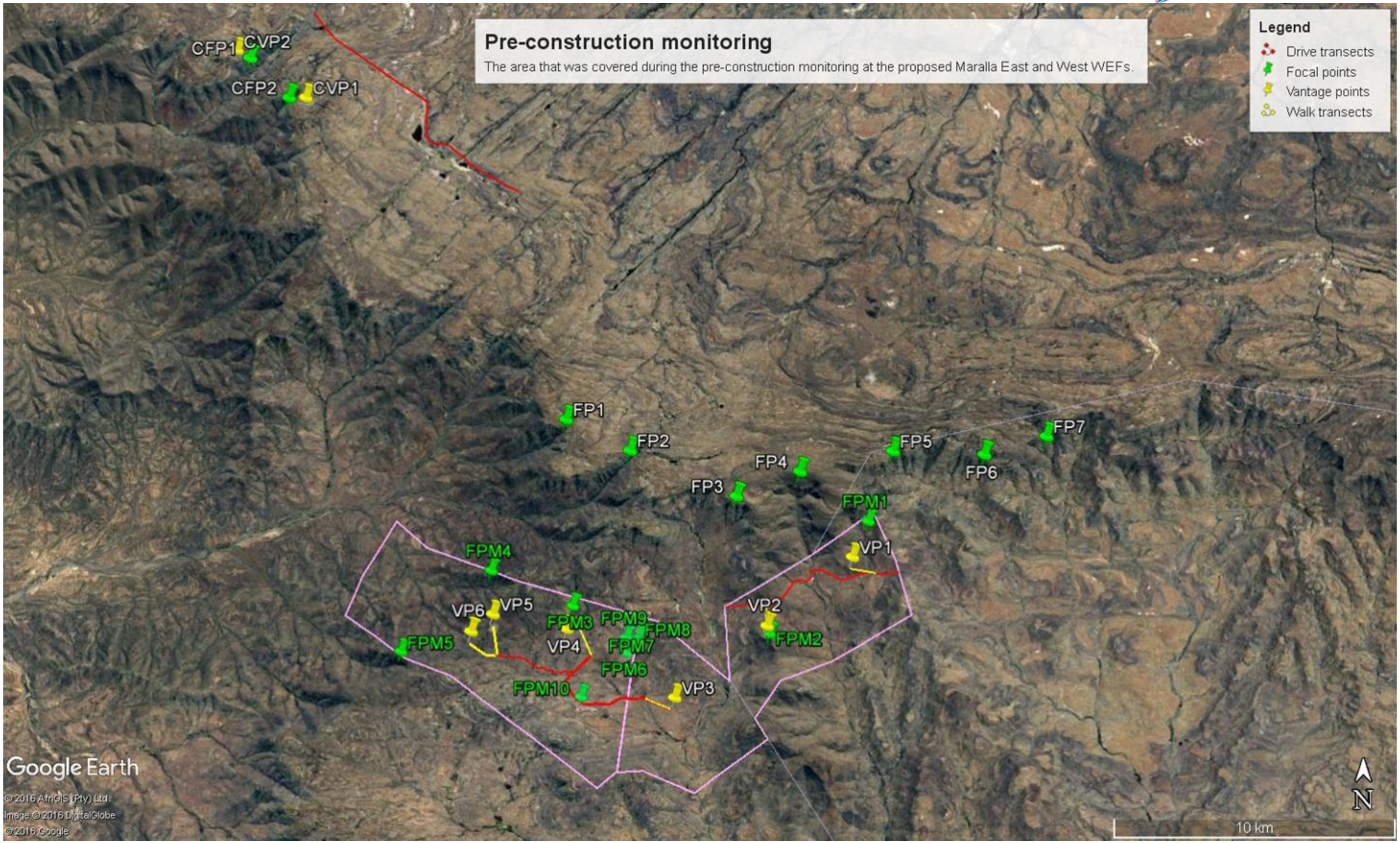


Figure 1: Area where pre-construction monitoring was performed for the proposed Maralla West and West WEFs.

APPENDIX 2: CHRIS VAN ROOYEN CV

Curriculum vitae: Chris van Rooyen

Name	:	Chris van Rooyen
Profession/Specialisation	:	Avifaunal Specialist
Highest Qualification	:	LLB
Nationality	:	South African
Years of experience	:	20 years

Key Qualifications

Chris van Rooyen has twenty 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 more than 100 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 (see key project experience below).

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 (2014)
23. De Aar – North (Mulilo) Wind Energy Project – 12 month preconstruction avifaunal monitoring project (2014)

24. De Aar – South (Mulilo) Wind Energy Project – 12 month bird monitoring (2014)
25. Namies – Aggenys Wind Energy Project – 12 month bird monitoring (2014)
26. Pofadder - Wind Energy Project – 12 month bird monitoring (2014)
27. Dwarsrug Loeriesfontein - Wind Energy Project – 12 month bird monitoring (2014)
28. Waaihoek – Utrecht Wind Energy Project – 12 month bird monitoring (2014)
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)

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. Veld Solar One Project, Aggeneys, Northern 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
117. Matla-Glockner 400kV
118. Delmas North 44kV
119. Houwhoek 11kV Refurbishment
120. Clau-Clau 132kV
121. Ngwedi-Silwerkrans 134kV
122. Nieuwehoop 400kV walk-through
123. Booysendal 132kV Switching Station
124. Tarlton 132kV
125. Medupi - Witkop 400kV walk-through
126. Germiston Industries Substation
127. Sekgame 132kV
128. Botswana – South Africa 400kV Transfrontier Interconnector
129. Syferkuil – Rampheri 132kV

130. Queens Substation and associated 132kV powerlines
131. Oranjemond 400kV Transmission line

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. Sommerset 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

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.

APPENDIX 3: BIRD HABITAT

Figure 1: The Maralla West development area is located in a transitional zone between the Fynbos and Succulent Karoo Biomes.

Figure 2: Existing Laingsburg / Roggeveld 1 66kV distribution power line infrastructure running north-east of the site.


Figure 3: An artificial impoundment in the study area.


Figure 4: The temporary wind mast showing the Martial Eagles roosting on the booms.

APPENDIX 4: SPECIES LIST

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Bustard, Ludwig's	*Neotis ludwigii*	x	EN	EN		Near-endemic	6.25	✓ 10.42
Buzzard, Jackal	*Buteo rufofuscus*	x			Near endemic	Endemic	53.13	✓ 22.22
Buzzard, Steppe	*Buteo vulpinus*	x					15.63	✓ 17.65
Eagle, Booted	*Aquila pennatus*	x					3.13	✓ 10.71
Eagle, Martial	*Polemaetus bellicosus*	x	VU	EN			21.88	✓ 10.42
Eagle, Verreaux's	*Aquila verreauxii*	x	LC	VU			6.25	✓ 16.67
Eagle-owl, Spotted	*Bubo africanus*	x					28.13	✓ 5.88
Flamingo, Greater	*Phoenicopterus ruber*	x	LC	NT			0	✓ 18.18
Francolin, Grey-winged	*Scleroptila africanus*	x			Endemic (SA, Lesotho, Swaziland)	Endemic	40.63	✓ 8.33
Goshawk, Southern Pale Chanting	*Melierax canorus*	x				Near-endemic	34.38	✓ 30.00
Harrier, Black	*Circus maurus*	x	VU	EN	Near endemic	Endemic	0	✓ 12.00
Kestrel, Lesser	*Falco naumanni*	x					3.13	✗ 0.00
Kite, Black-shouldered	*Elanus caeruleus*	x					0	✓ 29.41
Korhaan, Karoo	*Eupodotis vigorsii*	x	LC	NT		Endemic	15.63	✓ 15.00
Korhaan, Southern Black	*Afrotis afra*	x	VU	VU	Endemic	Endemic	25	✓ 16.00
Snake-eagle, Black-chested	*Circaetus pectoralis*	x					3.13	✓ 16.67
Sparrowhawk, Rufous-chested	*Accipiter rufiventris*	x					9.38	✗ 0.00
Stork, Black	*Ciconia nigra*	x	LC	VU			0	✓ 5.88
Falcon, Lanner	*Falco biarmicus*	x	LC	VU			0	0
Kestrel, Rock	*Falco rupicolus*						43.75	✓ 54.17

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Apalis, Bar-throated	*Apalis thoracica*							✓ 8.33
Avocet, Pied	*Recurvirostra avosetta*							✓ 11.11
Barbet, Acacia Pied	*Tricholaema leucomelas*					Near-endemic	3.13	✓ 39.58
Batis, Pririt	*Batis pririt*					Near-endemic	3.13	✓ 29.73
Bee-eater, European	*Merops apiaster*							✓ 10.34
Bishop, Southern Red	*Euplectes orix*						6.25	✓ 25.00
Bokmakierie	*Telophorus zeylonus*						90.63	✓ 66.67
Bulbul, African Red-eyed	*Pycnonotus nigricans*					Near-endemic		✓ 10.00
Bulbul, Cape	*Pycnonotus capensis*				Endemic	Endemic	12.5	✓ 21.74
Bunting, Cape	*Emberiza capensis*					Near-endemic	68.75	✓ 70.83
Bunting, Lark-like	*Emberiza impetuani*					Near-endemic	34.38	✓ 19.35
Canary, Black-headed	*Serinus alario*				Near endemic	Endemic	31.25	✓ 29.17
Canary, Cape	*Serinus canicollis*					Endemic	9.38	✓ 9.09
Canary, White-throated	*Crithagra albogularis*					Near-endemic	50	✓ 58.33
Canary, Yellow	*Crithagra flaviventris*					Near-endemic	53.13	✓ 43.75
Chat, Anteating	*Myrmecocichla formicivora*					Endemic	15.63	✓ 16.00
Chat, Familiar	*Cercomela familiaris*						46.88	✓ 39.58
Chat, Karoo	*Cercomela schlegelii*					Near-endemic	50	✓ 77.08
Chat, Sickle-winged	*Cercomela sinuata*				Near endemic	Endemic	50	✓ 24.00
Chat, Tractrac	*Cercomela tractrac*					Near-endemic		✓ 25.00
Cisticola, Grey-backed	*Cisticola subruficapilla*					Near-endemic	62.5	✓ 52.08
Coot, Red-knobbed	*Fulica cristata*						3.13	✓ 16.67

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Cormorant, Reed	*Phalacrocorax africanus*						3.13	✓ 8.33
Cormorant, White-breasted	*Phalacrocorax carbo*						3.13	✗ 0.00
Crombec, Long-billed	*Sylvietta rufescens*						9.38	✓ 18.75
Crow, Cape	*Corvus capensis*							✓ 17.65
Crow, Pied	*Corvus albus*						56.25	✓ 27.59
Cuckoo, Diderick	*Chrysococcyx caprius*							✓ 25.00
Dove, Laughing	*Streptopelia senegalensis*						9.38	✓ 29.17
Dove, Namaqua	*Oena capensis*						9.38	✓ 20.00
Dove, Red-eyed	*Streptopelia semitorquata*						18.75	✓ 25.00
Duck, African Black	*Anas sparsa*						3.13	✓ 24.14
Duck, Yellow-billed	*Anas undulata*						15.63	✓ 22.92
Egret, Cattle	*Bubulcus ibis*							✓ 5.88
Eremomela, Karoo	*Eremomela gregalis*				Near endemic	Endemic	25	✓ 20.00
Eremomela, Yellow-bellied	*Eremomela icteropygialis*						28.13	✓ 14.58
Fiscal, Common (Southern)	*Lanius collaris*						65.63	✓ 66.67
Flycatcher, Chat	*Bradornis infuscatus*					Near-endemic		✓ 9.09
Flycatcher, Fairy	*Stenostira scita*				Near endemic	Endemic	12.5	✓ 17.39
Flycatcher, Fiscal	*Sigelus silens*				Near endemic	Endemic	3.13	✓ 16.22
Flycatcher, Spotted	*Muscicapa striata*							✓ 8.33
Goose, Egyptian	*Alopochen aegyptiacus*						46.88	✓ 41.67
Goose, Spur-winged	*Plectropterus gambensis*						18.75	✓ 9.09
Grebe, Black-necked	*Podiceps nigricollis*							✓ 9.09

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Grebe, Little	*Tachybaptus ruficollis*						6.25	✓ 15.79
Greenshank, Common	*Tringa nebularia*						6.25	✓ 11.11
Guineafowl, Helmeted	*Numida meleagris*						28.13	✓ 6.90
Hamerkop	*Scopus umbretta*						6.25	✓ 17.39
Heron, Black-headed	*Ardea melanocephala*						12.5	✓ 11.76
Heron, Grey	*Ardea cinerea*						3.13	✓ 16.22
Honeyguide, Lesser	*Indicator minor*						3.13	✗ 0.00
Hoopoe, African	*Upupa africana*							✓ 6.90
Ibis, African Sacred	*Threskiornis aethiopicus*						9.38	✓ 10.34
Ibis, Hadeda	*Bostrychia hagedash*						65.63	✓ 16.22
Kingfisher, Malachite	*Alcedo cristata*							✓ 8.33
Lapwing, Blacksmith	*Vanellus armatus*						9.38	✓ 50.00
Lapwing, Crowned	*Vanellus coronatus*						21.88	✓ 5.88
Lark, Cape Clapper	*Mirafra apiata*				Near endemic	Endemic	21.88	✓ 11.76
Lark, Eastern Clapper	*Mirafra fasciolata*					Near-endemic	3.13	✓ 11.76
Lark, Karoo	*Calendulauda albescens*				Near endemic	Endemic	15.63	✓ 8.11
Lark, Karoo Long-billed	*Certhilauda subcoronata*					Endemic	62.5	✓ 33.33
Lark, Large-billed	*Galerida magnirostris*				Near endemic	Endemic	56.25	✓ 35.42
Lark, Red-capped	*Calandrella cinerea*						28.13	✓ 16.67
Lark, Spike-heeled	*Chersomanes albofasciata*					Near-endemic	6.25	✓ 19.44
Martin, Brown-throated	*Riparia paludicola*						3.13	✓ 29.17
Martin, Rock	*Hirundo fuligula*						68.75	✓ 52.08

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Masked-weaver, Southern	*Ploceus velatus*						40.63	✓ 52.08
Moorhen, Common	*Gallinula chloropus*						3.13	✗ 0.00
Mousebird, Red-faced	*Urocolius indicus*						15.63	✓ 19.35
Mousebird, White-backed	*Colius colius*					Endemic	28.13	✓ 35.42
Night-Heron, Black-crowned	*Nycticorax nycticorax*							✓ 16.67
Nightjar, Rufous-cheeked	*Caprimulgus rufigena*							✗ 0.00
Penduline-tit, Cape	*Anthoscopus minutus*					Near-endemic	21.88	✗ 0.00
Pigeon, Speckled	*Columba guinea*						43.75	✓ 31.25
Pipit, African	*Anthus cinnamomeus*						18.75	✓ 16.22
Pipit, Long-billed	*Anthus similis*							✓ 8.00
Plover, Kittlitz's	*Charadrius pecuarius*						3.13	✓ 12.50
Plover, Three-banded	*Charadrius tricollaris*						40.63	✓ 31.25
Pochard, Southern	*Netta erythrophthalma*							✓ 9.09
Prinia, Karoo	*Prinia maculosa*				Near endemic	Endemic	75	✓ 62.50
Quail, Common	*Coturnix coturnix*							✓ 12.50
Raven, White-necked	*Corvus albicollis*						59.38	✓ 29.17
Reed-warbler, African	*Acrocephalus baeticatus*							✓ 8.33
Robin-chat, Cape	*Cossypha caffra*						37.5	✓ 25.00
Ruff	*Philomachus pugnax*							✓ 12.50
Sandgrouse, Namaqua	*Pterocles namaqua*					Near-endemic	46.88	✓ 18.92
Sandpiper, Curlew	*Calidris ferruginea*		NT	LC				✓ 12.50

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Sandpiper, Marsh	*Tringa stagnatilis*							✓ 9.09
Sandpiper, Wood	*Tringa glareola*							✓ 5.88
Scrub-robin, Karoo	*Cercotrichas coryphoeus*					Endemic	65.63	✓ 58.33
Seedeater, Streaky-headed	*Crithagra gularis*							✓ 9.09
Shelduck, South African	*Tadorna cana*					Endemic	56.25	✓ 54.17
Shoveler, Cape	*Anas smithii*					Near-endemic	3.13	✓ 21.05
Sparrow, Cape	*Passer melanurus*					Near-endemic	71.88	✓ 70.83
Sparrow, House	*Passer domesticus*						34.38	✓ 29.73
Sparrow, Southern Grey-headed	*Passer diffusus*						3.13	✓ 8.33
Sparrowlark, Black-eared	*Eremopterix australis*				Near endemic	Endemic		✓ 8.33
Sparrowlark, Grey-backed	*Eremopterix verticalis*					Near-endemic		✓ 12.50
Spoonbill, African	*Platalea alba*						3.13	✓ 12.50
Spurfowl, Cape	*Pternistis capensis*				Near endemic	Endemic	53.13	✓ 40.54
Starling, Common	*Sturnus vulgaris*						28.13	✓ 25.00
Starling, Pale-winged	*Onychognathus nabouroup*					Near-endemic	12.5	✓ 47.92
Starling, Pied	*Spreo bicolor*				Endemic (SA, Lesotho, Swaziland)	Endemic	71.88	✓ 58.33
Starling, Wattled	*Creatophora cinerea*						3.13	✓ 6.90
Stilt, Black-winged	*Himantopus himantopus*							✓ 15.79
Stint, Little	*Calidris minuta*						3.13	✓ 12.50
Sunbird, Dusky	*Cinnyris fuscus*					Near-endemic	3.13	✓ 30.43

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Sunbird, Malachite	*Nectarinia famosa*						25	✓ 29.17
Sunbird, Southern Double-collared	*Cinnyris chalybeus*				Near endemic	Endemic	18.75	✓ 33.33
Swallow, Barn	*Hirundo rustica*						37.5	✓ 18.92
Swallow, Greater Striped	*Hirundo cucullata*						46.88	✓ 20.83
Swallow, White-throated	*Hirundo albigularis*							✓ 12.50
Swamp-warbler, Lesser	*Acrocephalus gracilirostris*						3.13	✓ 16.67
Swift, African Black	*Apus barbatus*						3.13	✓ 8.00
Swift, Alpine	*Tachymarptis melba*						3.13	✓ 5.88
Swift, Common	*Apus apus*						3.13	✓ 5.88
Swift, Little	*Apus affinis*						15.63	✓ 25.81
Swift, White-rumped	*Apus caffer*						18.75	✓ 13.89
Teal, Cape	*Anas capensis*						3.13	✓ 11.11
Teal, Red-billed	*Anas erythrorhyncha*							✓ 10.53
Tern, White-winged	*Chlidonias leucopterus*							✓ 12.50
Thick-knee, Spotted	*Burhinus capensis*						3.13	✗ 0.00
Thrush, Karoo	*Turdus smithi*				Near endemic	Endemic	12.5	✓ 8.70
Thrush, Olive	*Turdus olivaceus*						6.25	✓ 8.70
Tit, Grey	*Parus afer*				Near endemic	Endemic	21.88	✓ 33.33
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*					Near-endemic		✓ 37.84
Tit-babbler, Layard's	*Parisoma layardi*				Near endemic	Endemic	9.38	✓ 15.00
Turtle-dove, Cape	*Streptopelia capicola*						40.63	✓ 56.25

Species	Taxonomic name	Priority species	Global status Red Data	Regional status Red Data	Endemic status SA	Endemic status region	SABAP2 reporting rate % (9 pentad)	SABAP1 reporting rate % (3220DA)
Wagtail, Cape	*Motacilla capensis*						56.25	✓ 68.75
Warbler, Namaqua	*Phragmacia substriata*				Near endemic	Endemic	15.63	✓ 37.84
Warbler, Rufous-eared	*Malcorus pectoralis*					Endemic	31.25	✓ 16.67
Warbler, Willow	*Phylloscopus trochilus*							✓ 8.33
Waxbill, Common	*Estrilda astrild*						25	✓ 29.17
Weaver, Cape	*Ploceus capensis*				Near endemic	Endemic	46.88	✓ 14.58
Wheatear, Capped	*Oenanthe pileata*							✓ 22.22
Wheatear, Mountain	*Oenanthe monticola*					Near-endemic	40.63	✓ 45.83
White-eye, Cape	*Zosterops virens*				Near endemic	Endemic	3.13	✓ 40.00
White-eye, Orange River	*Zosterops pallidus*					Endemic		✓ 40.00
Whydah, Pin-tailed	*Vidua macroura*							✓ 8.33
Woodpecker, Cardinal	*Dendropicos fuscescens*							✓ 16.67
Woodpecker, Ground	*Geocolaptes olivaceus*				Endemic (SA, Lesotho, Swaziland)	Endemic	12.5	✓ 12.50

SUTHERLAND (MARALLA) SURVEY

STATISTICAL ANALYSIS

1. INTRODUCTION

This report is based on data captured in the MS Excel file "*Maralla Sutherland VP Su Au Wi Sp Data 2016-10-24 v1.xls*". This file contains records for each individual flight of priority species birds that were recorded at six vantage points set up at the site. Observations were recorded in sampling units of time referred to as "watch periods", each of three hours duration. The word "*flight"* indicates a group of birds flying or associating together. Individual birds in a flight were counted and recorded and these are referred to as "*individual*" counts. When no birds were seen during a watch period, the species was identified by the label "*None*". Every species is categorised into a "*Flight Class".* In this survey two flight classes were recorded viz. "Soaring" and "Terrestrial".

There were *96 watch periods* of three hours each, spread over the *six* vantage points, allocated to each of the four seasons as set out in Table *1*. Environmental and other relevant information were also recorded (e.g. Temperature, Wind Direction, Wind Speed, categories of height at which the birds were observed, etc.).

Table *1*. The survey dates.

Start Date	End Date	Season	Watch Periods	Hours Observed
2016-01-18	2016-01-24	Summer 2015/16	24	72
2016-04-16	2016-04-23	Autumn 2016	24	72
2016-06-14	2016-06-22	Winter 2016	24	72
2016-09-26	2016-10-02	Spring 2016	24	72

Basic summary statistics concerning the data are presented in this report in tables *A – I* in Section *A* of the Appendix. The matter of whether the data obtained are representative of the true occurrence of those birds identified as priority species is investigated. The sample size (number of watch periods) is also considered to establish the validity of the estimates of the average number of birds observed.

The statistical terminology used is defined and explained in Section *B* of the *Appendix* at the end of this report.

2. DESCRIPTIVE STATISTICS

Several tables of descriptive statistics are presented. The watch periods were all of the same length, viz. three hours and thus counts, averages and variabilities are expressed per *3* hours.

The following basic statistics were computed and presented in Section *A* of the *Appendix*.

- A count of the total number of individual birds (by species and flight class) observed during the survey against the *Height* at which they flew. These data are displayed as Table *A* in Section *A* of the *Appendix*.
- Table *B* shows the times that the soaring and terrestrial birds were observed flying at medium height and at all heights. The times spent at medium height are expressed as a percentage of the total observed flying times. These percentages have to be interpreted with care and should always be seen together with the total flight time.

- Tables *C – G* provide summary statistics for insight into the behaviour of the species observed w.r.t. their presence according to season and their occurrence profiles during various weather conditions such as temperature, wind direction and wind strength.
- The counts observed during consecutive watch periods, also identified by season and vantage point, are listed separately in Table *H* (soaring birds) and Table *I* (terrestrial birds) in section *A* of the *Appendix*. These tables also contain updated average counts for consecutive watch periods.

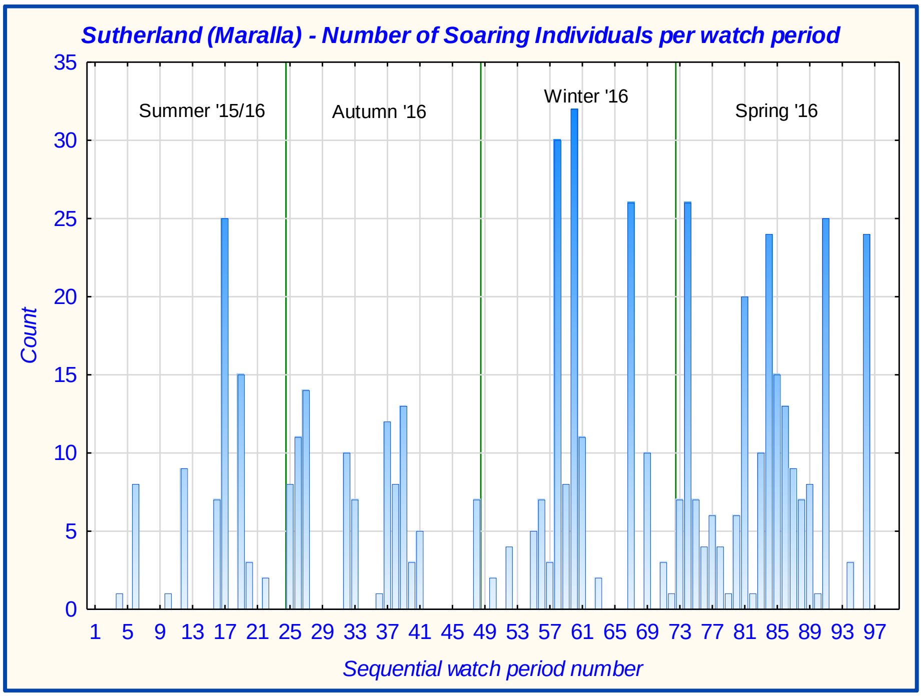
The computations were done using STATISTICA statistical software (Dell Inc., *2015*) and with routines developed for this purpose in "Statistica Visual Basic", the programming language of STATISTICA.

3. ESTIMATION OF THE POPULATION MEAN

The descriptive statistics of average counts, standard deviations (*Std.Dev.*) and *95%* lower and upper confidence intervals (LCL and UCL) for the mean count per watch period for the data in each of the seasons are computed from Tables *H* and *I*. The seasonal and overall estimates are listed in Tables *2 – 5*.

The computation of confidence intervals assumes that certain assumptions are to be met by the underlying distribution of counts. One possibility is to assume the normal distribution which is the default standard for such computations in statistical software packages.
The viability of such an assumption is investigated by plotting the raw data counts for soaring and terrestrial individual counts per watch period in their time sequence (see Figures *1* and *2*) and looking at the empirical distribution.

Figure *1*: **Sequential time plot (by consecutive watch period number) of *individual* soaring bird counts.**



A similar graph for flight counts shows much the same picture but of course the counts per watch period are lower.

Figure 2: **Sequential time plot (by consecutive watch period number) of *individual* terrestrial bird counts.**

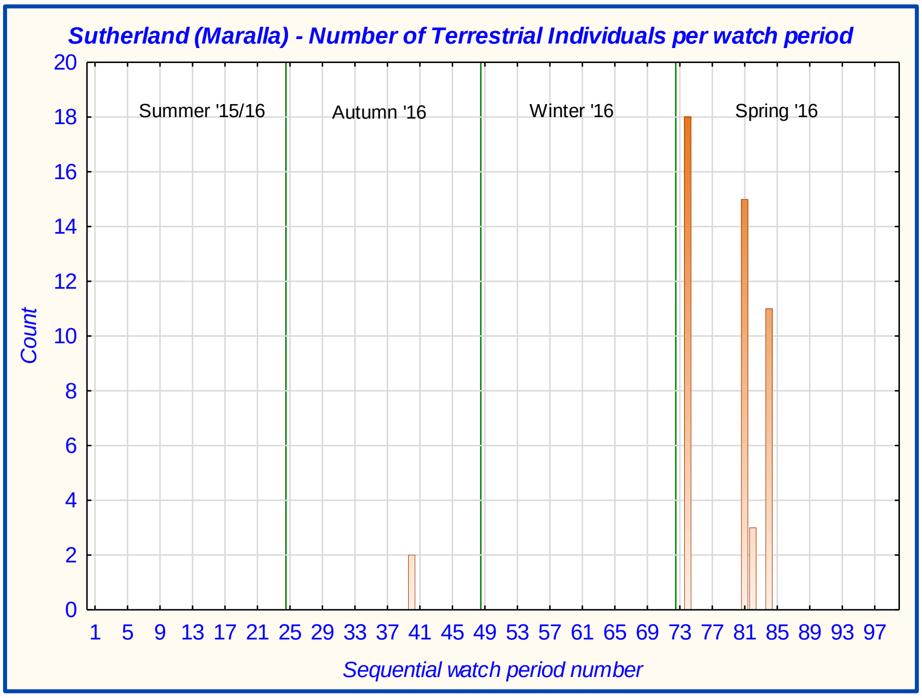
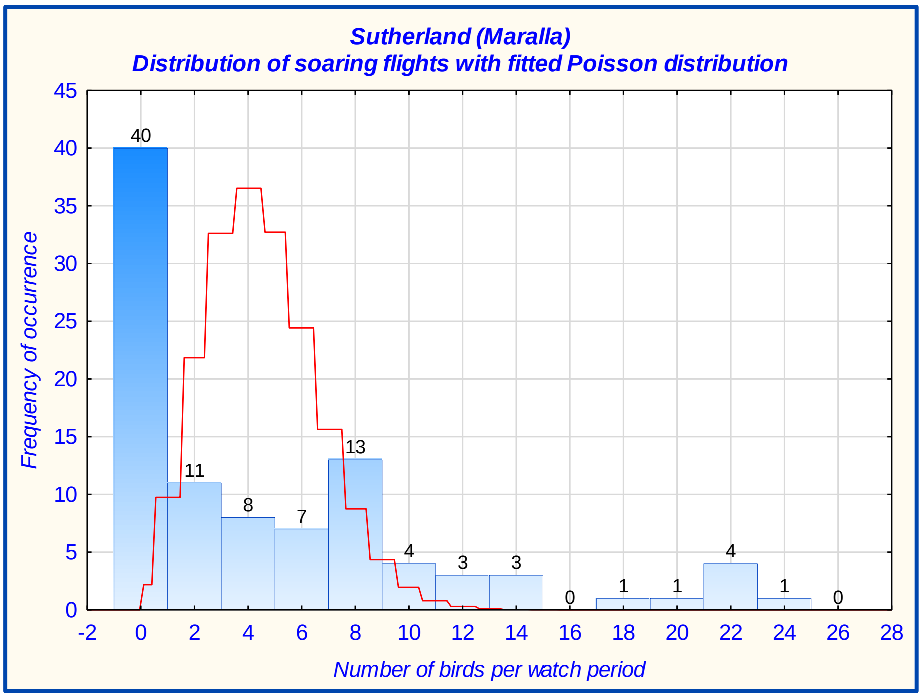


Figure *2* shows that no terrestrial birds were recorded in the *24* watch periods of the Summer and Winter surveys and that only two flights with a single bird each were recorded in one watch period during the Autumn survey. A total of only *49* terrestrials were recorded in the *96* watch periods of all four seasons.

The distribution of the counts is the supporting information required for estimating the average number of birds with prescribed confidence. For this purpose it is flights (rather than individual counts) that will be considered for the purpose of investigating the counts distribution. It is thought that flights are the random events that materialise in each sampling unit (watch period) and thus determine the distribution. Moreover, in the light of the small number of terrestrial birds observed in the survey the distribution of counts will be done for soaring birds only.

Figure *3*. **Histogram of the distribution of soaring bird flight counts over all four seasons.**



In general, for situations where *counts* are made per fixed sampling unit (in this case a watch period of 3*h*) the Poisson distribution is particularly relevant. The Poisson process is a probability model in which events (e.g. the sighting of a flight of birds) occur randomly and uniformly in time or space. The assumptions supporting such a model are independence of the events, individuality of each event and the uniform arrival of events over the time period of the sampling unit. Details of this is discussed by Kalbfleisch, 1985, pp. *128 – 133*. There may be arguments against the validity of this distribution underlying bird counts but it is theoretically probably as close to reality as can be hoped for. One way to recognise the Poisson distribution is that its average value and variance are identical (see Kalbfleisch, *1985*, p. *172*). This property is not unique to the Poisson - other distributions may also possess it.

If a Poisson distribution is fitted to the data set plotted in Figure *3* a very poor fit is obtained for the soaring flight counts. Even so, it is believed that the Poisson is a more appropriate approximation to the observed data than the normal distribution (which has an equally poor fit). Thus calculations for sample size, done in section 4, will be based on the assumption of a Poisson distribution for the counts.

4. SAMPLE SIZE

Table *2* reports the statistics for the number of *flights* recorded over all watch periods for soaring birds. Tables *3, 4* and *5* report the same for individual soaring birds, terrestrial flights and terrestrial individuals respectively. The mathematical details of computing the confidence intervals and precisions are presented in section *C* of the Appendix.

Table *2*. Soaring birds, Flights: basic statistics with *95*% confidence interval and precision for the number of flights per *3*h watch period.

Season	Watch periods	Soaring birds: Flights						
		Count	Avge	Variance	Std.Dev.	95% LCL	95% UCL	Precision
Summer '15/16	24	38	1.58	8.17	2.86	1.12	2.17	0.53
Autumn '16	24	95	3.96	23.26	4.82	3.20	4.84	0.82
Winter '16	24	116	4.83	50.93	7.14	3.99	5.80	0.90
Spring '16	24	181	7.54	48.95	7.00	6.48	8.72	1.12
All Grps	96	430	4.48	36.38	6.03	4.07	4.92	0.43

The data in Table *2* is virtually self-explanatory. The *95%* confidence limits for the average count in the Spring survey, for example, is (*6.48 – 8.72*). This leads to a precision for the estimate of the mean value for that season of *1.12*. The values in Tables *3 – 5* are interpreted similarly.

Table *3*. Soaring birds, Individuals: basic statistics with *95*% confidence interval and precision for the number of individuals per *3*h watch period.

Season	Watch periods	Soaring birds: Individuals						
		Count	Avge	Variance	Std.Dev.	95% LCL	95% UCL	Precision
Summer '15/16	24	71	2.96	36.91	6.08	2.31	3.73	0.71
Autumn '16	24	99	4.13	25.33	5.03	3.35	5.02	0.83
Winter '16	24	144	6.00	92.96	9.64	5.06	7.06	1.00
Spring '16	24	221	9.21	74.78	8.65	8.03	10.51	1.24
All Grps	96	535	5.57	61.32	7.83	5.11	6.07	0.48

Table *4*. Terrestrial birds, Flights: basic statistics with *95*% confidence interval and precision for the number of individuals per *3*h watch period.

Season	Watch periods	Terrestrial birds: Flights						
		Count	Avge	Variance	Std.Dev.	95% LCL	95% UCL	Precision
Summer '15/16	24	0	0.00	0.00	0.00	0.00	0.15	0.08
Autumn '16	24	2	0.08	0.17	0.41	0.01	0.30	0.15
Winter '16	24	0	0.00	0.00	0.00	0.00	0.15	0.08
Spring '16	24	15	0.63	3.72	1.93	0.35	1.03	0.34
All Grps	96	17	0.18	1.01	1.01	0.10	0.28	0.09

Table 5. **Terrestrial birds, Individuals: basic statistics with *95%* confidence interval and precision for the number of individuals per *3*h watch period.**

Season	Watch periods	Terrestrial birds: Individuals						
		Count	Avge	Variance	Std.Dev.	95% LCL	95% UCL	Precision
Summer '15/16	24	0	0.00	0.00	0.00	0.00	0.15	0.08
Autumn '16	24	2	0.08	0.17	0.41	0.01	0.30	0.15
Winter '16	24	0	0.00	0.00	0.00	0.00	0.15	0.08
Spring '16	24	47	1.96	25.52	5.05	1.44	2.60	0.58
All Grps	96	49	0.51	6.93	2.63	0.38	0.67	0.15

Due to the small number of terrestrial birds, the precision by which their average occurrence can be estimated is also small (i.e. better precision). The main issue is thus to determine if the sample size was sufficiently large to estimate the average of the abundance of soaring birds with prescribed precision.

The largest precision occurs for soaring individuals during the Spring survey (*d = 1.24*). This means that the average for that (or any other season) could be estimated to within *1.24* birds per *3*h watch period (with *95%* certainty). This means that with the density of birds of *9.21* per *3*h watch period (as observed in the Spring 2016 survey) the *24* watch periods is sufficiently large to lead to a precision of about *1¼* bird.

For another perspective on sample size, if the density of birds per *3*h watch period is *9.21* as is the case for the Spring 2016 survey, and if a *95%* precision of *1* bird is desired, the computation based on the Poisson formula (*1*) in section D of the Appendix leads to a value *N = 30* watch periods.

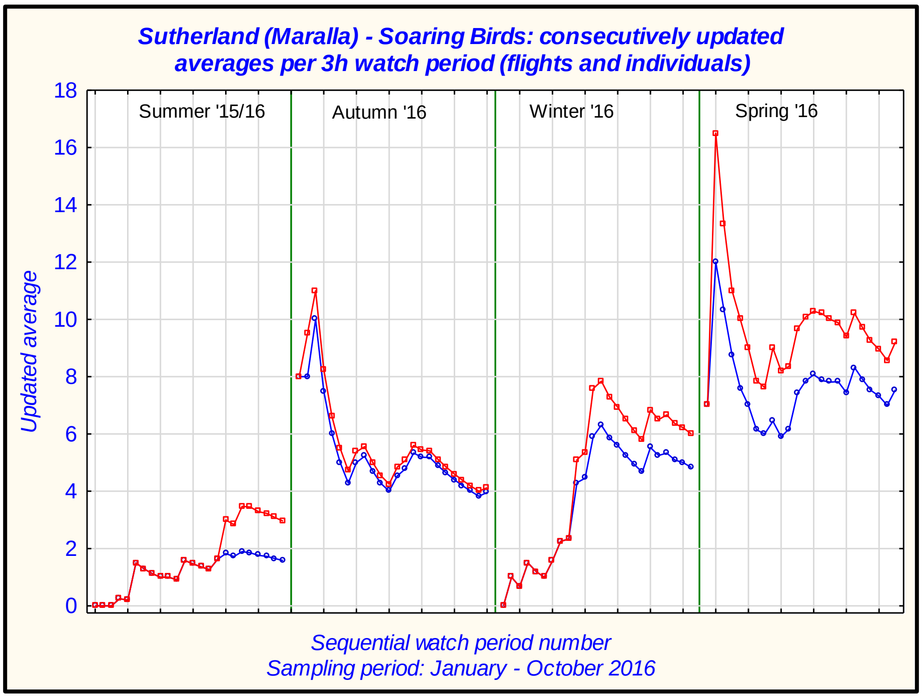
The final conclusion is that for a density of as high as *9.21* (the highest over all seasons) the 24 watch periods is sufficient to estimate the average to a precision of *1.25*. This is the weakest link in the chain over all four seasons for both soaring and terrestrial birds.

5. *Stability and Representativeness*

Insight into the accuracy (i.e. closeness to the true value), representativeness and stability of the counting process may be obtained by noting that as the data are gathered watch period by watch period an improved estimate of the average number of birds occurring in the area will be achieved for each added count. As more data are gathered the more accurate the estimate will become. The issue is to determine if the updated average count begins to stabilise towards the end of the survey (and thus the conclusion that an accurate, representative sample has been achieved).
To investigate the behaviour of this process the average number of *flights* (and *individual*s) per *3*h watch period is computed from all preceding data as the data become available in consecutive watch periods. These updated averages are expected to vary to some extent in the initial stages of sampling but to stabilise as more data come in. Since the counts may vary

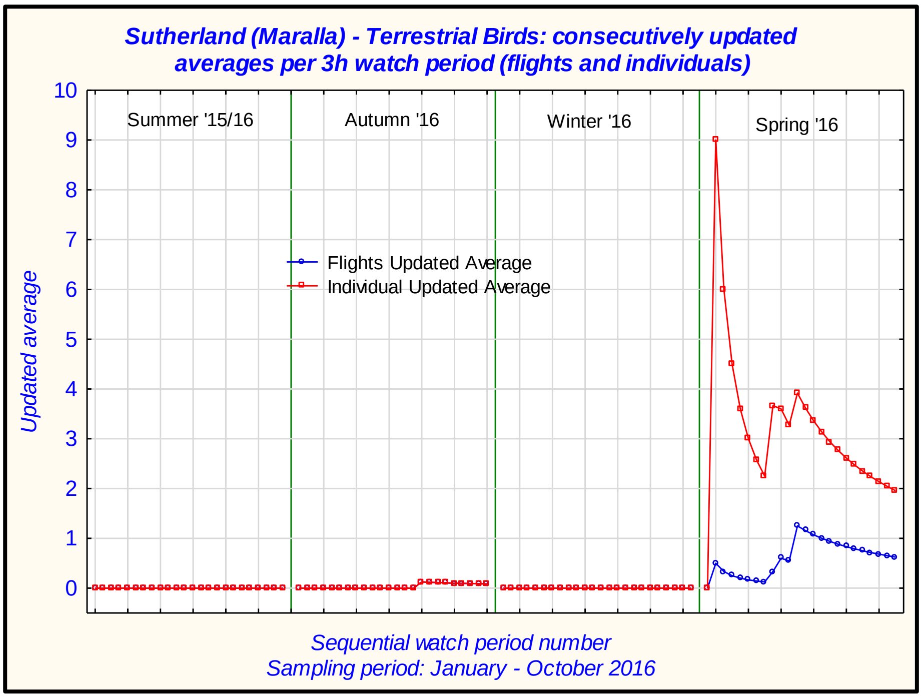
(in principle) substantially over the seasons (especially for individual counts) the updated averages are determined separately for each season and are listed in Tables *H* and *I* in the Appendix. These data are plotted (by season) in Figure *4* for soaring birds and Figure *5* for terrestrials.

Figure *4*. **Soaring birds: updated average for *Flight* and *Individual* counts, separately by season.**



When a single red line appears in the chart, each recorded flight consists of only a single bird. The graphs tend to flatten out towards the end of each separate season and that implies stability of the series of counts. This trend is even much more visible in Figure *5*as is to be expected with a low density of counts.

Figure *5*. **Terrestrial birds: updated average for *Flight* and *Individual* counts, separately by season.**



6. Conclusion

The computations and the outcome of the data exhibited in the tables and graphs in this report show that the survey may be taken to be statistically representative of the soaring and terrestrial priority species of birds that occur in the area. It has also been demonstrated that more samples would not yield a meaningful improvement in the accuracy and precision of estimating the terrestrial mean number of birds per watch period. The seasonal averages are estimated with *95%* confidence to (at the worst) 1.25 birds per *3*h watch period, but in most seasons as well as for the overall estimate, considerably precise that that.

7. References

Brownlee, K.A., (1960), *Statistical Theory and Methodology in Science and Engineering.* John Wiley: New York.

Dell, Inc., (2015), Dell STATISTICA (data analysis software system), Version 12. www.Software.dell.com.

Kalbfleisch, J.G., (1985), *Probability and statistical inference, Vol. 1: Probability.* Springer Verlag: New York.

Zar, J.H., (2010), *Biostatistical Analysis* (5th ed.), Prentice-Hall, Inc., Upper Saddle River: NJ 07458.

APPENDIX

A. *Additional Statistics*

Table A. Number of individual priority species recorded during the survey by Species, Flight Class and Flying Height.

Species	Flight Class	Flying Height			Row Totals
		Low	Medium	High	
Verreauxs' Eagle	Soaring	15	92	89	196
Martial Eagle	Soaring	5	31	34	70
African Fish-Eagle	Soaring	0	0	3	3
Booted Eagle	Soaring	1	8	2	11
Jackal Buzzard	Soaring	23	84	43	150
Steppe Buzzard	Soaring	7	8	0	15
Southern Pale Chanting Goshawk	Soaring	4	0	0	4
Black Harrier	Soaring	15	19	8	42
Lesser Kestrel	Soaring	7	6	31	44
Count (Soaring)		77	248	210	535
Percentage		14%	46%	39%	100%
Ludwig's Bustard	Terrestrial	1	1	0	2
Southern Black Korhaan	Terrestrial	15	0	0	15
Greater Flamingo	Terrestrial	0	32	0	32
Count (Terrestrial)		16	33	0	49
Percentage		33%	67%	0%	100%
Total count (Overall)		93	281	210	584
Percentage		16%	48%	36%	100%

Table B. Number of individual priority species recorded during the survey by Species, Flight Class, the number (N) that flew at medium / all heights and Flight Duration (minutes) at medium / all heights. The time at medium height is expressed as a percentage of the time at all heights.

Species	Flight Class	Valid N and Flight Duration (minutes)				
		At Medium Height		At All Heights		% Time at Medium Ht
		N	Time (min)	N	Time (min)	
Booted Eagle	Soaring	8	4.57	11	6.93	65.9%
Jackal Buzzard	Soaring	84	118.28	150	189.88	62.3%
Black Harrier	Soaring	19	14.85	42	27.20	54.6%
Steppe Buzzard	Soaring	8	2.50	15	4.75	52.6%
Verreauxs' Eagle	Soaring	92	209.17	196	424.43	49.3%
Martial Eagle	Soaring	31	34.37	70	104.43	32.9%
Lesser Kestrel	Soaring	6	7.00	44	193.23	3.6%
Southern Pale Chanting Goshawk	Soaring	0	0	4	19.55	0%
African Fish-Eagle	Soaring	0	0	3	2.33	0%
Count (Soaring)		248	390.73	535	972.75	40.2%
Percentage (of N)		46%	-	100%	-	-
Greater Flamingo	Terrestrial	32	174.60	32	174.60	100%
Ludwig's Bustard	Terrestrial	1	0.95	2	1.18	80.3%
Southern Black Korhaan	Terrestrial	0	0	15	6.73	0%
Count (Terrestrial)		33	175.55	49	182.52	96.2%
Percentage (of N)		67%	-	100%	-	-
Total count (Overall)		281	566.28	584	1155.27	49.0%
Percentage (of N)		48%	-	100%	-	-

Table C: Number of individual priority species recorded by Species, Flight Class and Season.						
Species	**Flight Class**	**Season**				**Row Totals**
		Summer '15	**Summer '16**	**Autumn16**	**Winter16**	
Verreauxs' Eagle	Soaring	1	35	80	80	196
Martial Eagle	Soaring	2	40	8	20	70
African Fish-Eagle	Soaring	0	0	0	3	3
Booted Eagle	Soaring	0	0	0	11	11
Jackal Buzzard	Soaring	9	22	54	65	150
Steppe Buzzard	Soaring	15	0	0	0	15
Southern Pale Chanting Goshawk	Soaring	0	2	2	0	4
Black Harrier	Soaring	0	0	0	42	42
Lesser Kestrel	Soaring	44	0	0	0	44
Count (Soaring)		71	99	144	221	535
Percentage		13%	19%	27%	41%	100%
Ludwig's Bustard	Terrestrial	0	2	0	0	2
Southern Black Korhaan	Terrestrial	0	0	0	15	15
Greater Flamingo	Terrestrial	0	0	0	32	32
Count (Terrestrial)		0	2	0	47	49
Percentage		0%	4%	0%	96%	100%
Total count (Overall)		71	101	144	268	584
Percentage		12%	17%	25%	46%	100%

Table D: Number of individual priority species recorded by Species, Flight Class and Temperature.

Species	Flight Class	Temperature				Row Totals
		Cold	Mild	Warm	Hot	
Verreauxs' Eagle	Soaring	122	39	34	1	196
Martial Eagle	Soaring	21	41	8	0	70
African Fish-Eagle	Soaring	3	0	0	0	3
Booted Eagle	Soaring	2	9	0	0	11
Jackal Buzzard	Soaring	87	44	18	1	150
Steppe Buzzard	Soaring	0	0	9	6	15
Southern Pale Chanting Goshawk	Soaring	2	2	0	0	4
Black Harrier	Soaring	10	23	9	0	42
Lesser Kestrel	Soaring	0	0	44	0	44
Count (Soaring)		247	158	122	8	535
Percentage		46%	30%	23%	1%	100%
Ludwig's Bustard	Terrestrial	2	0	0	0	2
Southern Black Korhaan	Terrestrial	3	12	0	0	15
Greater Flamingo	Terrestrial	0	32	0	0	32
Count (Terrestrial)		5	44	0	0	49
Percentage		10%	90%	0%	0%	100%
Total count (Overall)		252	202	122	8	584
Percentage		43%	35%	21%	1%	100%

Table E: Number of individual priority species, by Species, Flight Class and Weather Condition.

Species	Flight Class	Cloudy	Partly Cloudy	Sunny	Row Totals
Verreauxs' Eagle	Soaring	10	30	156	196
Martial Eagle	Soaring	9	48	13	70
African Fish-Eagle	Soaring	0	0	3	3
Booted Eagle	Soaring	0	2	9	11
Jackal Buzzard	Soaring	10	34	106	150
Steppe Buzzard	Soaring	9	6	0	15
Southern Pale Chanting Goshawk	Soaring	1	1	2	4
Black Harrier	Soaring	0	7	35	42
Lesser Kestrel	Soaring	17	27	0	44
Count (Soaring)		56	155	324	535
Percentage		10%	29%	61%	100%
Ludwig's Bustard	Terrestrial	2	0	0	2
Southern Black Korhaan	Terrestrial	0	0	15	15
Greater Flamingo	Terrestrial	0	0	32	32
Count (Terrestrial)		2	0	47	49
Percentage		4%	0%	96%	100%
Total count (Overall)		58	155	371	584
Percentage		10%	27%	64%	100%

Table F: Number of individual priority species recorded by Species and Wind Direction.

Species	Flight Class	Wind Direction								Row Totals
		N	NE	E	SE	S	SW	W	NW	
Verreauxs' Eagle	Soaring	20	0	1	26	0	0	0	149	196
Martial Eagle	Soaring	20	8	1	8	0	0	0	33	70
African Fish-Eagle	Soaring	0	0	0	3	0	0	0	0	3
Booted Eagle	Soaring	0	0	0	2	0	0	0	9	11
Jackal Buzzard	Soaring	4	5	8	56	0	0	0	77	150
Steppe Buzzard	Soaring	0	0	6	9	0	0	0	0	15
Southern Pale Chanting Goshawk	Soaring	1	0	0	0	0	0	0	3	4
Black Harrier	Soaring	0	0	0	10	0	0	0	32	42
Lesser Kestrel	Soaring	0	0	0	24	0	5	15	0	44
Count (Soaring)		45	13	16	138	0	5	15	303	535
Percentage		8%	2%	3%	26%	0%	1%	3%	57%	100%
Ludwig's Bustard	Terrestrial	0	0	0	0	0	0	0	2	2
Southern Black Korhaan	Terrestrial	0	0	0	0	0	0	0	15	15
Greater Flamingo	Terrestrial	0	0	0	0	0	0	0	32	32
Count (Terrestrial)		0	0	0	0	0	0	0	49	49
Percentage		0%	0%	0%	0%	0%	0%	0%	100 %	100%
Total count (Overall)		45	13	16	138	0	5	15	352	584
Percentage		8%	2%	3%	24%	0%	1%	3%	60%	100%

Table G: Number of individual priority species birds recorded by Species, Flight Class and Wind Strength (Beaufort scale).

Species	Flight Class	Light Air	Light Breeze	Gentle Breeze	Moderate Breeze	Fresh Breeze	Strong Breeze	Total
Verreauxs' Eagle	Soaring	10	59	93	22	6	6	196
Martial Eagle	Soaring	1	18	34	8	9	0	70
African Fish-Eagle	Soaring	0	0	3	0	0	0	3
Booted Eagle	Soaring	0	8	3	0	0	0	11
Jackal Buzzard	Soaring	17	14	70	49	0	0	150
Steppe Buzzard	Soaring	0	6	9	0	0	0	15
Southern Pale Chanting Goshawk	Soaring	0	2	2	0	0	0	4
Black Harrier	Soaring	0	16	22	0	4	0	42
Lesser Kestrel	Soaring	42	2	0	0	0	0	44
Count (Soaring)		70	125	236	79	19	6	535
Percentage		13%	23%	44%	15%	4%	1%	100%
Ludwig's Bustard	Terrestrial	0	0	2	0	0	0	2
Southern Black Korhaan	Terrestrial	0	11	4	0	0	0	15
Greater Flamingo	Terrestrial	0	0	14	18	0	0	32
Count (Terrestrial)		0	11	20	18	0	0	49
Percentage		0%	22%	41%	37%	0%	0%	100%
Total count (Overall)		70	136	256	97	19	6	584
Percentage		12%	23%	44%	17%	3%	1%	100%

Table H: ***Soaring Birds*: Flights and Individuals for priority species per watch period and by vantage point over time with updated averages per consecutive watch period.**

Watch Number	Date	Season	VP	Flights count	Flights Updated Avge *	Individuals count	Individuals Updated Avge*
1	2016-01-18	Summer '15/16	VP1	0.0	0.00	0.0	0.00
2	2016-01-18	Summer '15/16	VP1	0.0	0.00	0.0	0.00
3	2016-01-18	Summer '15/16	VP1	0.0	0.00	0.0	0.00
4	2016-01-19	Summer '15/16	VP2	1.0	0.25	1.0	0.25
5	2016-01-19	Summer '15/16	VP2	0.0	0.20	0.0	0.20
6	2016-01-19	Summer '15/16	VP1	8.0	1.50	8.0	1.50
7	2016-01-20	Summer '15/16	VP3	0.0	1.29	0.0	1.29
8	2016-01-20	Summer '15/16	VP3	0.0	1.13	0.0	1.13
9	2016-01-20	Summer '15/16	VP3	0.0	1.00	0.0	1.00
10	2016-01-21	Summer '15/16	VP4	1.0	1.00	1.0	1.00
11	2016-01-21	Summer '15/16	VP4	0.0	0.91	0.0	0.91
12	2016-01-21	Summer '15/16	VP3	9.0	1.58	9.0	1.58
13	2016-01-22	Summer '15/16	VP6	0.0	1.46	0.0	1.46
14	2016-01-22	Summer '15/16	VP5	0.0	1.36	0.0	1.36
15	2016-01-22	Summer '15/16	VP2	0.0	1.27	0.0	1.27
16	2016-01-22	Summer '15/16	VP2	7.0	1.63	7.0	1.63
17	2016-01-23	Summer '15/16	VP5	5.0	1.82	25.0	3.00
18	2016-01-23	Summer '15/16	VP6	0.0	1.72	0.0	2.83
19	2016-01-23	Summer '15/16	VP5	5.0	1.89	15.0	3.47
20	2016-01-23	Summer '15/16	VP6	1.0	1.85	3.0	3.45
21	2016-01-23	Summer '15/16	VP5	0.0	1.76	0.0	3.29
22	2016-01-23	Summer '15/16	VP6	1.0	1.73	2.0	3.23
23	2016-01-24	Summer '15/16	VP4	0.0	1.65	0.0	3.09
24	2016-01-24	Summer '15/16	VP4	0.0	1.58	0.0	2.96
25	2016-04-16	Autumn '16	VP1	8.0	8.00	8.0	8.00
26	2016-04-16	Autumn '16	VP1	8.0	8.00	11.0	9.50
27	2016-04-16	Autumn '16	VP1	14.0	10.00	14.0	11.00
28	2016-04-17	Autumn '16	VP1	0.0	7.50	0.0	8.25
29	2016-04-17	Autumn '16	VP2	0.0	6.00	0.0	6.60
30	2016-04-17	Autumn '16	VP2	0.0	5.00	0.0	5.50
31	2016-04-18	Autumn '16	VP2	0.0	4.29	0.0	4.71
32	2016-04-18	Autumn '16	VP2	10.0	5.00	10.0	5.38
33	2016-04-18	Autumn '16	VP4	7.0	5.22	7.0	5.56
34	2016-04-19	Autumn '16	VP4	0.0	4.70	0.0	5.00

35	2016-04-19	Autumn '16	VP4	0.0	4.27	0.0	4.55
36	2016-04-19	Autumn '16	VP4	1.0	4.00	1.0	4.25
37	2016-04-20	Autumn '16	VP3	11.0	4.54	12.0	4.85
38	2016-04-20	Autumn '16	VP3	8.0	4.79	8.0	5.07
39	2016-04-20	Autumn '16	VP3	13.0	5.33	13.0	5.60
40	2016-04-21	Autumn '16	VP3	3.0	5.19	3.0	5.44
41	2016-04-22	Autumn '16	VP5	5.0	5.18	5.0	5.41
42	2016-04-22	Autumn '16	VP6	0.0	4.89	0.0	5.11
43	2016-04-22	Autumn '16	VP5	0.0	4.63	0.0	4.84
44	2016-04-22	Autumn '16	VP6	0.0	4.40	0.0	4.60
45	2016-04-22	Autumn '16	VP5	0.0	4.19	0.0	4.38
46	2016-04-22	Autumn '16	VP6	0.0	4.00	0.0	4.18
47	2016-04-23	Autumn '16	VP6	0.0	3.83	0.0	4.00
48	2016-04-23	Autumn '16	VP5	7.0	3.96	7.0	4.13
49	2016-06-14	Winter '16	VP1	0.0	0.00	0.0	0.00
50	2016-06-14	Winter '16	VP1	2.0	1.00	2.0	1.00
51	2016-06-14	Winter '16	VP1	0.0	0.67	0.0	0.67
52	2016-06-15	Winter '16	VP1	4.0	1.50	4.0	1.50
53	2016-06-15	Winter '16	VP2	0.0	1.20	0.0	1.20
54	2016-06-16	Winter '16	VP2	0.0	1.00	0.0	1.00
55	2016-06-16	Winter '16	VP2	5.0	1.57	5.0	1.57
56	2016-06-16	Winter '16	VP2	7.0	2.25	7.0	2.25
57	2016-06-17	Winter '16	VP3	3.0	2.33	3.0	2.33
58	2016-06-17	Winter '16	VP3	22.0	4.30	30.0	5.10
59	2016-06-17	Winter '16	VP3	6.0	4.45	8.0	5.36
60	2016-06-18	Winter '16	VP3	22.0	5.92	32.0	7.58
61	2016-06-18	Winter '16	VP4	11.0	6.31	11.0	7.85
62	2016-06-19	Winter '16	VP4	0.0	5.86	0.0	7.29
63	2016-06-19	Winter '16	VP4	2.0	5.60	2.0	6.93
64	2016-06-19	Winter '16	VP4	0.0	5.25	0.0	6.50
65	2016-06-21	Winter '16	VP6	0.0	4.94	0.0	6.12
66	2016-06-21	Winter '16	VP5	0.0	4.67	0.0	5.78
67	2016-06-21	Winter '16	VP5	21.0	5.53	26.0	6.84
68	2016-06-21	Winter '16	VP6	0.0	5.25	0.0	6.50
69	2016-06-21	Winter '16	VP5	7.0	5.33	10.0	6.67
70	2016-06-21	Winter '16	VP6	0.0	5.09	0.0	6.36
71	2016-06-22	Winter '16	VP6	3.0	5.00	3.0	6.22
72	2016-06-22	Winter '16	VP5	1.0	4.83	1.0	6.00
73	2016-09-26	Spring '16	VP1	7.0	7.00	7.0	7.00
74	2016-09-26	Spring '16	VP1	17.0	12.00	26.0	16.50

75	2016-09-26	Spring '16	VP1	7.0	10.33	7.0	13.33
76	2016-09-27	Spring '16	VP1	4.0	8.75	4.0	11.00
77	2016-09-27	Spring '16	VP2	3.0	7.60	6.0	10.00
78	2016-09-27	Spring '16	VP2	4.0	7.00	4.0	9.00
79	2016-09-28	Spring '16	VP2	1.0	6.14	1.0	7.86
80	2016-09-28	Spring '16	VP2	5.0	6.00	6.0	7.63
81	2016-09-28	Spring '16	VP3	10.0	6.44	20.0	9.00
82	2016-09-29	Spring '16	VP3	1.0	5.90	1.0	8.20
83	2016-09-29	Spring '16	VP3	9.0	6.18	10.0	8.36
84	2016-09-29	Spring '16	VP3	21.0	7.42	24.0	9.67
85	2016-09-30	Spring '16	VP4	13.0	7.85	15.0	10.08
86	2016-09-30	Spring '16	VP4	11.0	8.07	13.0	10.29
87	2016-09-30	Spring '16	VP4	5.0	7.87	9.0	10.20
88	2016-10-01	Spring '16	VP4	7.0	7.81	7.0	10.00
89	2016-10-01	Spring '16	VP5	8.0	7.82	8.0	9.88
90	2016-10-01	Spring '16	VP6	1.0	7.44	1.0	9.39
91	2016-10-01	Spring '16	VP5	24.0	8.32	25.0	10.21
92	2016-10-01	Spring '16	VP6	0.0	7.90	0.0	9.70
93	2016-10-02	Spring '16	VP6	0.0	7.52	0.0	9.24
94	2016-10-02	Spring '16	VP5	3.0	7.32	3.0	8.95
95	2016-10-02	Spring '16	VP6	0.0	7.00	0.0	8.57
96	2016-10-02	Spring '16	VP5	20.0	7.54	24.0	9.21

* The updated averages (for each season) are computed over the number consecutive watch periods in the season.

Table I: ***Terrestrial Birds*: Flights and Individuals for priority species per watch period and by vantage point over time with updated averages per consecutive watch period.**

Watch Number	Date	Season	VP	Flights count	Flights Updated Avge *	Individuals count	Individuals Updated Avge*
1	2016-01-18	Summer '15/16	VP1	0.0	0.00	0.0	0.00
2	2016-01-18	Summer '15/16	VP1	0.0	0.00	0.0	0.00
3	2016-01-18	Summer '15/16	VP1	0.0	0.00	0.0	0.00
4	2016-01-19	Summer '15/16	VP2	0.0	0.00	0.0	0.00
5	2016-01-19	Summer '15/16	VP2	0.0	0.00	0.0	0.00
6	2016-01-19	Summer '15/16	VP1	0.0	0.00	0.0	0.00
7	2016-01-20	Summer '15/16	VP3	0.0	0.00	0.0	0.00
8	2016-01-20	Summer '15/16	VP3	0.0	0.00	0.0	0.00
9	2016-01-20	Summer '15/16	VP3	0.0	0.00	0.0	0.00
10	2016-01-21	Summer '15/16	VP4	0.0	0.00	0.0	0.00
11	2016-01-21	Summer '15/16	VP4	0.0	0.00	0.0	0.00
12	2016-01-21	Summer '15/16	VP3	0.0	0.00	0.0	0.00
13	2016-01-22	Summer '15/16	VP6	0.0	0.00	0.0	0.00
14	2016-01-22	Summer '15/16	VP5	0.0	0.00	0.0	0.00
15	2016-01-22	Summer '15/16	VP2	0.0	0.00	0.0	0.00
16	2016-01-22	Summer '15/16	VP2	0.0	0.00	0.0	0.00
17	2016-01-23	Summer '15/16	VP5	0.0	0.00	0.0	0.00
18	2016-01-23	Summer '15/16	VP6	0.0	0.00	0.0	0.00
19	2016-01-23	Summer '15/16	VP5	0.0	0.00	0.0	0.00
20	2016-01-23	Summer '15/16	VP6	0.0	0.00	0.0	0.00
21	2016-01-23	Summer '15/16	VP5	0.0	0.00	0.0	0.00
22	2016-01-23	Summer '15/16	VP6	0.0	0.00	0.0	0.00
23	2016-01-24	Summer '15/16	VP4	0.0	0.00	0.0	0.00
24	2016-01-24	Summer '15/16	VP4	0.0	0.00	0.0	0.00
25	2016-04-16	Autumn '16	VP1	0.0	0.00	0.0	0.00
26	2016-04-16	Autumn '16	VP1	0.0	0.00	0.0	0.00
27	2016-04-16	Autumn '16	VP1	0.0	0.00	0.0	0.00
28	2016-04-17	Autumn '16	VP1	0.0	0.00	0.0	0.00
29	2016-04-17	Autumn '16	VP2	0.0	0.00	0.0	0.00
30	2016-04-17	Autumn '16	VP2	0.0	0.00	0.0	0.00
31	2016-04-18	Autumn '16	VP2	0.0	0.00	0.0	0.00
32	2016-04-18	Autumn '16	VP2	0.0	0.00	0.0	0.00
33	2016-04-18	Autumn '16	VP4	0.0	0.00	0.0	0.00
34	2016-04-19	Autumn '16	VP4	0.0	0.00	0.0	0.00

35	2016-04-19	Autumn '16	VP4	0.0	0.00	0.0	0.00
36	2016-04-19	Autumn '16	VP4	0.0	0.00	0.0	0.00
37	2016-04-20	Autumn '16	VP3	0.0	0.00	0.0	0.00
38	2016-04-20	Autumn '16	VP3	0.0	0.00	0.0	0.00
39	2016-04-20	Autumn '16	VP3	0.0	0.00	0.0	0.00
40	2016-04-21	Autumn '16	VP3	2.0	0.13	2.0	0.13
41	2016-04-22	Autumn '16	VP5	0.0	0.12	0.0	0.12
42	2016-04-22	Autumn '16	VP6	0.0	0.11	0.0	0.11
43	2016-04-22	Autumn '16	VP5	0.0	0.11	0.0	0.11
44	2016-04-22	Autumn '16	VP6	0.0	0.10	0.0	0.10
45	2016-04-22	Autumn '16	VP5	0.0	0.10	0.0	0.10
46	2016-04-22	Autumn '16	VP6	0.0	0.09	0.0	0.09
47	2016-04-23	Autumn '16	VP6	0.0	0.09	0.0	0.09
48	2016-04-23	Autumn '16	VP5	0.0	0.08	0.0	0.08
49	2016-06-14	Winter '16	VP1	0.0	0.00	0.0	0.00
50	2016-06-14	Winter '16	VP1	0.0	0.00	0.0	0.00
51	2016-06-14	Winter '16	VP1	0.0	0.00	0.0	0.00
52	2016-06-15	Winter '16	VP1	0.0	0.00	0.0	0.00
53	2016-06-15	Winter '16	VP2	0.0	0.00	0.0	0.00
54	2016-06-16	Winter '16	VP2	0.0	0.00	0.0	0.00
55	2016-06-16	Winter '16	VP2	0.0	0.00	0.0	0.00
56	2016-06-16	Winter '16	VP2	0.0	0.00	0.0	0.00
57	2016-06-17	Winter '16	VP3	0.0	0.00	0.0	0.00
58	2016-06-17	Winter '16	VP3	0.0	0.00	0.0	0.00
59	2016-06-17	Winter '16	VP3	0.0	0.00	0.0	0.00
60	2016-06-18	Winter '16	VP3	0.0	0.00	0.0	0.00
61	2016-06-18	Winter '16	VP4	0.0	0.00	0.0	0.00
62	2016-06-19	Winter '16	VP4	0.0	0.00	0.0	0.00
63	2016-06-19	Winter '16	VP4	0.0	0.00	0.0	0.00
64	2016-06-19	Winter '16	VP4	0.0	0.00	0.0	0.00
65	2016-06-21	Winter '16	VP6	0.0	0.00	0.0	0.00
66	2016-06-21	Winter '16	VP5	0.0	0.00	0.0	0.00
67	2016-06-21	Winter '16	VP5	0.0	0.00	0.0	0.00
68	2016-06-21	Winter '16	VP6	0.0	0.00	0.0	0.00
69	2016-06-21	Winter '16	VP5	0.0	0.00	0.0	0.00
70	2016-06-21	Winter '16	VP6	0.0	0.00	0.0	0.00
71	2016-06-22	Winter '16	VP6	0.0	0.00	0.0	0.00
72	2016-06-22	Winter '16	VP5	0.0	0.00	0.0	0.00
73	2016-09-26	Spring '16	VP1	0.0	0.00	0.0	0.00
74	2016-09-26	Spring '16	VP1	1.0	0.50	18.0	9.00

75	2016-09-26	Spring '16	VP1	0.0	0.33	0.0	6.00
76	2016-09-27	Spring '16	VP1	0.0	0.25	0.0	4.50
77	2016-09-27	Spring '16	VP2	0.0	0.20	0.0	3.60
78	2016-09-27	Spring '16	VP2	0.0	0.17	0.0	3.00
79	2016-09-28	Spring '16	VP2	0.0	0.14	0.0	2.57
80	2016-09-28	Spring '16	VP2	0.0	0.13	0.0	2.25
81	2016-09-28	Spring '16	VP3	2.0	0.33	15.0	3.67
82	2016-09-29	Spring '16	VP3	3.0	0.60	3.0	3.60
83	2016-09-29	Spring '16	VP3	0.0	0.55	0.0	3.27
84	2016-09-29	Spring '16	VP3	9.0	1.25	11.0	3.92
85	2016-09-30	Spring '16	VP4	0.0	1.15	0.0	3.62
86	2016-09-30	Spring '16	VP4	0.0	1.07	0.0	3.36
87	2016-09-30	Spring '16	VP4	0.0	1.00	0.0	3.13
88	2016-10-01	Spring '16	VP4	0.0	0.94	0.0	2.94
89	2016-10-01	Spring '16	VP5	0.0	0.88	0.0	2.76
90	2016-10-01	Spring '16	VP6	0.0	0.83	0.0	2.61
91	2016-10-01	Spring '16	VP5	0.0	0.79	0.0	2.47
92	2016-10-01	Spring '16	VP6	0.0	0.75	0.0	2.35
93	2016-10-02	Spring '16	VP6	0.0	0.71	0.0	2.24
94	2016-10-02	Spring '16	VP5	0.0	0.68	0.0	2.14
95	2016-10-02	Spring '16	VP6	0.0	0.65	0.0	2.04
96	2016-10-02	Spring '16	VP5	0.0	0.63	0.0	1.96

* The updated averages (for each season) are computed over the number consecutive watch periods in the season.

B. DEFINITION OF TERMS

These notes explain some of the terminology used in the report.

Average: The *average value* (also referred to as the *mean value*) is a measure of the location of the centre of gravity of a data distribution.

Variability: The *variance* is a measure of the variability of the observed data (e.g. counts per *3*h) around the mean value of the data. Its square root, the *standard deviation*, does the same but is scaled to the same units as those of the observed data.

Confidence Interval: A *confidence interval* for the true mean of a population (e.g. the true mean of the number of terrestrial birds occurring in an area) is an interval, computed from a random sample, that reflects the uncertainty of the estimate based on a single sample. If it were possible to take the infinite number of all possible samples of size *N* per season (in the present case of sampling) and a *95%* confidence interval for the mean is computed in each case, then *0.95*N* of those intervals will contain the true mean value. The larger the sample size, the narrower the confidence interval. On the other hand, the larger the standard deviation of a distribution, the wider the confidence interval for the mean. The lower limit of the confidence interval is denoted by LCL and the upper limit by UCL.

Precision: A sample *estimate* of a parameter that describes a population (e.g. its true mean) depends on the sample size and is desired to be close to the true value of the parameter. The closeness of such an estimate to the true value is known as its *accuracy*. The precision of an estimate relates to the variability of the measurements. The closer together the data, the more precise the estimate. Half the width of the confidence interval for the parameter is defined as the *precision* of the estimate of the parameter. The larger the sample size the better (smaller) the precision.

Distribution of counts: It is recognised that counts of events (randomly distributed over space or time) that took place, for example, in a fixed time period (e.g. the count of birds in a watch period of fixed length) may have a *Poisson distribution* when the events occur randomly over time. The mean value and variance (the squared standard deviation) of a Poisson distribution are identical. This means that large mean values (of counts per SU) imply poorer precision.

C. POISSON DISTRIBUTION – CONFIDENCE INTERVAL

If the count of birds per sampling unit (SU) [i.e. a watch period] is assumed to have a Poisson distribution with an (unknown) average value of λ and if N SUs were sampled (for example 2h watch periods are sampled $N = 30$ times) the sum of the N counts also has a Poisson distribution (with true average λN), see Brownlee, *1960*, p. *141*.

The Poisson probability (which is characterised uniquely by its average parameter (in this case λN) for finding a count of X = x birds from the N SUs is given by: $P(X = x) = e^{-\lambda N}(\lambda N)^x / x!$, for values of $x = 0, 1, 2, \ldots$.

A $(1 - \beta)$ confidence interval for the mean value, λN, of this Poisson is determined by a lower limit $L_1 = \frac{1}{2}\chi^2_{\beta/2}(2X)$ and an upper limit $L_2 = \frac{1}{2}\chi^2_{1-\beta/2}(2X + 2)$, see Zar (2010), pp. 587 – 589. Here $\chi^2_\alpha(\nu)$ is the α-point of the chi-squared distribution with ν degrees of freedom, i.e. the χ^2-value with cumulative probability of α up to that value. X denotes the count of the number of birds over N SUs.

This means that the coverage probability for λN, based on a count of X birds per N SUs is $P(L_1 \leq \lambda N \leq L_2) = 1 - \beta$. Thus a $1 - \beta$ confidence interval for λ (the expected average value per SU) is given by the interval $(L_1 / N; \quad L_2 / N)$.

These formulas were used to determine the confidence intervals in the Tables in Section *3* of the report.

D. POISSON DISTRIBUTION – SAMPLE SIZE

Consider the question of how many watch periods (i.e. sampling units, N) must be sampled in order to obtain an estimate of the true count per SU with *precision* of "*d*" units with prescribed probability, e.g. 95%. Thus, what must N be so that the true mean count per SU lies in an interval of half-width d with certainty of $1 - \beta$?

As was indicated in the previous section, this interval is $(L_1 / N;\ \ L_2 / N)$ and thus the precision is $d = \frac{1}{2}(L_2 - L_1) / N.$ The true average is estimated from the observed total count, X, and is given by $\hat{\lambda} = X / N.$ This estimate is NOT in the centre of the confidence interval, but even so, we shall take half of the width of the confidence interval and call it the *$1 - \beta$ precision*. A sample size that will be sufficiently large to provide an estimate of the true mean count per SU with an acceptable value for its precision (say $d = d_0$) must thus satisfy the inequality: $\frac{1}{2}(L_2 - L_1) / N \leq d_0$ or, solving for N:

(1) $$N \geq \tfrac{1}{2}(L_2 - L_1) / d_0 = \left(\chi^2_{1-\beta/2}(2X + 2) - \chi^2_{\beta/2}(2X) \right) / 4d_0.$$

If a count *of* $X = x$ is observed and a specified value for d_0 is desired, the sample size must be at least N as in (*1*). This allows the user to verify, for a given count, if the actual number of SU's is sufficiently large to achieve the desired precision.

APPENDIX 6: RENEWABLE ENERGY APPLICATIONS WITHIN A 70KM RADIUS

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts													Proposed Mitigation Measures
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
Proposed 280 MW Gunstfontein Wind Energy Project	14/12/16/3/3/2/395	S&EIR	Networx Eolos Renewables (Pty) Ltd	12 000	280 MW				L	L		L		L	L					Pre-construction monitoring Delineation of suitable buffer zones Post-construction monitoring
Proposed development of renewable energy facility at 3 x Sutherland wind farm sites, Western and Northern Cape.	12/12/20/1782/AM1	S&EIR	Mainstream Power Sutherland	28 600	811 MW					M		M		M						Delineation of no-go zones and pre-construction monitoring. On-site demarcation of 'no-go' areas

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts														Proposed Mitigation Measures
							Construction				Operation					Decommissioning					
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement				
																					identified during pre-construction monitoring must be undertaken to minimise disturbance impacts associated with the construction of the facility. Schedule maintenance activities to avoid disturbances in sensitive areas (identified through

PROPOSED DEVELOPMENT NAME	DEA REFERENCE	CURRENT EA STATUS	PROPONENT	EXTENT	PROPOSED CAPACITY	FARMS	IMPACTS														PROPOSED MITIGATION MEASURES
							Construction				Operation					Decommissioning					
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement				
																					operational monitoring). Carefully monitoring the local avifauna pre- and post-construction monitoring must be undertaken. Excluding development from within 500 m of the edge of the escarpment along its entire length through the development area to reduce

PROPOSED DEVELOPMENT NAME	DEA REFERENCE	CURRENT EA STATUS	PROPONENT	EXTENT	PROPOSED CAPACITY	FARMS	IMPACTS													PROPOSED MITIGATION MEASURES
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
																				collision risk, primarily for slope soaring raptors.
Proposed Hidden Valley Wind Energy Facility, Northern Cape	12/12/20/2370/2	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd	9 530	150 MW				M	M		M			L					Implement exclusion zones In high sensitivity zones Implement post-construction monitoring Curtailment of turbines if need be Nest searches

PROPOSED DEVELOPMENT NAME	DEA REFERENCE	CURRENT EA STATUS	PROPONENT	EXTENT	PROPOSED CAPACITY	FARMS	IMPACTS													PROPOSED MITIGATION MEASURES
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
																				Control of staff and equipment to prevent disturbance
Proposed Hidden Valley wind energy facility , Northern Cape	12/12/20/2370/3	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd	9 180	150 MW				M	M		M			L					Implement exclusion zones In high sensitivity zones Implement post-construction monitoring Curtailment of turbines if need be Nest searches Control of staff and

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts													Proposed Mitigation Measures
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
																				equipment to prevent disturbance
Proposed Hidden Valley wind energy facility , Northern Cape	12/12/20/2370/1	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd	16 620	150MW				M	M		M			L					Implement exclusion zones In high sensitivity zones Implement post-construction monitoring Curtailment of turbines if need be Nest searches Control of staff and equipment

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts											Proposed Mitigation Measures
							Construction				Operation					Decommissioning		
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement	
																		to prevent disturbance
Proposed Hidden Valley wind energy facility, Northern Cape	12/12/20/2370	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd		650 MW				M	M		M			L			Implement exclusion zones In high sensitivity zones Implement post-construction monitoring Curtailment of turbines if need be Nest searches Control of staff and equipment

PROPOSED DEVELOPMENT NAME	DEA REFERENCE	CURRENT EA STATUS	PROPONENT	EXTENT	PROPOSED CAPACITY	FARMS	IMPACTS													PROPOSED MITIGATION MEASURES
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
																				to prevent disturbance
Proposed Construction Of The 140MW Roggeveld Wind Farm Within The Karoo Hoogland Local Municipality Of The Northern Cape Province And Within The Laingsburg Local Municipality Of The Western Cape Province	12/12/20/1988/1/AM1	Amendment	G7 Renerable Energies (Pty) Ltd	26 529	140 MW				L	L		L	L	L	M					Maintain 1.3km buffer zones around Verreaux's Eagle nests Perform a pre-construction walk-through on the 132kV grid connection.

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts													Proposed Mitigation Measures
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
Proposed Photovoltaic (PV) Solar Energy Facility On A Site South Of Sutherland, Within The Karoo Hoogland Municipality Of The Namakwa District Municipality, Northern Cape Province	12/12/20/2235	BAR	Inca Komsberg Wind (Pty) Ltd	2 859	10 MW							M			L					Install visibility “flappers” on all new power lines that are associated with the solar energy facility in order to reduce bird collisions with the power lines. Implement existing Eskom standards for this mitigation. Install “safe” perch or nesting sites at or around the live

PROPOSED DEVELOPMENT NAME	DEA REFERENCE	CURRENT EA STATUS	PROPONENT	EXTENT	PROPOSED CAPACITY	FARMS	IMPACTS													PROPOSED MITIGATION MEASURES
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
																				electric sites on power line pylons so that large perching birds like eagles will not be electrocuted when perching or nesting on these parts of the pylons.
Proposed establishment of the Suurplaat wind energy facility and associated infrastructure on a site near Sutherland,	12/12/20/1583	S&EIR	Moyeng Energy (Pty) Ltd	28 600	120 MW															Could not be sourced

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts														Proposed Mitigation Measures
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
Western Cape and Northern Cape.																				
Proposed establishment of the Witberg Bay wind energy facility, Laingsburg Local Municipality, Central Karoo District, Western cape	12/12/20/1966/A2	Amendment	Witberg Wind Power (Pty) Ltd	23 777	Unknown															Could not be sourced
Proposed Wind Energy facility at Konstabel	12/12/20/1787	S&EIR	South Africa Mainstream Renewable Power Development	5 129	170 MW															Could not be sourced
Proposed development of a renewable Energy	12/12/20/1783/2/AM1	Amendment	South Africa Mainstream Renewable	6 347	Unknown															Could not be sourced

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts													Proposed Mitigation Measures
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
facility at Perdekraal, Western Cape - Split 1			Power Development																	
Proposed Touwsrivier Solar energy facility	12/12/20/1956	S&EIR	Unknown	215	36 MW			L	M	L		L					M			The security fence should be adequately marked and the entire length of the 132 kV transmission line should be marked with bird “flappers” or diverters to make it visible.
Proposed development of renewable energy facility at Komsberg East and	?	S&EIR	Komsberg Wind Farms (Pty) Ltd	25 600	550 MW				L	L		M	L	L	L					Implement exclusion zones in high sensitivity areas

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts													Proposed Mitigation Measures
							Construction				Operation					Decommissioning				
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement			
West near Sutherland																				Implement operational phase monitoring Use bird-friendly powerline designs Mark powerlines with BFDs Implement construction phase monitoring of raptor nests
				Total Ha	**Total MW**															
				193 986	3 217 MW															

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity	Farms	Impacts											Proposed Mitigation Measures
							Construction				Operation					Decommissioning		
							Overall	Collision	Displacement	Habitat loss	Overall	Collision	Displacement	Habitat loss	Electrocution	Overall	Displacement	
Significance Totals per impact	Significance Rating							**Total Hectares per impact**										
	High Significance																	
	Medium Significance								35 545	63 930		63 932		28 600	26 529		215	
	Low Significance							215	38 529	38 744		38 744	26 529	38 529	47 332			
	Positive Impacts																	

APPENDIX 7: IMPACT TABLES

Attached as a separate spreadsheet

BioTherm Energy - Maralla West

Avifauna

Significance Rating Table

Operational Phase									
Maralla West									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
PRIORITY SPECIES MORTALITY DUE TO COLLISION WITH THE TURBINES	Nature of impact:	Negative							
	Without Mitigation	2	4	10	4	64	High	-	High
	degree to which impact can be reversed:	Irreversable							
	degree of impact on irreplaceable resources:	High							
	Mitigation Measures	1) The results of the pre-construction monitoring must guide the lay-out of the turbines, especially as far as proposed no-turbine zones are concerned. No turbines must be constructed in the high risk areas which were identified based on the results of the pre-construction monitoring, with a specific view to limiting the risk of collisions to Verreaux's Eagle, Martial Eagle, Black Harrier and Greater Flamingo. 2) Once the turbines have been constructed, post-construction monitoring should be implemented under the guidance of an avifaunal specialist to assess collision rates, in accordance with the latest version of the Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. 3) If collision rates indicate unacceptable mortality levels of priority species, curtailment of selective turbines should be implemented if sufficient evidence emerges to link mortality to specific turbines. 4) Care should be taken not to create habitat for prey species that could draw priority raptors into the area and expose them to collision risk. Rock piles must be covered with topsoil to prevent them from becoming habitat for Rock Hyrax (Dassie). 5) The booms on the wind mast must be modified to prevent them from becoming roost sites for large raptors. It is recommended that a horizontal thick steel cable is installed 300 - 400mm above the boom to create a physical barrier to prevent large raptors from perching on the boom.							
	With Mitigation	2	4	10	3	48	Medium		Low
DISPLACEMENT OF PRIORITY SPECIES DUE TO HABITAT TRANSFORMATION	Nature of impact:	Negative							
	Without Mitigation	1	4	6	4	44	Medium	-	Medium
	degree to which impact can be reversed:	Irreversable							
	degree of impact on irreplaceable resources:	Low							
	Mitigation Measures	1) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction 2) Existing roads and farm tracks should be used where possible; 3) The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths; 4) No off-road driving; 5) Environmental Control Officers to oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced; 6) Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist. 7) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a rehabilitation specialist and included within the Construction Environmental Management Plan (CEMP).							
	With Mitigation	1	4	4	3	27	Low		Medium

Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
PRIORITY SPECIES MORTALITY DUE TO COLLISION WITH THE ON-SITE POWERLINES	Nature of impact:	Negative							
	Without Mitigation	2	4	10	4	64	High	-	High
	degree to which impact can be reversed:	Medium							
	degree of impact on irreplaceable resources:	High							
	Mitigation Measures	1)An avifaunal specialist must conduct a site walk through of final pylon positions prior to construction to determine if, and where, bird flight diverters (BFDs) are required. 2) Install bird flight diverters as per the instructions of the specialist following the site walkthrough, which may include the need for modified BFDs fitted with solar powered LED lights on certain spans. 3) The operational monitoring programme must include regular monitoring of the grid connection power line for collision mortalities.							
	With Mitigation	2	4	10	3	48	Medium		Medium
PRIORITY SPECIES MORTALITY DUE TO ELECTROCUTION ON THE ON-SITE POWERLINES	Nature of impact:	Negative							
	Without Mitigation	2	4	10	3	48	Medium	-	High
	degree to which impact can be reversed:	Medium							
	degree of impact on irreplaceable resources:	High							
	Mitigation Measures	1)An avifaunal specialist must certify that the pole structures to be used on the internal MV network is bird-friendly.							
	With Mitigation	2	4	10	1	16	Low		High

Maralla West - No-Go

Potential Impact	Mitigation	Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained.	Nature of impact:								
	Without Mitigation								
	degree to which impact can be reversed:								
	degree of impact on irreplaceable resources:								
	Mitigation Measures								
	With Mitigation								

BioTherm Energy - Maralla West

Avifauna

Significance Rating Table

Decommissioning Phase									
Maralla West									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
DISPLACEMENT OF PRIORITY SPECIES DUE TO DISTURBANCE DURING DECOMMISSIONING OPERATIONS	Nature of impact:	Negative							
	Without Mitigation	1	1	4	4	24	Low	-	Medium
	degree to which impact can be reversed:	High							
	degree of impact on irreplaceable resources:	Low							
	Mitigation Measures	1) A site-specific De-commissioning Environmental Management Plan (DEMP) must be implemented, which gives appropriate and detailed description of how decommissioning activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the DEMP and should apply good environmental practice during decommissioning. 2) Following decommissioning, rehabilitation of all areas disturbed must be undertaken and to this end a habitat restoration plan is to be developed by a rehabilitation specialist and included within the De-commissioning Environmental Management Plan (CEMP).							
	With Mitigation	1	1	4	3	18	Low		Medium

Maralla West - No-Go									
Potential Impact	Mitigation	Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained.	Nature of impact:								
	Without Mitigation								
	degree to which impact can be reversed:								
	degree of impact on irreplaceable resources:								
	Mitigation Measures								
	With Mitigation								

BioTherm Energy - Maralla West

Avifauna

Significance Rating Table

Cumulative Impacts									
Maralla West									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Possible impacts by renewable energy projects on birds within a 70km radius are temporary displacement due to disturbance associated with the construction of the facility and associated infrastructure, collisions with solar panels and wind turbines, permanent displacement due to habitat transformation, entrapment in perimeter fences and collisions with the associated power lines.	Nature of impact:	Negative							
	Without Mitigation	3	4	8	5	75	High	-	Medium
	degree to which impact can be reversed:	Low							
	degree of impact on irreplaceable resources:	High							
	Mitigation Measures	1) Careful monitoring of operational facilities to assess the impacts on priority species. 2) Meta-analyses across projects to assess the cumulative impacts of multiple facilities to ensure that the regional and national populations an absorb the impacts. 3) The results of meta-analyses should be fed through to the authorities to ensure informed decision-making.							
	With Mitigation	3	4	8	3	45	Medium	-	Medium
Maralla West - No-Go									
Potential Impact	Mitigation	Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained.	Nature of impact:								
	Without Mitigation								
	degree to which impact can be reversed:								
	degree of impact on irreplaceable resources:								
	Mitigation Measures								
	With Mitigation								