BIRD IMPACT ASSESSMENT STUDY

Proposed Biotherm Aletta Wind Energy Facility near Copperton in the Northern Cape Province

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Prepared by:

AFRIMAGE Photography (Pty) Ltd t/a:
Chris van Rooyen Consulting
VAT#: 4580238113
email: vanrooyen.chris@gmail.com
Tel: +27 (0)82 4549570 cell

DECLARATION OF INDEPENDENCE

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 Sivest 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 Aletta Wind Energy Facility near Copperton.

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Full Name: Chris van Rooyen

Position: Director

RELEVANT EXPERTISE

Chris van Rooyen

Chris has 19 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 more than 160 power line and 30 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 (Pr.Sci.Nat)

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). He is a registered Professional Natural Scientist in the field of zoological science with the South African Council of Natural Scientific Professionals (SACNASP). In 1998, he joined the Endangered Wildlife Trust where he headed up the Airports Company South Africa – Endangered Wildlife 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 they are 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 more than 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.

EXECUTIVE SUMMARY

The proposed BioTherm Aletta (Copperton) Wind Farm will have a variety of impacts on avifauna which range from low to high. The impacts are (1) displacement of priority species due to disturbance during construction phase (2) displacement of priority species due to habitat destruction during construction phase (3) displacement of priority species due to disturbance during operational phase (4) and collisions of priority species with the turbines in the operational phase.

Displacement of priority species due to disturbance during construction phase is likely to be a temporary medium negative impact, but can be reduced to low with the application of mitigation measures. Mitigation measures are the restriction of construction activities to the construction footprint area, no access to the remainder of the property during the construction period, measures to control noise and dust, maximum use of existing access roads, the implementation of a 3km no development buffer zone around a Verreaux's Eagle nest, and a 300m no development buffer zone around a Southern Pale Chanting Goshawk nest.

Displacement of priority species due to habitat destruction during construction phase is likely to be a medium negative impact and will remain so, despite the application of mitigation measures. Mitigation measures comprise strict adherence to the recommendations of the specialist ecological study and maximum use of existing access roads with the construction of new roads kept to a minimum.

Displacement of priority species due to disturbance during the operational phase is likely to be of low significance and it could be further reduced through the application of mitigation measures. Mitigation measures are the restriction of operational activities to the plant area, no access to other parts of the property unless it is necessary for wind farm related work, post-construction monitoring, and if densities of key priority species are proven to be significantly reduced due to the operation of the wind farm, engagement of the wind farm management to devise ways of reducing the impact on these species.

Collisions of priority species with the turbines in the operational phase are likely to be a high negative impact but it could be reduced to medium negative through the application of mitigation measures. Mitigation measures are the implementation of post-construction monitoring and, if actual collision rates indicate high mortality levels, curtailment of selective turbines. Lastly, the implementation of a 3km no development buffer zone around a Verreaux's Eagle nest, a 200m no turbine zone around waterpoints and a 300m no development buffer zone around a Southern Pale Chanting Goshawk nest are recommended.

Finally, it is concluded that, after taking into account the expected impact of proposed renewable energy projects within a 35km radius around Kronos MTS, that the cumulative impact of the proposed Aletta WEF on priority avifauna, after appropriate mitigation has been implemented, will range from minor to insignificant.

The impacts of the proposed Aletta WEF on priority avifauna could be mitigated to acceptable levels, therefore the development could proceed provided that mitigation measures are strictly implemented.

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1. INTRODUCTION & BACKGROUND

The proposed Aletta Wind Energy Facility (WEF) will be located approximately 17km east of Copperton, within the Siyathemba Local Municipality of the Pixley ka Seme District Municipality in the Northern Cape Province. The proposed project is located on the following properties:

- Portion 1 of Drielings Pan No.101
- Portion 2 of Drielings Pan No.101
- Portion 3 of Drielings Pan No.101
- Remainder of Drielings Pan No.101

1.1 Wind Farm Technical details

The key technical details and infrastructure required is presented in the table below (**Error! Reference source not found.**1 - 1).

Table 1 - 1: Technical details of the proposed Aletta WEF

Project Name	DEA Reference	Farm name and area	Technical details and infrastructure necessary for the proposed project
Aletta WEF	14/12/16/3/3/2/945	• Portion 1 of Drielings Pan No.101 • Portion 2 of Drielings Pan No.101 • Portion 3 of Drielings Pan No.101 • Remainder of Drielings Pan No.101	▪ **60 wind turbines** with a total export capacity of up to 140MW. Turbines will have a hub height of up to 120m and a rotor diameter of up to 150m. ▪ **132kV onsite Aletta IPP Substation** ▪ The turbines will be connected via **medium voltage cables** to the proposed 132kV onsite Aletta IPP Substation. ▪ Internal **access roads** are proposed to be between 4m to 6m wide. ▪ A temporary construction **lay down area.** ▪ A **hard standing area / platform** per turbine. ▪ The **operations and maintenance buildings**, including an on-site spares storage building, a workshop and an operations building. ▪ **Fencing** (if required) will be up to 5m where required and will be either mesh or palisade.

The key components of the project are detailed below.

1.1.1 Turbines

The total amount of developable area is 5 200 hectares. The wind turbines and all other project infrastructure will be placed strategically within the development area based on environmental constraints. The size of the wind turbines will depend on the development area and the total generation capacity that can be produced as a result. The wind turbines will therefore likely have a hub height of up to 120m and a rotor diameter of up to 150m (see Figure 1). The blade rotation direction will be clock-wise. Each wind turbine will have a foundation diameter of up to 20m, and will be approximately 3m deep. The area occupied by each wind turbine will be up to 0.5 hectares (85m x 60m). The excavation area will be approximately 1 000m^2 in sandy soils due to access requirements and safe slope stability requirements. A hard standing area / platform of approximately 2 400m^2 (60m x 40m) per turbine will be required for turbine crane usage. There will be a maximum of 60 wind turbines constructed with a total generation capacity of up to 140MW. The electrical generation capacity for each turbine will range from 1.5 to 3.5MW depending on the final wind turbine selected for the proposed development.

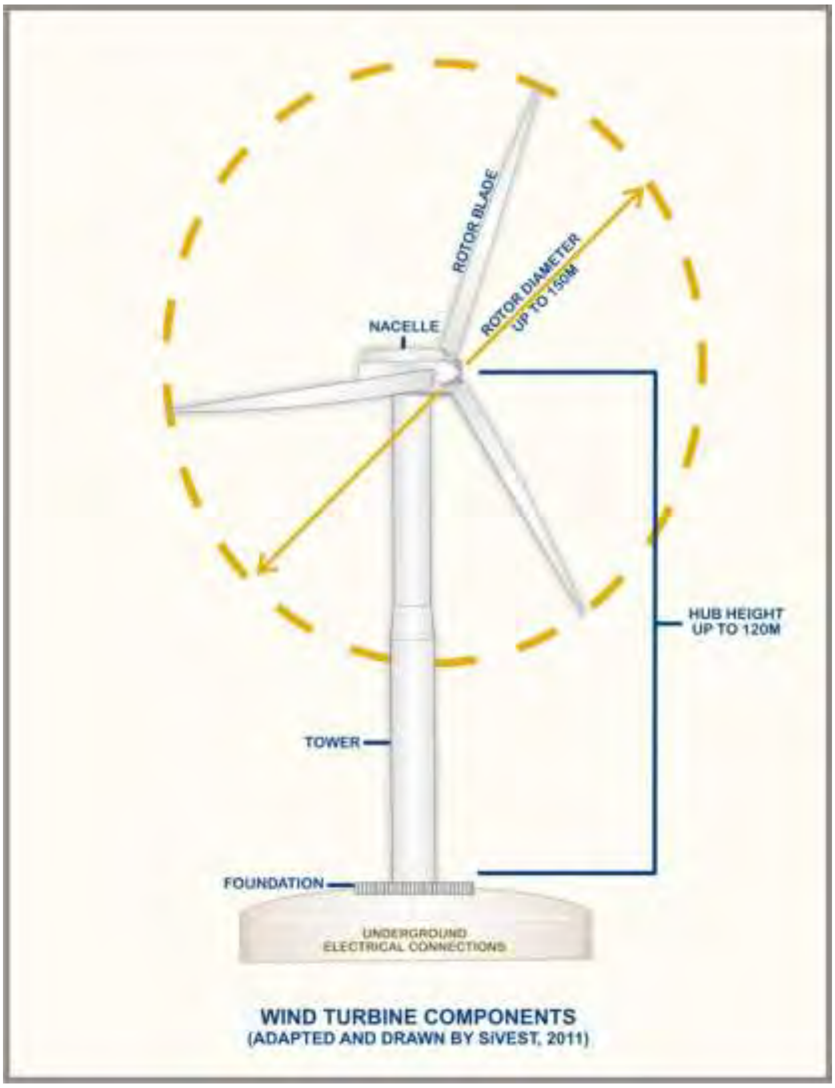

Figure 1: Typical components of a wind turbine

1.1.2 Electrical connections

The wind turbines will be connected to the proposed onsite Aletta 132Kv substation using buried (up to a 1.5m depth) medium voltage cables except where a technical assessment of the proposed design suggests that overhead lines are more appropriate such as over rivers, gullies and long runs. Where overhead power lines are to be constructed, self-supported or H-pole tower types will be used. The height will vary based on the terrain, but will ensure minimum Overhead Line (OHL) clearances with buildings, roads and surrounding infrastructure will be maintained. The dimensions of the specific OHL structure types will depend on electricity safety requirements. The exact location of the towers, the selection of the final OHL structure types and the final designs will comply with the best practise and SANS requirements.

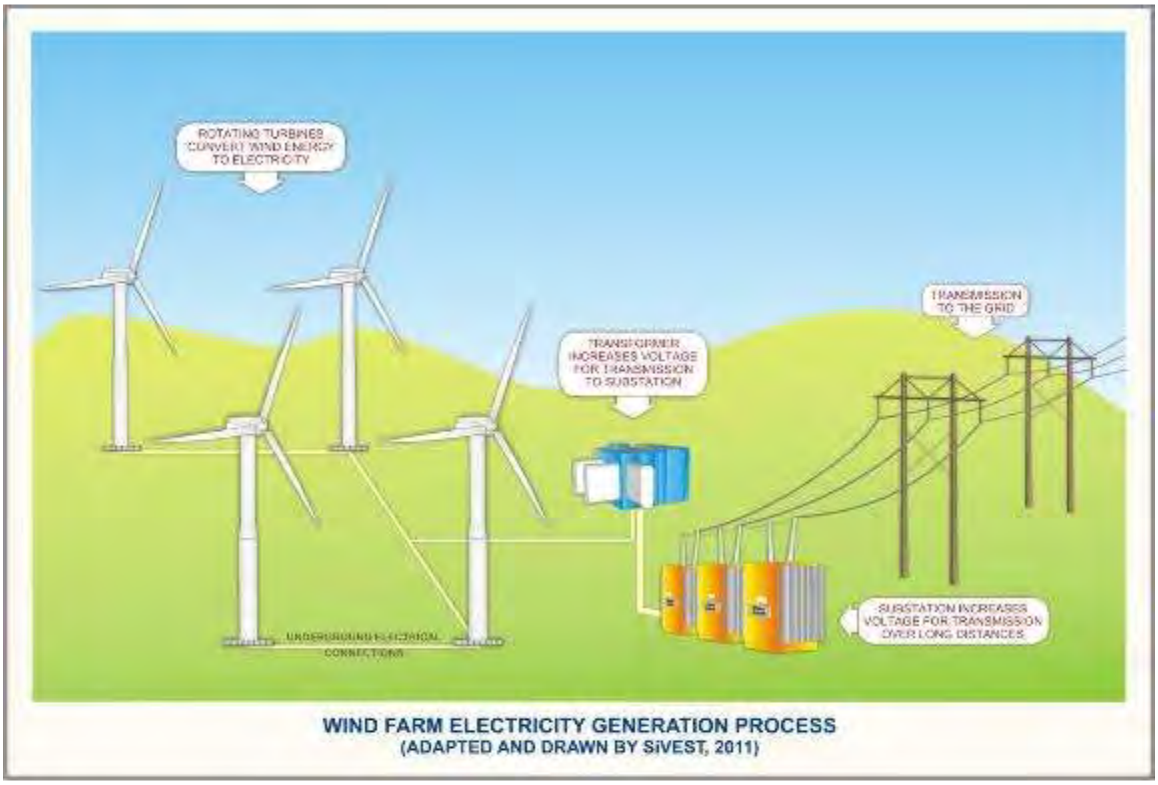

Figure 2: Conceptual wind farm electricity generation process showing electrical connections

1.1.3 Roads

The internal access roads are proposed to be between 4m to 6m wide and up to 60km each. This will include the net load carrying surface excluding any V drains that might be required. Double width roads will be required in strategic places for vehicle passing.

1.1.4 Temporary Construction Area

The temporary construction lay down area will be approximately 2 400m² (60m x 40m). The lay-down / staging area will be approximately 11 250m² whilst the lay-down area for concrete towers (only if required) will be approximately 40 000m².

1.1.5 Operation and Maintenance Buildings

The operation and maintenance buildings will include an on-site spares storage building, a workshop and operations building with a total combined footprint that will not exceed 300m^2. The operation and maintenance buildings will be situated in proximity to the wind farm substation due to requirements for power, water and access.

1.1.6 Other Associated Infrastructure

Other infrastructure includes the following:

- Fencing (if required) will be up to 5m where required and will be either mesh or palisade.

See Figures 3-5 below for maps of the study area

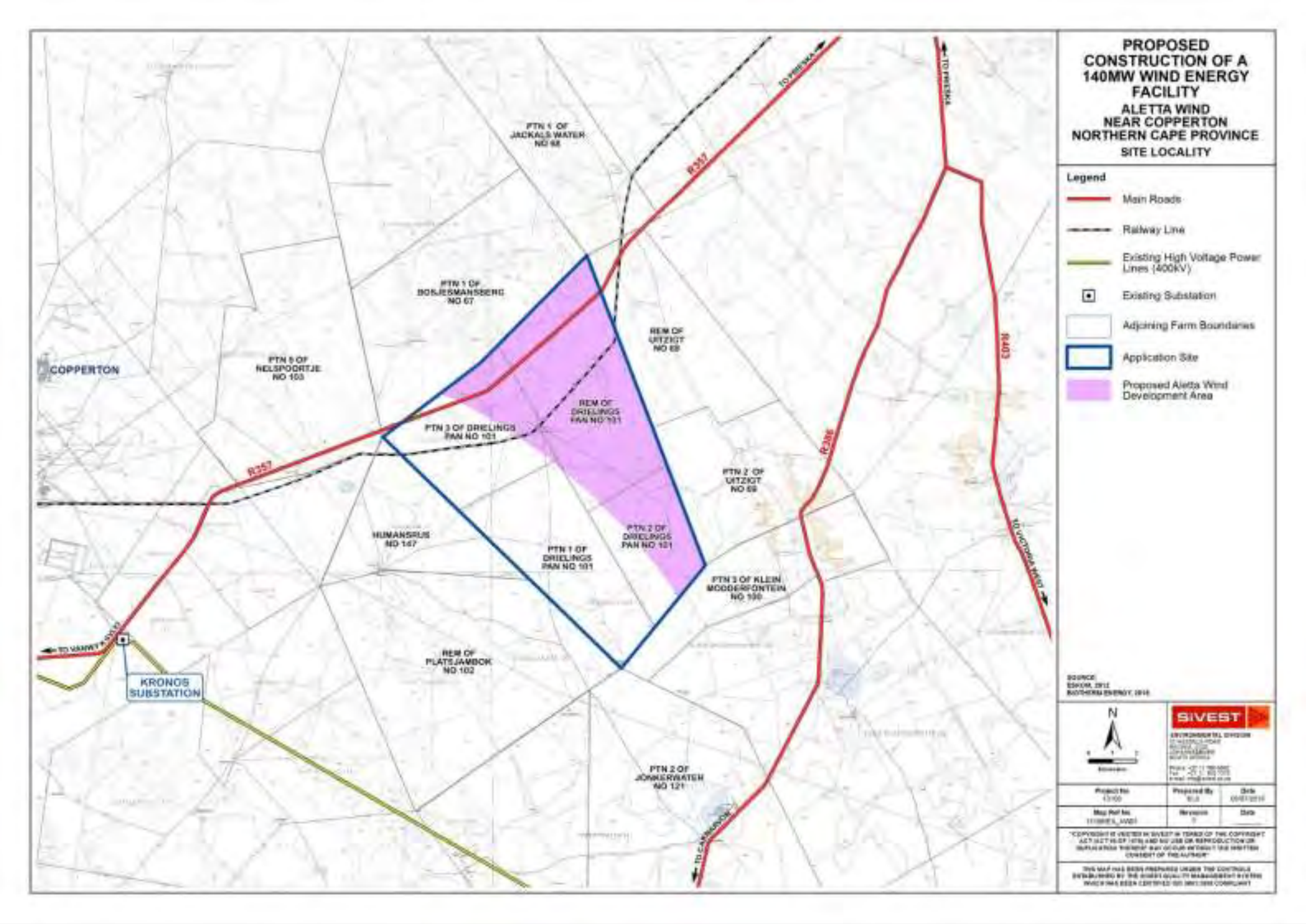

Figure 3: Map of proposed Biotherm Aletta WEF.

Figure 4: Regional map indicating the location of the proposed Biotherm Aletta WEF.

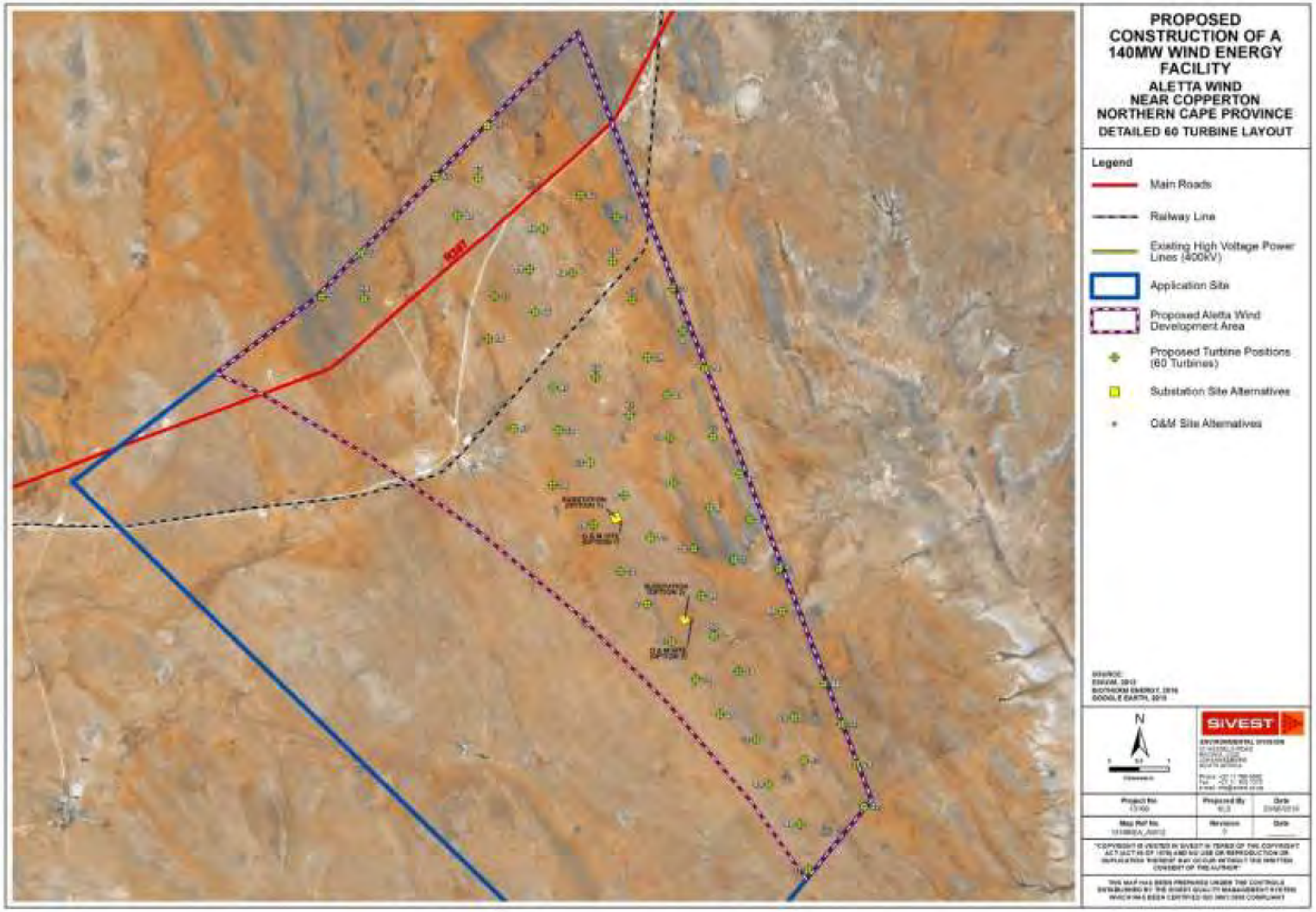

Figure 5: Close-up view of proposed Biotherm Aletta WEF study site on a background of satellite imagery.

2. TERMS OF REFERENCE

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

- Describe the affected environment from an avifaunal habitat perspective.
- Discuss any applicable legislation pertaining to impacts on avifauna.
- Identify gaps in baseline data.
- Assess the expected impacts.
- Provide a sensitivity map of the proposed development site from an avifaunal perspective.

3. SOURCES OF INFORMATION AND METHODOLOGY

The following methods were applied to compile this report:

- Bird distribution data of the South African Bird Atlas 2 (SABAP 2) was obtained from the Animal Demography Unit of the University of Cape Town, as a means to ascertain which species occurs within the broader area i.e. within a block consisting of nine pentad grid cells within which the proposed solar facilities are situated. The nine pentad grid cells are the following: 2950_2225, 2950_2250, 2950_2235, 2955_2225, 2955_2230, 2955_2235, 3000_2225, 3000_2230 and 3000_2235 (see Figure 6). A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. From 2007 to date, a total of 37 full protocol cards (i.e. 37 surveys lasting a minimum of two hours each) have been completed for this area.
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa (Taylor 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 (2016.1) IUCN Red List of Threatened Species.[1]
- 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 Important Bird Areas of Southern Africa (Barnes 1998; Marnewick *et al*. 2015) was consulted for information on Important Bird Areas (IBAs).

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[1] http://www.iucnredlist.org/.

- Satellite imagery was used in order to view the broader development area on a landscape level and to help identify sensitive bird habitat.
- 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).
- A site visit was conducted from 13 – 17 July 2015 to record bird habitat at the site and to identify transects, vantage points and potential focal points for the 12-months pre-construction monitoring which commenced in August 2015.
- The results of the 12-months pre-construction monitoring was the primary source of information on the variety and abundance of avifauna in the study area and it was the principal source of information used to guide the assessment and the lay-out of the wind farm.

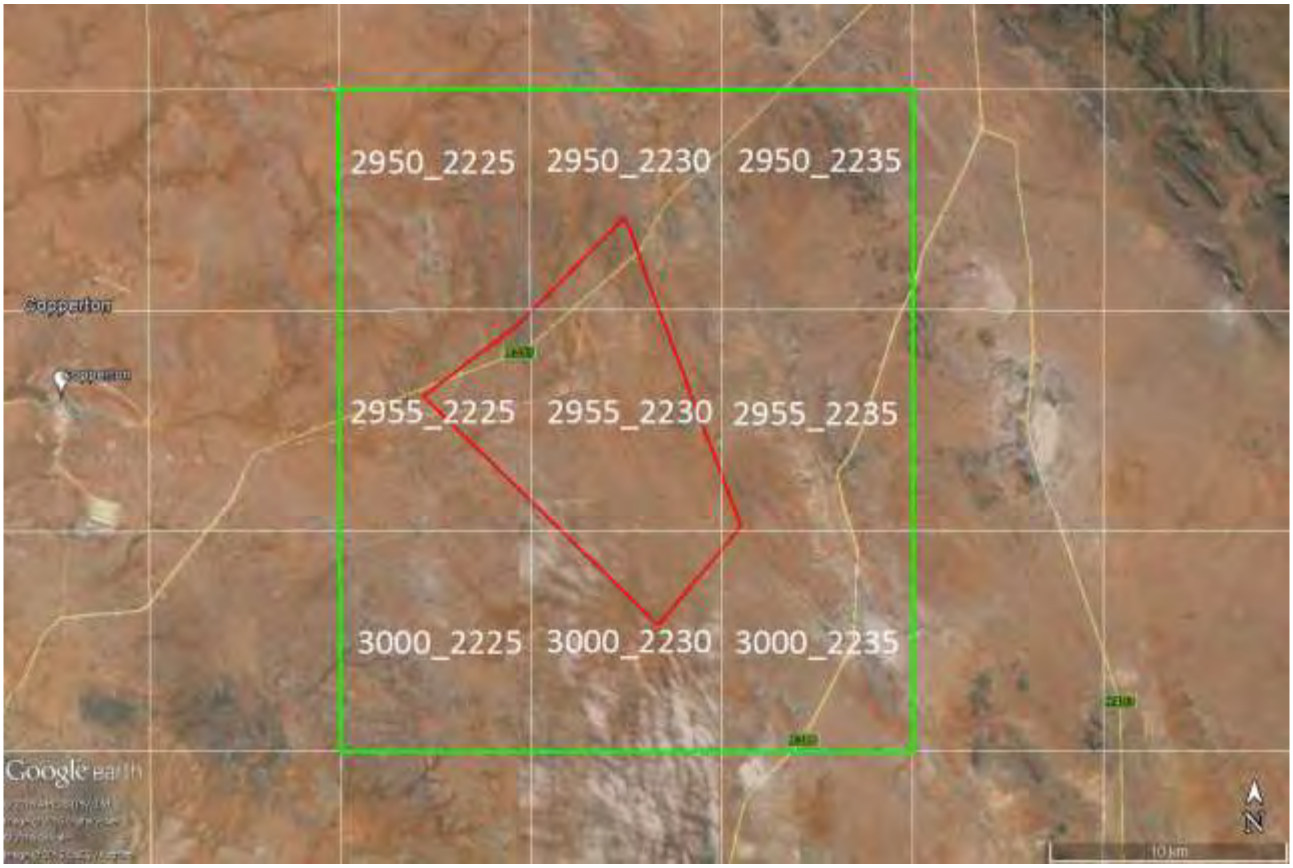

Figure 6: Area covered by the SABAP2 pentads (green square).

4. ASSUMPTIONS & LIMITATIONS

The following assumptions and limitations are applicable in this study:

- A total of 37 full protocol lists has been completed to date for the 9 pentads where the study area is located (i.e. listing surveys lasting a minimum of two hours each). This is a fairly comprehensive dataset which provides a reasonably accurate snapshot of the avifauna which could occur at the proposed site. 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 the results of the 12-months pre-construction 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.
- To date, few comprehensive studies (other than a number of environmental impact reports), and no peer-reviewed scientific papers, are available on the impacts wind farms have 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[2]. 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."
- Even in the international arena predicted mortality rates are often significantly off the mark, 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).
- 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 comprises the application site and immediate environs (see Figures 3 - 5).
- No comparative assessment was undertaken of the various powerline connection alternatives. This will form part of a separate Environmental Impact Assessment (EIA).

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[2] http://www.unep.org

5. DESCRIPTION OF AFFECTED ENVIRONMENT

5.1 Biomes and vegetation types

The proposed site is situated on a wide flat plain approximately 17km east of the mining settlement of Copperton, in the Northern Cape Province. The study area is not located in an Important Bird Area. The closest Important Bird Area (IBA), the Platberg Karoo Conservancy IBA SA037 is located approximately 144km away (Barnes 1998, Marnewick *et al*. 2015).

The habitat in the broader development area is highly homogenous and consists of extensive sandy and gravel plains with low shrub. Although Mucina & Rutherford (2006) classify the vegetation as Bushmanland Arid Grassland, the dominant vegetation type leans more towards Bushmanland Basin Shrubland. Bushmanland Basin Shrubland consists of dwarf shrubland dominated by a mixture of low, sturdy and spiny (and sometimes also succulent) shrubs (*Rhigozum*, *Salsola*, *Pentzia*, *Eriocephalus*), 'white' grasses (*Stipagrostis*) and in years of high rainfall also abundant annual flowering plants such as species of *Gazania* and *Leysera* (Mucina & Rutherford 2006).

SABAP1 recognises six primary vegetation divisions within South Africa, namely (1) Fynbos (2) Succulent Karoo (3) Nama Karoo (4) Grassland (5) Savanna and (6) Forest (Harrison *et al.* 1997). The criteria used by the authors to amalgamate botanically defined vegetation units, or to keep them separate were (1) the existence of clear differences in vegetation structure, likely to be relevant to birds, and (2) the results of published community studies on bird/vegetation associations. It is important to note that no new vegetation unit boundaries were created, with use being made only of previously published data. Using this classification system, the natural vegetation in the study area is classified as Nama Karoo. Nama Karoo is dominated by low shrubs and grasses; peak rainfall occurs in summer from December to May. Average daily temperatures range between 35°C in January and 18°C in July[3]. Trees, e.g. *Vachellia karroo* are mainly restricted to ephemeral watercourses, but in the proposed development area, due to the extreme aridity (average annual precipitation 147mm in the 12 years from 2000 – 2012[4]) the ephemeral watercourses contain only small stunted trees and dense shrubs. In comparison with the Succulent Karoo, the Nama Karoo has higher proportions of grass and tree cover.

5.2 Habitat classes and avifauna potentially occurring in the study area

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[3] http://www.worldweatheronline.com/Copperton-weather-averages/Northern-Cape/ZA.aspx.

[4] http://www.worldweatheronline.com

Whilst much of the distribution and abundance of the bird species in the study area can be explained by the description of the biomes and vegetation types above, it is as important to examine the modifications which have changed the natural landscape, and which may have an effect on the distribution of avifauna. These are sometimes evident at a much smaller spatial scale than the biome or vegetation types, and are determined by a host of factors such as topography, land use and man-made infrastructure.

The following bird habitat classes were identified in the study area:

5.2.1 Nama Karoo

This habitat class is described above under 5.1.

5.2.2 Waterbodies

Surface water is of specific importance to avifauna in this arid study area. The study area contains at least nine boreholes and a small pan. Boreholes with open water troughs are important sources of surface water. Pans are endorheic wetlands having closed drainage systems; water usually flows in from small catchments but with no outflow from the pan basins themselves. They are characteristic of poorly drained, relatively flat and dry regions. Water loss is mainly through evaporation, sometimes resulting in saline conditions, especially in the most arid regions. Water depth is shallow (<3m), and flooding characteristically ephemeral (Harrison *et al.* 1997). In this instance the pan is very small and unlikely to hold water regularly.

5.2.3 Trees

The study area is generally devoid of trees, except for isolated clumps of trees at two of the water points, where a mixture of alien and indigenous trees are growing. The trees could attract a variety of species for purposes of nesting.

5.2.4 High voltage lines and telephone lines

High voltage lines are an important potential roosting and breeding substrate for large raptors in the greater study area. There are no existing high voltage lines crossing the actual study area, but there are sub-transmission lines on 5-pole wooden structures running north and south of the site.

High voltage lines hold a special importance for large raptors (Jenkins *et al.* 2006). A Martial Eagle nest site on the Hydra-Kronos 400kV line at the Kronos MTS was initially recorded in the early 2000s in surveys of large raptors nesting on Eskom's transmission network in the Karoo (Jenkins *et al.* 2013). The presence of the nest was re-confirmed in 2013, with a pair of adults in attendance at a nest on tower 519 (30º 01.579 S, 22º 20.675 E) in May 2013, and feeding a small chick in August of the same year. This chick was successfully fledged by November, and at least one adult was present in the area, with the nest showing signs of preparation for the upcoming breeding season, in March 2014 (Jenkins & Du Plessis 2014). The nest was inspected during the site visit in June 2015, but the birds were not observed, which is an indication that the nest may not have been active during 2015. At the time of the site visit, there was extensive activity at the Kronos MTS with continuous movements of trucks and pedestrians, which may account for the absence of the eagles at this specific nest site. The nest was again inspected in August 2015 and January 2016, but there was no sign of the birds. Although the nest is too far away to be directly impacted by the construction activity at the site, the proposed grid connection could potentially impact on the eagle nest through displacement due to disturbance associated with the construction of the power line, if the grid connection terminates in Kronos MTS. However, indications are that the birds have abandoned the nest, most likely due to disturbance.

There is also a telephone line next to the R357 tar road running through the north of the site. The poles are used extensively by Sociable Weavers *Philetairus socius* for nesting. A Verreaux's Eagle pair is breeding on a Sociable Weaver nest on one of the poles approximately 1.65km east of the western border of the site. The nest was active in June 2015.

See **APPENDIX 1** for a photographic record of the bird habitat in the study area

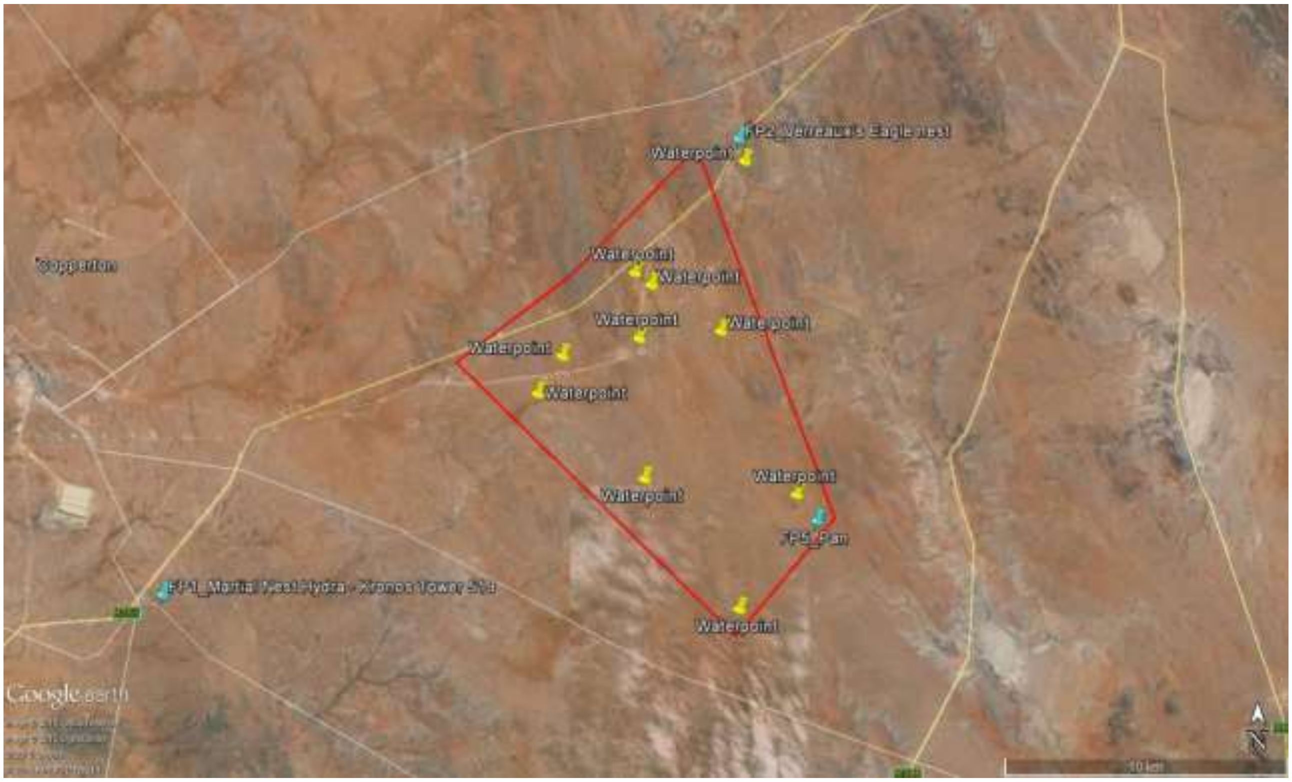

Figure 7: The location of waterpoints, high voltage lines (white lines) and large raptor nests in the study area.

6. AVIFAUNA

A total of 96 species were recorded in the study area from all data sources (drive transects, walk transects, VP watches, focal point counts and incidental sightings[5]), of which 17 are priority species. See Table 6-1 for a list of all priority species that were recorded in the study area, as well as those that could potentially occur at the site itself. Table 6–2 lists all species recorded in the study area and table 6-3 lists the priority species recorded at the site itself, and the method by which they were recorded.

6.1 Transect counts

6.1.1. Drive transects

A total of 1 931 individual birds were recorded during drive transect counts at the turbine site, of which 154 were priority species and 1 777 were non-priority species, belonging to 67 species (9 priority species and 58 non-priority species). At the control

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[5] See **APPENDIX 2** for an exposition of the methodology used for the pre-construction monitoring

site, a total of 627 birds were recorded during transect counts, of which 84 were priority species and 543 non-priority species, belonging to 49 species (10 priority species and 39 non-priority species).

6.1.2. *Walk transects*

A total of 6 807 individual birds were recorded during walk transect counts at the turbine site, of which 215 were priority species and 6 592 were non-priority species, belonging to 74 species (6 priority species and 68 non-priority species). At the control site, a total of 1 549 birds were recorded during transect counts, of which 36 were priority species and 1 513 non-priority species, belonging to 49 species (7 priority species and 42 non-priority species).

6.1.3. *Index of kilometric abundance*

An Index of Kilometric Abundance (IKA = birds/km) was calculated for each priority species, and also for all priority species combined. This was done separately for drive transects and walk transects. Figures 8 and 9 shows the relative abundance of priority species recorded during the pre-construction monitoring through drive and walk transects.

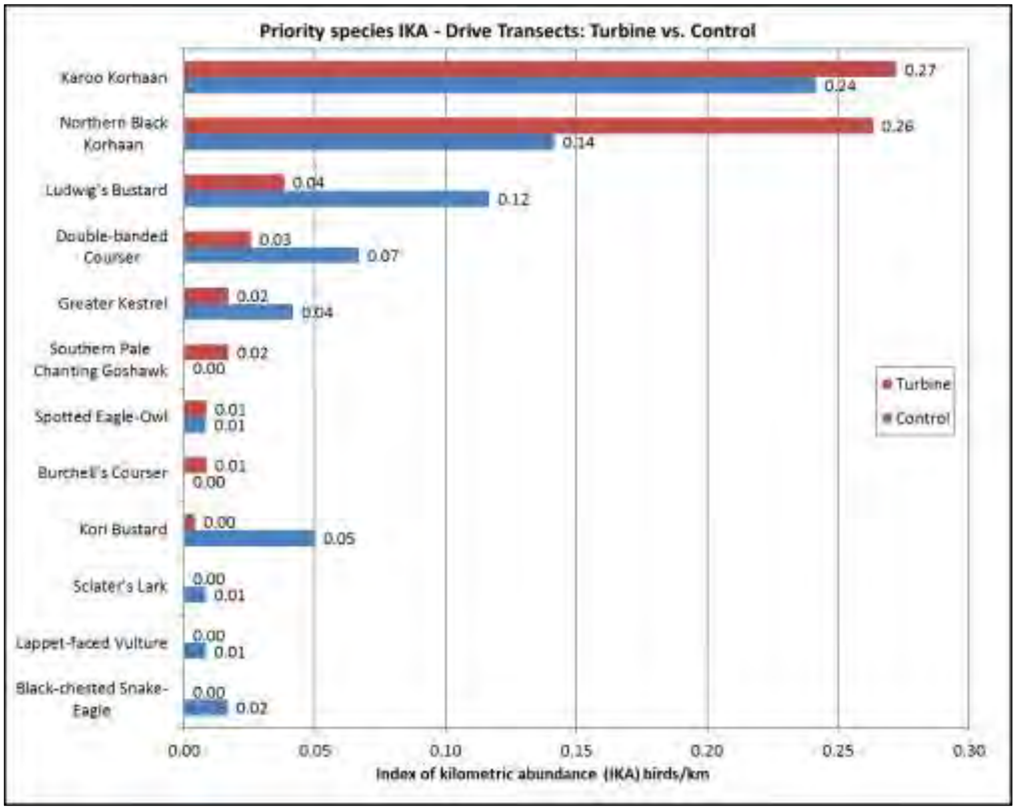

Figure 8: Priority species recorded at the turbine and control site through drive transect surveys

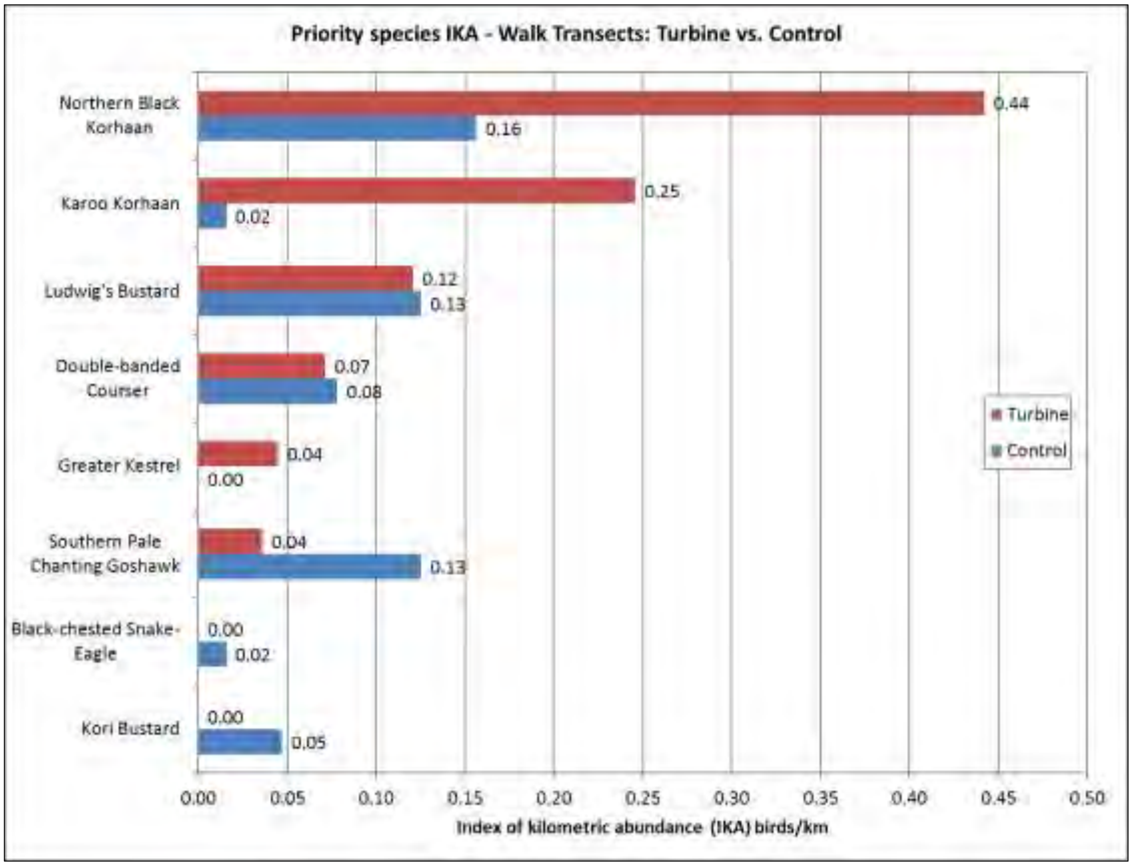

Figure 9: Priority species recorded at the turbine and control site through walk transect surveys

6.1.4 Overall species composition

The study area supports a relatively low diversity and abundance of avifauna, which is to be expected in an arid area like Bushmanland. Based on species diversity recorded during transect surveys, the turbine and control sites are fairly similar as far as priority species are concerned. The higher counts at the turbine is most likely a result of the difference in survey effort, and does not reflect any intrinsic differences in habitat quality or species diversity.

6.1.5 Abundance

The abundance of priority species at the turbine site is low, with 0.65 birds/km recorded on drive transects, and 0.96 birds/km recorded during walk transects. Karoo Korhaan, Northern Black Korhaan and Ludwig's Bustard consistently emerged as the three most abundant priority species at the turbine site during both walk and drive transect counts. Karoo Korhaan and Northern Black Korhaan definitely breed in the study area, and Ludwig's Bustard potentially too, although no evidence of bustard display areas or nests were recorded. Raptors were generally scarce with Greater Kestrel and Southern Pale Chanting Goshawk the only raptors recorded during transect counts, in equal numbers.

6.1.6 Spatial distribution of transect records and incidental sightings at the turbine site

No clear distribution patterns emerged from the sightings data for Karoo Korhaan, Northern Back Korhaan and Ludwig's Bustard at the site, with sightings more or less evenly distributed along all the transects. This is to be expected given the uniformity of the habitat all over the site. As far as raptors are concerned, the sightings of Greater Kestrel similarly not linked to any specific landscape feature. In the case of Southern Pale Chanting Goshawk, the sightings are clearly linked to the telephone line running adjacent to the R357 in the north of the site. The rest of the priority species were not recorded in sufficient numbers for any clear conclusions to be drawn as far has bird/habitat associations are concerned, with random sightings scattered all over the site and immediate surroundings.

Figure 10 below indicates the spatial distribution of priority species (transect counts and incidental sightings).

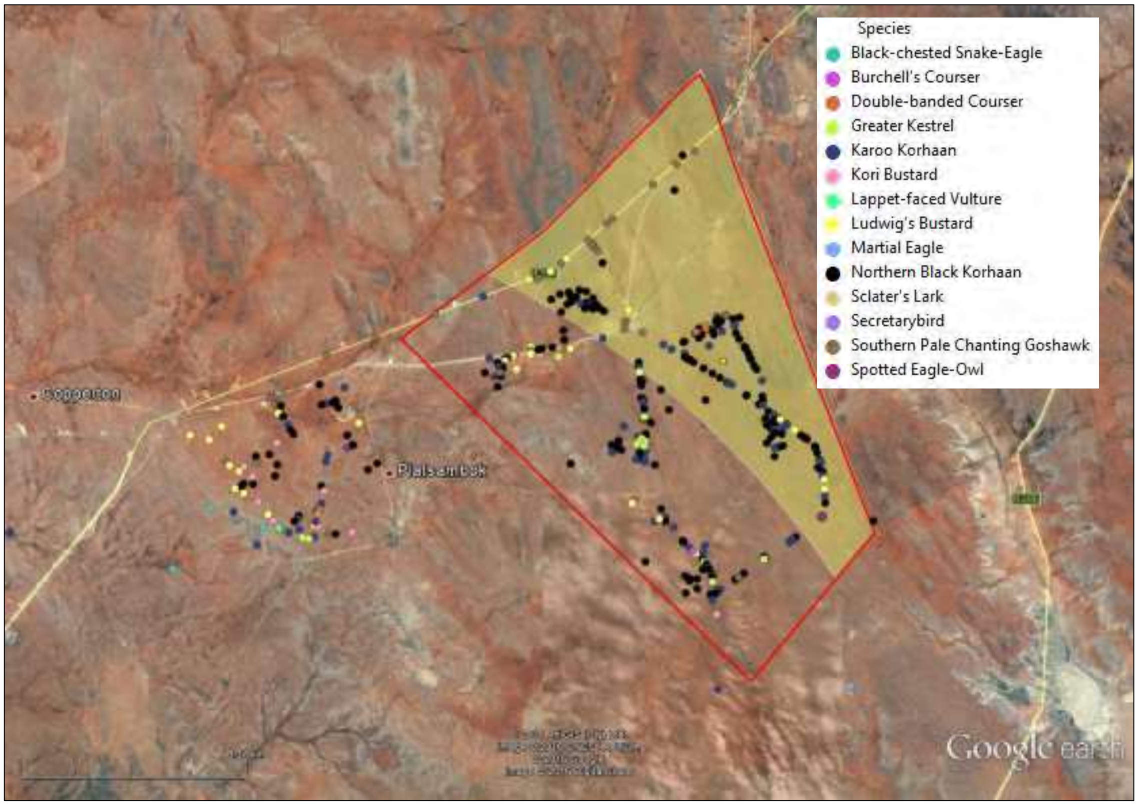

Figure 10: Spatial distribution of sightings of priority species (transects and incidental sightings).

Table 6-1 below lists all the priority species that could potentially occur at the turbine site and the potential impact on the respective species by the development infrastructure. Species actually recorded at the site during pre-construction surveys are shaded. The following abbreviations and acronyms are used:

VU	Vulnerable
NT	Near threatened
EN	Endangered
SAE	Southern African endemic or near endemic
Ct	Collisions with turbines
Cp	Collisions with power line
Dd	Displacement through disturbance
Dh	Displacement habitat transformation

Table 6-1: Priority species (Retief *et al.* 2012) potentially occurring at the site. **Species recorded at the turbine site are shaded.**

Name	**Scientific name**	**Regional threatened status (Taylor et al. 2015)**	**Global threatened status (IUCN 2016)**	**BLSA/EWT Priority rating (on scale of 170 – 395)**	**Terrestrial**	**Soaring**	**Likelihood of occurrence**	**Potential impact**
Martial Eagle	*Polemaetus bellicosus*	EN	NT	330		x	Medium. One incidental sighting of a flying bird in the broader area. Could sporadically be attracted to water troughs.	Ct, Dd,
Ludwig’s Bustard	*Neotis ludwigii*	SAE, EN	EN	320	x		Confirmed. Occurrence likely to be linked to habitat conditions. The species is nomadic and a partial migrant and may occur sporadically.	Ct, Cp, Dd,
Secretarybird	*Sagittarius serpentarius*	VU	VU	320	x	x	Confirmed. Two foraging individuals recorded at the site itself.	Ct, Cp, Dd,
Kori Bustard	*Ardeotis kori*	NT	Least concern	280	x		Confirmed. One bird flying over the site. May occur sporadically. Lack of dry watercourses with trees may be an inhibiting factor.	Ct, Cp, Dd,

Name	**Scientific name**	**Regional threatened status (Taylor et al. 2015)**	**Global threatened status (IUCN 2016)**	**BLSA/EWT Priority rating (on scale of 170 – 395)**	**Terrestrial**	**Soaring**	**Likelihood of occurrence**	**Potential impact**
Lanner Falcon	*Falco biarmicus*	VU	Least concern	280		x	High. Was recorded as an incidental in the broader study area. Could occur sporadically. Most likely to perch on telephone lines running through the site, but may also be attracted to the water points where it hunts small birds.	Ct
Sclater's Lark	*Spizocorys sclateri*	SAE, NT	NT	240	x		Medium. The species was recorded incidentally once in the broader area during monitoring, but large sections of the habitat seem suitable, i.e. stony arid to semi-arid plains with scattered shrubs, grasses and extensive bare patches. The species is nomadic and may occur sporadically.	Dd Dh

Name	**Scientific name**	**Regional threatened status (Taylor et al. 2015)**	**Global threatened status (IUCN 2016)**	**BLSA/EWT Priority rating (on scale of 170 – 395)**	**Terrestrial**	**Soaring**	**Likelihood of occurrence**	**Potential impact**
Black-chested Snake-Eagle	*Circaetus pectoralis*	Least concern	Least concern	230		x	High. Recorded at the control site. Most sightings associated with the distribution line which is used for perching. May visit water points at the turbine site.	Ct
Southern Pale Chanting Goshawk	*Melierax canorus*	SAE	Least concern	200	x	x	Confirmed. Habitat is very suitable for the species.	Ct, Dd,
Karoo Korhaan	*Eupodotis vigorsii*	SAE, NT	Least concern	190	x		Confirmed. One of the most commonly recorded terrestrial species. Occurs all over the site.	Ct, Dd, Cp
Northern Black Korhaan	*Afrotis afraoides*	SAE	Least concern	180	x		Confirmed. One of the most commonly recorded terrestrial species. Occurs all over the site.	Ct, Dd, Cp
Greater Kestrel	*Falco rupicoloides*	Least concern	Least concern	174		x	Confirmed. Encountered all over the site, but most likely to be associated with utility lines and fences which are used for perching.	Ct

Name	**Scientific name**	**Regional threatened status (Taylor et al. 2015)**	**Global threatened status (IUCN 2016)**	**BLSA/EWT Priority rating (on scale of 170 – 395)**	**Terrestrial**	**Soaring**	**Likelihood of occurrence**	**Potential impact**
Spotted Eagle-Owl	*Bubo africanus*	Least concern	Least concern	170	Nocturnal raptor but flight characteristics more like terrestrial species		Confirmed. Recorded at a stand of trees, where they may be breeding, but could not be confirmed.	Ct
Jackal Buzzard	*Buteo rufofuscus*	SAE	Least concern	125		x	Low. Most likely to be associated with utility lines and fence lines. May occur sporadically, particularly immature birds.	Ct
Lappet-faced Vulture	*Torgos tracheliotis*	EN	VU	310		x	Low. A single adult was recorded at the control site. Unlikely to occur regularly, vagrant to the region.	Ct
Burchell's Courser	*Cursorius rufus*	SAE, VU	Least concern	140	x		Confirmed. Two individuals were recorded once.	Ct
Double-banded Courser	*Rhinoptilus africanus*	NT	Least concern	154	x		Confirmed. Recorded regularly during the winter surveys.	Ct
Booted Eagle	*Aquila pennatus*		Least concern	230		x	Confirmed. Most likely to be encountered foraging on the wing over the site, and coming down to water points to bath and drink.	Ct

Table 6-2 lists all the species recorded during the pre-construction surveys and incidental counts, as well as the manner in which they were recorded.

Table 6-2: Species recorded during pre-construction surveys and incidental counts in the broader area.

Priority Species	Scientific Name	Turbine	Control	VP	Control VP	FP	Incidental
Black-chested Snake-Eagle	*Circaetus pectoralis*		*				
Booted Eagle	*Aquila pennatus*			*			
Burchell's Courser	*Cursorius rufus*	*					
Double-banded Courser	*Rhinoptilus africanus*	*	*				*
Greater Kestrel	*Falco rupicoloides*	*	*	*			
Karoo Korhaan	*Eupodotis vigorsii*	*	*	*	*		*
Kori Bustard	*Ardeotis kori*	*	*		*		
Lanner Falcon	*Falco biarmicus*						*
Lappet-faced Vulture	*Torgos tracheliotus*		*				
Ludwig's Bustard	*Neotis ludwigii*	*	*	*	*		*
Martial Eagle	*Polemaetus bellicosus*						*
Northern Black Korhaan	*Afrotis afraoides*	*	*	*			*
Sclater's Lark	*Spizocorys sclateri*		*				
Secretarybird	*Sagittarius serpentarius*						*
Southern Pale Chanting Goshawk	*Melierax canorus*	*	*	*	*		*
Spotted Eagle-Owl	*Bubo africanus*	*	*				
Verreaux's Eagle	*Aquila verreauxii*					*	
17	**Total:**	**9**	**11**	**6**	**4**	**1**	**8**

Non-Priority Species		Turbine	Control
Acacia Pied Barbet	*Tricholaema leucomelas*	*	
African Pipit	*Anthus cinnamomeus*	*	*
Anteating Chat	*Myrmecocichla formicivora*	*	*
Ashy Tit	*Parus cinerascens*	*	
Barn Swallow	*Hirundo rustica*	*	*
Black-chested Prinia	*Prinia flavicans*	*	*
Black-Eared Sparrowlark	*Eremopterix australis*	*	*
Black-Headed Canary	*Serinus alario*	*	*
Blacksmith Lapwing	*Vanellus armatus*	*	
Black-winged Stilt	*Himantopus himantopus*	*	
Bokmakierie	*Telophorus zeylonus*	*	
Bradfield's Swift	*Apus bradfieldi*	*	
Cape Bunting	*Emberiza capensis*	*	
Cape Penduline-Tit	*Anthoscopus minutus*	*	
Cape Sparrow	*Passer melanurus*	*	*
Cape Teal	*Anas capensis*	*	
Cape Turtle-Dove	*Streptopelia capicola*	*	*
Cape Wagtail	*Motacilla capensis*	*	
Capped Wheatear	*Oenanthe pileata*	*	*
Chat Flycatcher	*Bradornis infuscatus*	*	*
Chestnut-vented Tit-babbler	*Parisoma subcaeruleum*	*	
Common Fiscal	*Lanius collaris*	*	*
Common Swift	*Apus apus*	*	*
Crowned Lapwing	*Vanellus coronatus*	*	*
Dusky Sunbird	*Cinnyris fuscus*	*	
Eastern Clapper Lark	*Mirafra [apiata] fasciolata*	*	
Egyptian Goose	*Alopochen aegyptiaca*	*	*
Fairy Flycatcher	*Stenostira scita*	*	*
Familiar Chat	*Cercomela familiaris*	*	*
Fawn-coloured Lark	*Calendulauda africanoides*	*	*
Fiscal Flycatcher	*Sigelus silens*	*	*
Greater Striped Swallow	*Hirundo cucullata*	*	
Grey Tit	*Parus afer*	*	
Grey-Backed Sparrowlark	*Eremopterix verticalis*	*	*
Hadeda Ibis	*Bostrychia hagedash*	*	
Helmeted Guineafowl	*Numida meleagris*	*	
House Sparrow	*Passer domesticus*	*	
Kalahari Scrub-Robin	*Cercotrichas paena*	*	*
Karoo Chat	*Cercomela schlegelii*		*
Karoo Eremomela	*Eremomela gregalis*	*	*
Karoo Long-Billed Lark	*Certhilauda subcoronata*	*	*
Karoo Scrub-Robin	*Cercotrichas coryphoeus*	*	*
Kittlitz's Plover	*Charadrius pecuarius*	*	
Large-Billed Lark	*Galerida magnirostris*	*	*
Lark-Like Bunting	*Emberiza impetuani*	*	*
Laughing Dove	*Streptopelia senegalensis*	*	*
Little Swift	*Apus affinis*	*	*
Long-billed Crombec	*Sylvietta rufescens*	*	
Long-billed Pipit	*Anthus similis*	*	*
Namaqua Dove	*Oena capensis*	*	*
Namaqua Sandgrouse	*Pterocles namaqua*	*	*
Pied Crow	*Corvus albus*	*	*
Plain-backed Pipit	*Anthus leucophrys*	*	*
Pririt Batis	*Batis pririt*	*	
Pygmy Falcon	*Polihierax semitorquatus*	*	
Red-Billed Quelea	*Quelea quelea*	*	
Red-Capped Lark	*Calandrella cinerea*	*	*
Red-Headed Finch	*Amadina erythrocephala*	*	*
Rock Martin	*Hirundo fuligula*	*	*
Rufous-Eared Warbler	*Malcorus pectoralis*	*	*
Sabota Lark	*Calendulauda sabota*	*	*
Scaly-feathered Finch	*Sporopipes squamifrons*	*	*
Sickle-winged Chat	*Cercomela sinuata*	*	*
Sociable Weaver	*Philetairus socius*	*	*
South African Shelduck	*Tadorna cana*	*	*
Southern Masked-Weaver	*Ploceus velatus*	*	*
Speckled Pigeon	*Columba guinea*	*	*
Spike-Heeled Lark	*Chersomanes albofasciata*	*	*
Spotted Thick-knee	*Burhinus capensis*	*	
Stark's Lark	*Spizocorys starki*	*	*
Three-banded Plover	*Charadrius tricollaris*	*	
Tractrac Chat	*Cercomela tractrac*	*	*
White-Backed Mousebird	*Colius colius*	*	
White-Browed Sparrow-Weaver	*Plocepasser mahali*	*	
White-Necked Raven	*Corvus albicollis*	*	
White-Rumped Swift	*Apus caffer*	*	
White-throated Canary	*Crithagra albogularis*	*	*
Yellow Canary	*Crithagra flaviventris*	*	*
Yellow-Bellied Eremomela	*Eremomela icteropygialis*	*	*
79	**Total:**	**78**	**50**
Grand Total		**87**	**61**

6.2 Vantage point watches

Six priority species were recorded during vantage point (VP) watches. A total of 336 hours of vantage point watches (12 hours per season per vantage point) was completed at 7 VPs in order to record flight patterns of priority species at the site. In the four seasonal sampling periods, priority species were recorded flying over the VP area for a total of 3 hours, 12 minutes and 45 seconds. A total of 114 individual flights were recorded. Of these, 0 (0.0%) flights were at high altitude (above rotor height), 45 (39.5%) were at medium altitude (i.e. approximately within rotor height) and 69 (60.5%) were at a low altitude (below rotor height). The passage rate for priority species over the VP area (all flight heights) was 0.24 birds/hour[6]. See Figure 11 below for the duration of flights within the VP area for each species, at each height class[7].

For purposes of flight analyses, priority species recorded during VP watches at the site were classified in two classes:

- Terrestrial species: Birds that 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. Some larger species undertake longer distance flights at higher altitudes, when commuting between foraging and roosting areas. At the wind farm site, korhaans, bustards and larks were included in this category.
- Soaring species: Species that 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 species that were recorded during VP watches were included in this class.

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[6] For calculating the passage rate, 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 all the flights still form part of the same passage.

[7] 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.

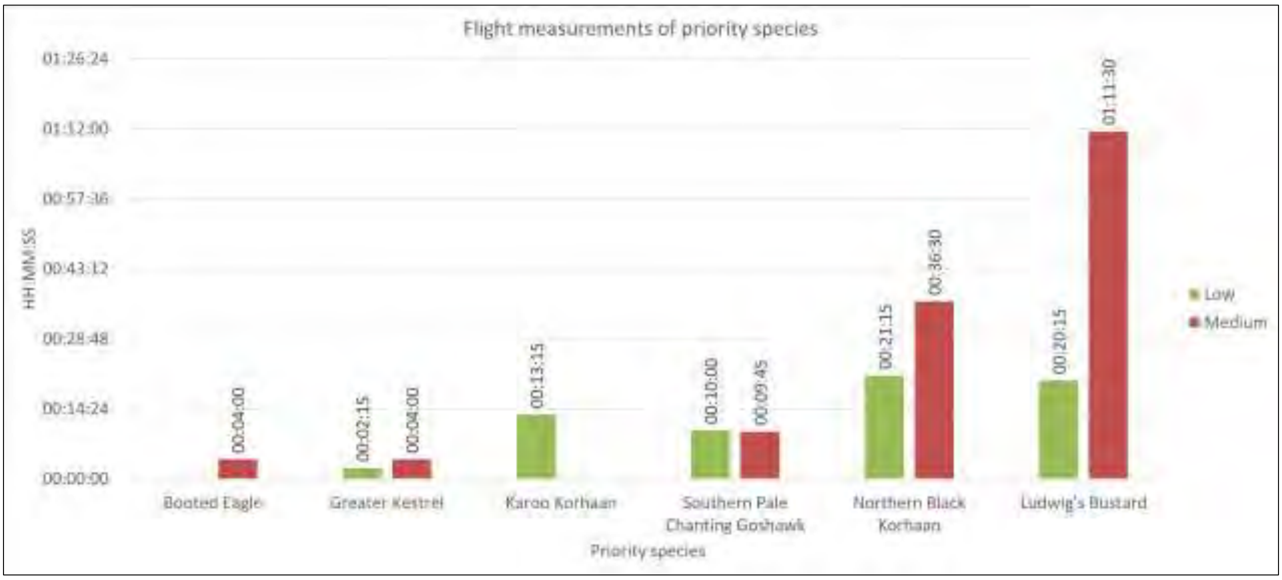

Figure 11: Flight duration and heights recorded for priority species. Low = below rotor height. Medium = within rotor height. No flights were recorded above rotor height.

6.2.1 Site specific collision risk rating

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 this site. 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 number of planned turbines.

This was done in order to gain some understanding of which species are likely to be most at risk of collision. The formula used is as follows[8]:

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

The results are displayed in Table 6-4 and Figure 12 below.

Table 6-4: Site specific collision risk rating for all priority species recorded during VP watches.

Species	Duration of flights (hr)	Collision rating	# turbines	Risk rating
Karoo Korhaan	0	60	60	0.00
Booted Eagle	0.07	80	60	3.36
Greater Kestrel	0.07	52	60	2.18
Southern Pale Chanting Goshawk	0.16	65	60	6.24
Northern Black Korhaan	0.61	55	60	20.13
Ludwig's Bustard	1.26	80	60	60.48

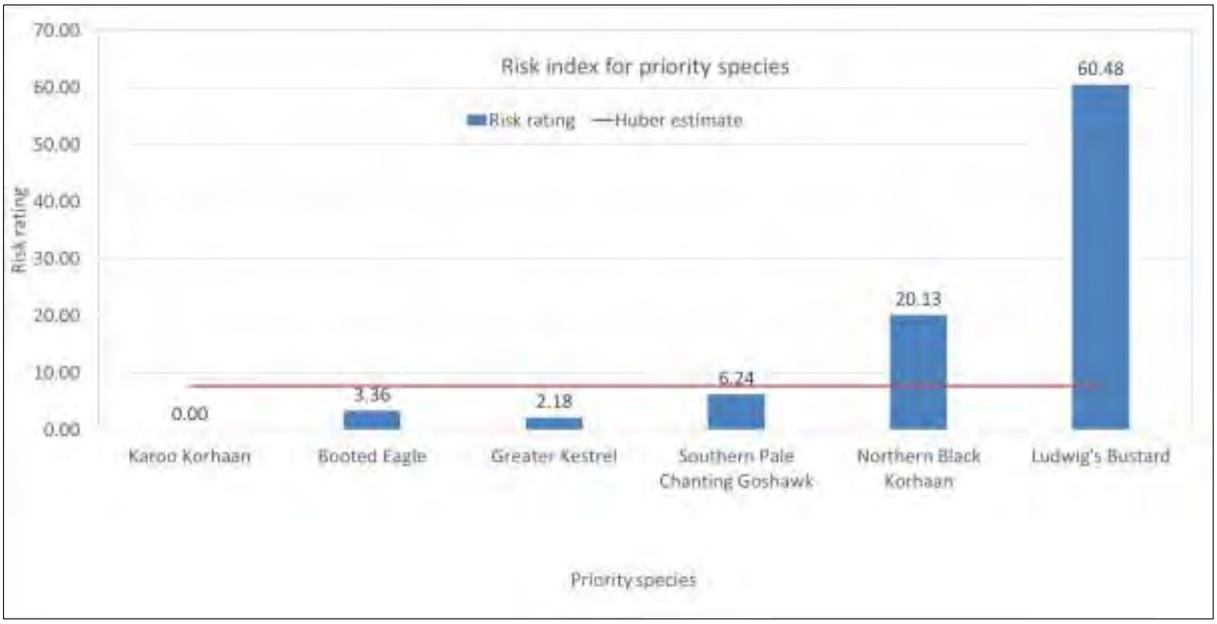

Figure 12: Site specific collision risk rating for priority species recorded during VP watches. Due to the wide range of values, the Huber estimator was used instead of average[9].

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[8] 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.

[9] An alternative estimation of the location parameter in the presence of outliers, rather than the average, is Huber's estimator (Huber, 1961). This is considered to be a more realistic estimate of the overall risk rating.

6.2.2 Sample size and representativeness of flight data

Insight into the 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 a representative sample has been achieved).

To investigate the behaviour of this process the average number of *flights* per 3h watch period (as well as for *individuals*) are 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. These data are plotted (by season) in Figure 13 for soaring birds and Figure 14 for terrestrial birds.

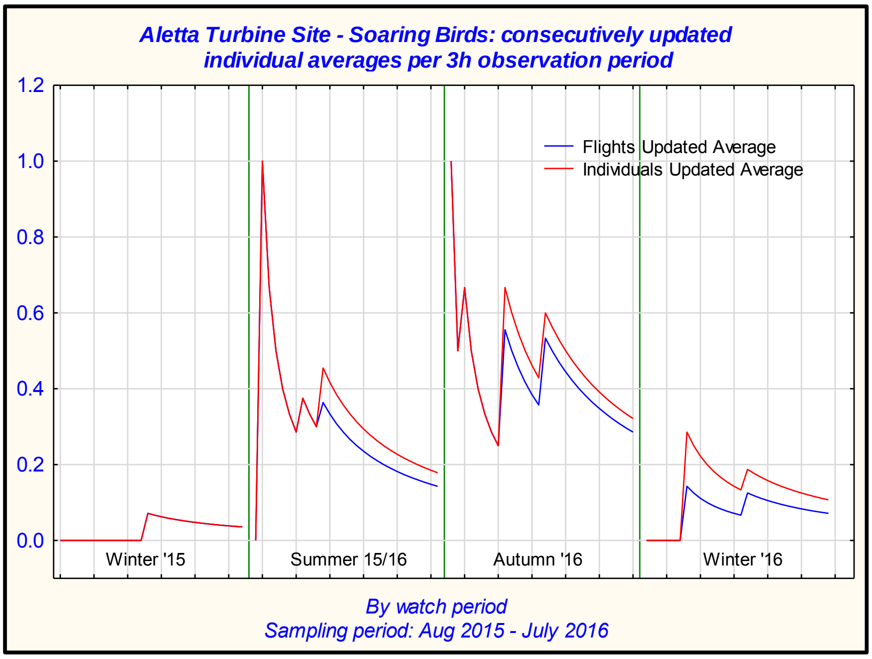

Figure 13: Soaring birds: updated average for *Flight* and *Individual* counts, separately by season.

Figure 13 shows that the updated averages for flights and individual birds are identical in Winter 2015. The other seasons show a gradual downward trend due to no sightings in the last 10 or more consecutive watch periods of each season. This implies a reasonable amount of stability of the series of counts.

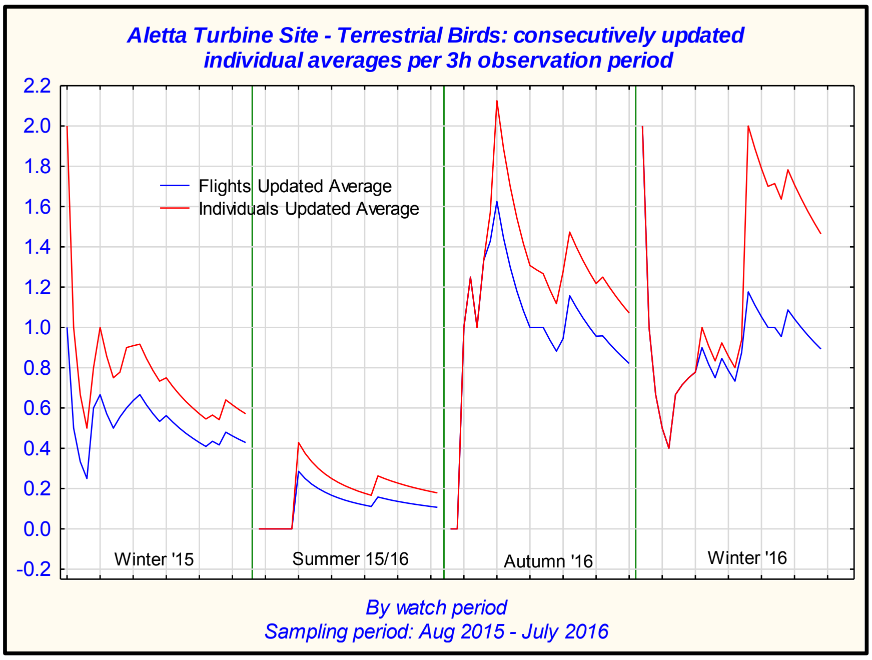

Figure 14: Terrestrial birds: updated average for *Flight* and *Individual* counts, separately by season.

In the case of terrestrial birds, Figure 14, the Winter of 2015 and Summer of 2015/16 updated averages for both flights and individual birds seem to stabilise reasonably well. The downward trend towards the end of the two last seasons is due to no new counts being recorded. As with the soaring birds these counts have also stabilised reasonably well.

Figure 15 is prepared for individual counts only by not recalculating the updated averages at the beginning of each season but continuing it over all seasons for the consecutive watch periods.

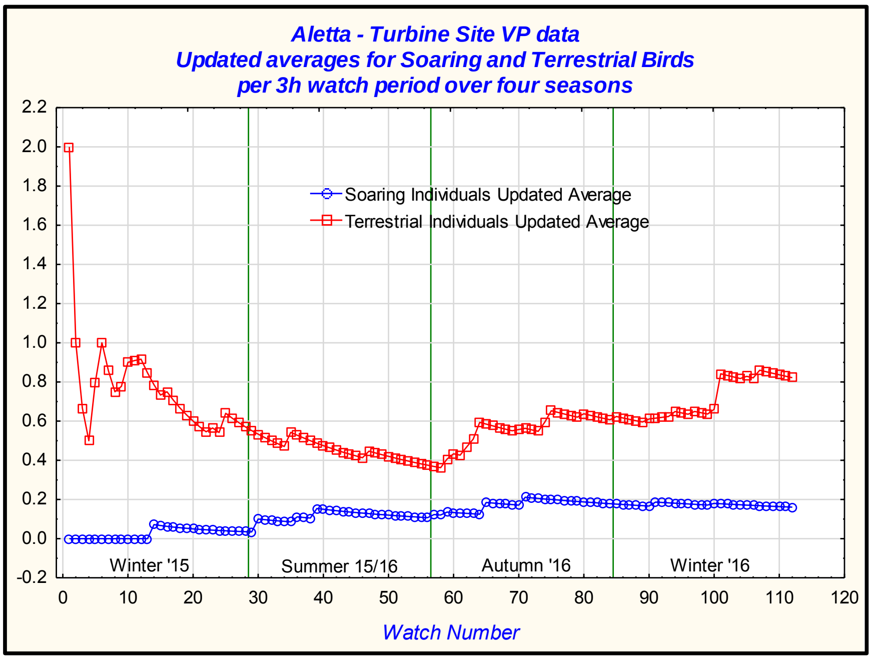

Figure 15: Soaring and Terrestrial birds: updated average for *Individual* counts.

Figure 15 shows that the average counts stabilise well towards the end of the second season. The Autumn and Winter 2016 seasons have shown an increase in the number of counts. The jump at the end for terrestrial individuals is due to the single outlying count.

The information depicted in Figures 13 - 15 shows that it is not expected that further sampling will succeed in changing the estimated average number of flight or individual counts in a substantial way.

See **APPENDIX 3** for a detailed explanation of the statistical methods.

6.2.3 Spatial distribution of flight activity

Flight maps were prepared, indicating the spatial distribution of passages of those priority species which emerged with higher than average collision risk ratings i.e. Ludwig's Bustard and Northern Black Korhaan, as observed from the various vantage points (see Figures 16-17 below). This was done by overlaying a 100m x 100m grid over the survey area. Each grid cell was then given a weighting score taking into account the duration and distance of individual flight lines through a grid cell and the number of individual birds associated with each flight crossing the grid cell. It is important to interpret these maps bearing in mind the amount of time that each species spent flying over the site i.e. the "High" category on the map for Ludwig's Bustard is not equivalent to the "High" category on the map for Northern Black Korhaan, as the flight duration for Ludwig's Bustard is much higher than the flight duration for Northern Black Korhaan.

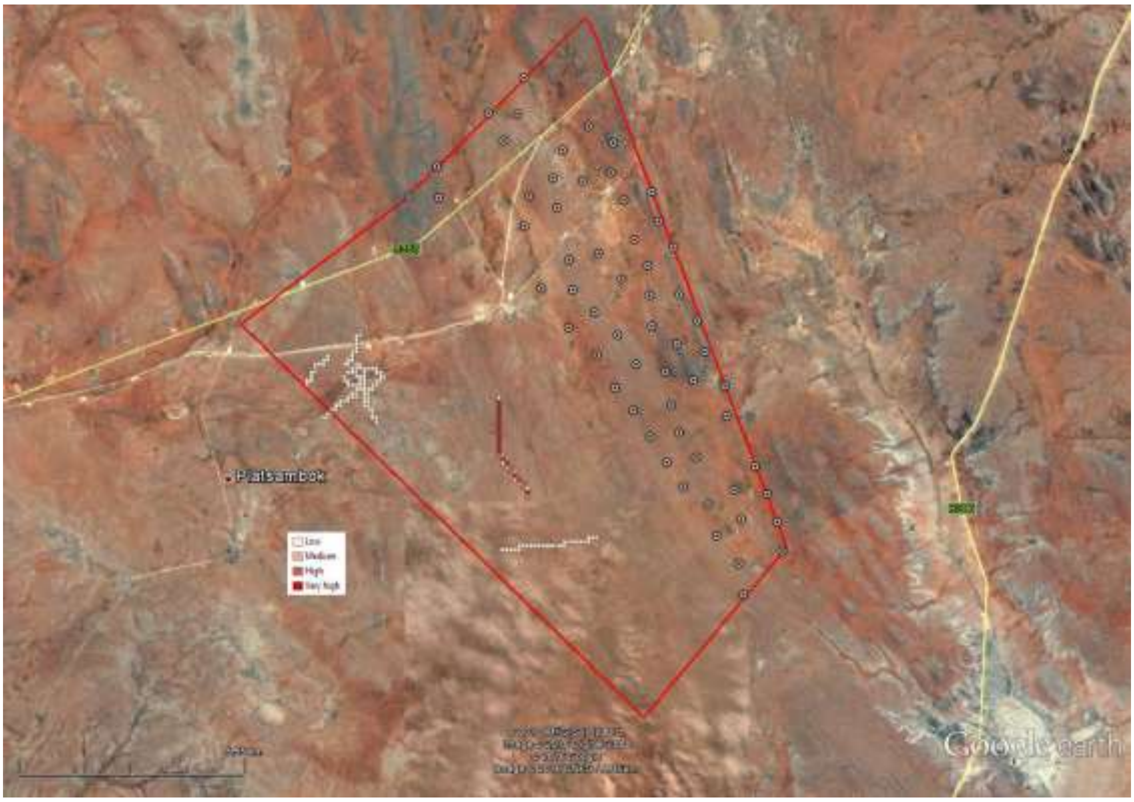

Figure 16: Spatial distribution and intensity of flights of Ludwig's Bustard.

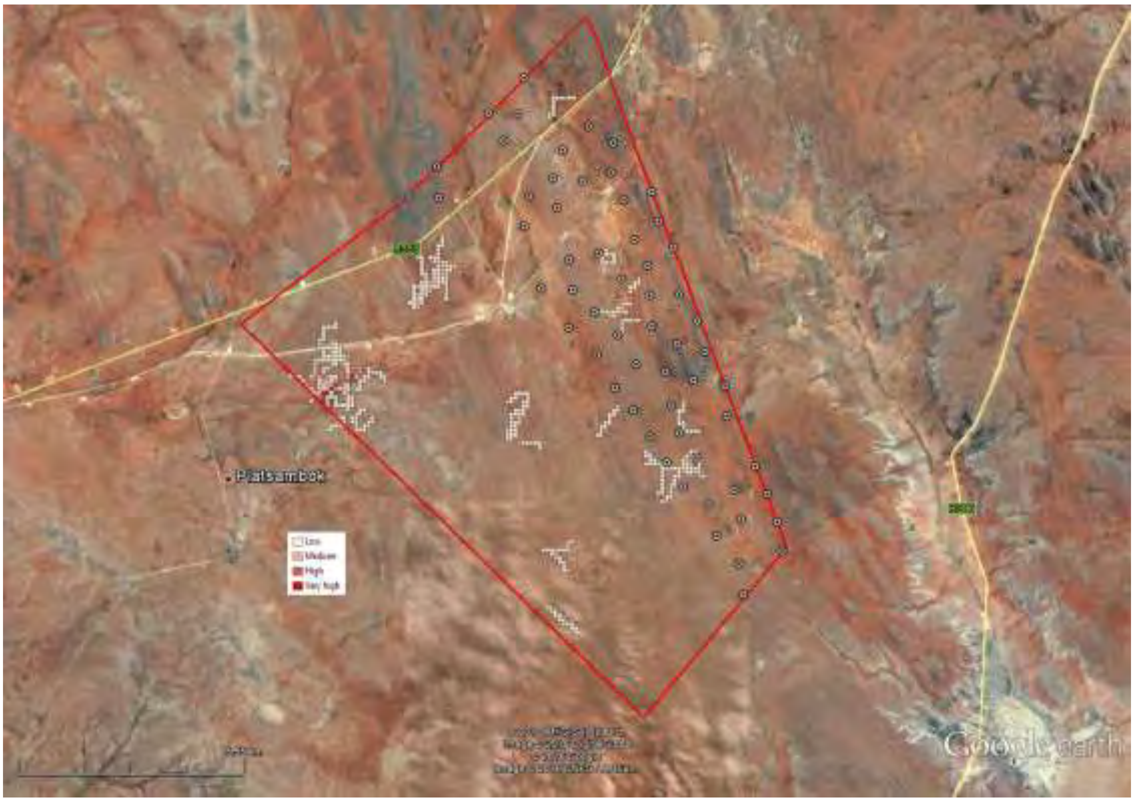

Figure 17: Spatial distribution and flight intensity for Northern Black Korhaan.

6.3 Focal points

A total of 5 potential focal points of bird activity were identified and monitored. The five focal points are a Martial Eagle nest on the Hydra – Kronos Tower 519 at Kronos MTS (FP1), a Verreaux's Eagle nest on a telephone pole just outside the proposed development area (FP2), a clump of trees at a borehole in the development area (FP3), a water trough at a borehole (FP4) and an ephemeral pan (FP5).

- FP1: The Martial Eagle nest was never active throughout the monitoring period. It seems the construction activity associated with multiple renewable energy facilities around Kronos MTS has led to the pair of eagles abandoning the nest due to chronic disturbance (see also 5.2.4).
- FP2: The Verreaux's Eagle nest was active during the pre-construction monitoring and the pair of eagles successfully raised a chick during this period (see also 5.2.4).
- FP3: A nest resembling that of a Southern Pale Chanting Goshawk was observed in the trees with two adult Southern Pale Chanting Goshawks in the vicinity of the nest in January 2016. This is an indication that the nest is active.
- FP4: No priority species were observed at the waterhole during any of the monitoring surveys.
- FP5: The ephemeral pan was dry during all the survey periods.

See Figure 18 for a map of the focal points.

Figure 18: Focal points at the turbine site.

7. 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; and
- Displacement due to habitat change and loss.
- Collision with the proposed power line grid connections[10]; and
- Displacement due to disturbance during the construction of the power line grid connection[11].

It is important to note that the assessment is made on the status quo as it is currently on site. The possible change in land use in the broader development 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.

7.1 Collision mortality on wind turbines[12]

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

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[10] Not assessed in this assessment report.

[11] Ibid

[12] 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

et al. 2012a). These numbers may not reflect the true magnitude of the problem, as some studies do not account for detectability biases such as those caused by scavenging, searching efficiency and search radius (Bernardino *et al.* 2013; Erickson *et al.* 2005; Huso and Dalthorp 2014). Additionally, 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). A deep 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.

7.1.1 Species-specific factors

- Morphological features

Certain morphological traits of birds, especially those related to size, are known to influence collision risk with structures such as power lines and wind turbines. 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.

Aletta wind farm

Priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are Northern Black Korhaan, Karoo Korhaan, Kori Bustard and Ludwig's Bustard.

- 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).

Aletta wind farm

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.

- 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).

<u>Aletta wind farm</u>

The priority species recorded at the site during the 12 months monitoring are all resident species, except Booted Eagle, which is a summer migrant.

- 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).

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 behavior 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). White Storks are one of the most common large soaring migratory species recorded crossing in tens of thousands from Europe into Africa at the Straits of Gibraltar, yet the species seem to be able to successfully avoid the wind turbines at the Tarifa wind farm (e.g. see Jans 2000 and De Lucas *et al.* 2004). White Storks are not mentioned in a comprehensive review by the Birdlife International of the literature on wind turbine/avian interactions spanning 10 years between 2003 and 2013 (Gove *et al.* 2013).

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).

Aletta wind farm

The priority species at the wind farm can be classified as either terrestrial species or soaring species, with some, e.g. Secretarybird exhibiting both types of flight behaviour.

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, bustards and larks 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 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. However, specific behaviour of some terrestrial species might put them at risk of collision, e.g. display flights of Northern Black Korhaan and Sclater's Lark 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).

Aletta wind farm

It is anticipated that most birds at the proposed wind farm will successfully avoid the wind turbines. Possible exceptions might be raptors engaged in hunting which might serve to distract them and place them at risk of collision, or birds engaged in display behaviour, e.g. Northern Black Korhaan (see earlier point). 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. Complete macro-avoidance of the wind farm is unlikely for any of the priority species.

- Bird abundance

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

Aletta wind farm

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. In general, higher populations of priority species are likely to be present when the veld conditions are good, especially in the rainy season. This could increase the risk of collisions due to heightened flight activity, especially of species such as Karoo Korhaan and Ludwig's Bustard. Conversely, some species might be more at risk during dry conditions, e.g. Sclater's Lark which seems to increase in numbers during dry spells (Hockey *et al.* 2005).

7.1.2 Site-specific factors

- Landscape features

Susceptibility to collision can also heavily depend on landscape features at a wind farm site, particularly for soaring birds that predominantly rely on wind updrafts to fly (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.

<u>Aletta wind farm</u>

The proposed site does not contain many landscape features as the majority of the development area is situated on a vast open plain. There is a slight ridge to the north of the site which may be used by soaring species for declivity soaring, but this was not recorded during pre-construction monitoring. There is small pan in the south of the study area, and many boreholes with water troughs. Boreholes with open water troughs are important sources of surface water and are used extensively by various species, including large raptors, to drink and bath. Apart from raptors, smaller species congregate in large numbers around water troughs which in turn attracts raptors such as Lanner Falcon and Southern Pale Chanting Goshawk exposing them to collisions when they are distracted and hunting. If the small pan regularly holds water, it could attract all of the above as well as a variety of waterbirds. However, it seems as if the pan seldom contains water, it never contained water during the 12-months monitoring.

- 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 5858 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.

Aletta Wind Farm

The proposed windfarm site is not located on any known or obvious flight path. It is also not located on any known migration route. The pair of Verreaux's Eagles which breeds just outside the north-eastern corner of the site may at times forage over the site, especially in the area close to the nest, but they were never recorded flying at the site during the 12-months monitoring. Monitoring at other wind farm sites in the Karoo have indicated that the majority of flight activity is within a 2-3km radius around the nest (Ralston 2016; pers. obs). Another area of potential dense flight activity is around water points, which could regularly attract several priority species, especially large raptors (see 5.2.2 above). However, no such activity was recorded during the 12-months monitoring.

- Food availability

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

Aletta Wind Farm

In 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, Kori Bustard and various raptors. This in turn could heighten the risk of collisions.

- 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).

Aletta Wind Farm

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. The dominant wind directions at Copperton is West/West-southwest and East - northeast[13]. However, the majority of soaring flight activity was recorded during north-westerly wind conditions (see **APPENDIX 3**).

7.1.3 Wind farm-specific factors

- Turbine 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).

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[13] https://www.meteoblue.com/en/weather/forecast/modelclimate/copperton_south-africa_1012772

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.

Aletta Wind Farm

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 on a potential rotor swept area of 30m – 220m to incorporate a wide range of models, which accommodates the current proposed turbines (see Table 1-1).

- 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.

Aletta Wind Farm

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 layout 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).

Aletta Wind Farm

The recorded flight behaviour of priority species at the proposed wind farm provided few clues with regard to potential areas of greater risk, largely due to the low frequency and random nature of flights. A pre-cautionary no-turbine buffer zone of 3km is recommended around the Verreaux's Eagle nest site, based on the species' known vulnerability to turbine collisions[14].

7.2 Displacement due to disturbance

The displacement of birds from areas within and surrounding wind farms due to visual intrusion and disturbance in effect can amount to habitat loss. Displacement may occur during both the construction and 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

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[14] See Ralston, M. 2015. In press. Verreauxs' Eagle and Wind Farms. Guidelines for impact assessment, monitoring, and mitigation. BirdLife South Africa.

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.

Aletta Wind Farm

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 replacement is larger for large species such as Kori Bustard and 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 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.

It is recommended that a 3km buffer no development zone is implemented around the Verreaux's Eagle nest at FP2 as per the draft Verreaux's Eagle guidelines for wind farms produced by Birdlife SA in September 2015 (Ralston 2016). A 300m no development buffer zone is recommended for the suspected Southern Pale Chanting Goshawk nest at FP3.

7.3 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).

Aletta Wind Farm

The direct habitat transformation at the proposed wind farm is likely to be fairly minimal. The indirect habitat transformation is likely to have a bigger impact on priority species. It is expected that the densities of some terrestrial priority species may decrease due to this impact, e.g. Ludwig's Bustard, but complete displacement is unlikely. The degree of displacement will only become apparent through post-construction monitoring.

8. IMPACT ASSESSMENT

8.1 Impact assessment methodology

The Impact Assessment Methodology assists in evaluating the overall effect of a proposed activity on the environment. The determination of the effect of an environmental impact on an environmental parameter is determined through a systematic analysis of the various components of the impact. This is undertaken using information that is available to the environmental practitioner through the process of the environmental impact assessment. The impact evaluation of predicted impacts was undertaken through an assessment of the significance of the impacts.

8.2 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas Intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the duration of the impact and the overall probability of occurrence. Significance is calculated using the following formula: (Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity. The summation of the different criteria will produce a non-weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

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

8.3 Impact Rating System

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

- planning
- construction
- operation
- decommissioning

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

- Rating System Used to Classify Impacts

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

Table 8-1: Description of terms

NATURE		
This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).
2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.

4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).
4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		

1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.

Significance

SIGNIFICANCE

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

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

Points	**Impact Significance Rating**	**Description**
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.

51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

8.4 Impact ratings tables

IMPACT TABLE 1	
Environmental Parameter	*Avifauna*
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to disturbance during **construction** phase*
Extent	*The impact will only affect the site.*
Probability	*Impact will certainly occur (greater than a 75% chance of occurrence) for some species, particularly the larger ones.*
Reversibility	*Partly reversible. The construction activities will inevitably cause temporary displacement of some priority species. Once the source of the disturbance has been removed, i.e. the noise and movement associated with the construction activities, most species should re-colonise the areas which have not been transformed by the footprint. However, the indirect effect of habitat fragmentation could result in lower densities of priority species.*
Irreplaceable loss of resources	*Marginal loss of resources. The displacement of priority species is likely to be partial.*
Duration	*Short term. Once the source of the disturbance has been removed, i.e. the noise and movement associated with the construction activities, priority species should re-colonise the areas which have not been transformed by the footprint, albeit possibly at a lower density.*
Cumulative effect	*Medium cumulative impact. The priority species that occur (or are likely to occur) at the proposed site all have large distribution ranges, the cumulative impact of displacement would therefore be at most locally significant in some instances, rather than regionally or nationally significant (see also Section 9 below).*
Intensity/magnitude	*High. Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease.*
Significance Rating	*Medium significance.*

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	4	2
Reversibility	2	1
Irreplaceable loss	2	2

IMPACT TABLE 1		
Duration	1	1
Cumulative effect	3	2
Intensity/magnitude	3	2
Significance rating	-39 (medium negative)	-18 (low negative)
Mitigation measures	• Restrict the construction activities to the construction footprint area. • Do not allow any access to the remainder of the property during the construction period. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum. • Implement a 3km no development buffer zone around the Verreaux’s eagle nest at FP2 - 29°52'56.53"S 22°33'19.06"E. • Implement a 300m no development buffer zone around the Southern Pale Chanting Goshawk nest at FP3 - 29°56'34.42"S 22°32'55.35"E.	

IMPACT TABLE 2	
Environmental Parameter	*Avifauna*
Issue/Impact/Environmental Effect/Nature	*Displacement of priority species due to habitat destruction during* ***construction*** *phase*
Extent	*The impact will only affect the site.*
Probability	*Impact will certainly occur (greater than a 75% chance of occurrence)*
Reversibility	*Partly reversible. The footprint of the wind farm is an inevitable result of the development, but it is likely that priority species will still utilise the site, albeit at lower densities.*
Irreplaceable loss of resources	*Marginal loss of resources. It is likely that priority species will still utilise the site albeit at lower densities.*
Duration	*Long term. The habitat transformation will be permanent*
Cumulative effect	*Medium cumulative impact. There are several renewable energy developments planned around Copperton which could result in a significant area of transformed habitat at a local scale, for some species (see also Section 9 below).*
Intensity/magnitude	*Medium. It is likely that priority species will still utilise the site albeit at lower densities.*
Significance Rating	*Medium significance.*

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	1	1
Probability	4	3
Reversibility	2	2
Irreplaceable loss	2	2
Duration	4	4
Cumulative effect	3	3
Intensity/magnitude	2	2
Significance rating	-32 (medium negative)	-30 (medium negative)
Mitigation measures	• The recommendations of the specialist ecological study must be strictly adhered to. • Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum.	

<table>
<tr><th colspan="3">IMPACT TABLE 3</th></tr>
<tr><td>Environmental Parameter</td><td colspan="2">Avifauna</td></tr>
<tr><td>Issue/Impact/Environmental Effect/Nature</td><td colspan="2">Displacement of priority species due to disturbance during operational phase</td></tr>
<tr><td>Extent</td><td colspan="2">The impact will only affect the site.</td></tr>
<tr><td>Probability</td><td colspan="2">Probable. The impact may occur (between a 50% to 75% chance of occurrence).</td></tr>
<tr><td>Reversibility</td><td colspan="2">Partly reversible. The operational activities could cause displacement of some priority species, but the impact is likely to be much less than during the construction phase.</td></tr>
<tr><td>Irreplaceable loss of resources</td><td colspan="2">Marginal loss of resources. Habituation is likely for some species after the construction phase, especially smaller species.</td></tr>
<tr><td>Duration</td><td colspan="2">Long term. Although habituation may happen in some instances, it must be assumed that in some instances the impact may be long term i.e. for the life-time of the activity.</td></tr>
<tr><td>Cumulative effect</td><td colspan="2">Medium cumulative impact. The priority species that occur (or are likely to occur) at the proposed site all have large distribution ranges, the cumulative impact of displacement would therefore be locally significant at most, rather than regional or national (see also Section 9 below).</td></tr>
<tr><td>Intensity/magnitude</td><td colspan="2">Medium. Although habituation may happen in some instances, it must be assumed that in some instances the impact may be long term i.e. for the life-time of the activity.</td></tr>
<tr><td>Significance Rating</td><td colspan="2">Low significance.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td></td><td>Pre-mitigation impact rating</td><td>Post mitigation impact rating</td></tr>
<tr><td>Extent</td><td>1</td><td>1</td></tr>
<tr><td>Probability</td><td>3</td><td>2</td></tr>
<tr><td>Reversibility</td><td>2</td><td>2</td></tr>
<tr><td>Irreplaceable loss</td><td>2</td><td>2</td></tr>
<tr><td>Duration</td><td>3</td><td>3</td></tr>
<tr><td>Cumulative effect</td><td>2</td><td>2</td></tr>
<tr><td>Intensity/magnitude</td><td>2</td><td>2</td></tr>
<tr><td>Significance rating</td><td>-26 (low negative)</td><td>-24 (low negative)</td></tr>
<tr><td>Mitigation measures</td><td colspan="2">• Operational activities should be restricted to the plant area. Maintenance staff should not be allowed to access other parts of the property unless it is necessary for wind farm related work.
• Post-construction monitoring should be implemented to make comparisons with baseline conditions possible.
If densities of key priority species are proven to be significantly reduced due to the operation of the wind farm, the management of the wind farm must be engaged to devise ways of reducing the impact on these species.</td></tr>
<tr><td>Environmental Parameter</td><td colspan="2">Avifauna</td></tr>
</table>

<table>
<tr><th colspan="3">IMPACT TABLE 3</th></tr>
<tr><td>Issue/Impact/Environmental Effect/Nature</td><td colspan="2">Collisions of priority species with the turbines in the operational phase</td></tr>
<tr><td>Extent</td><td colspan="2">The impact will affect the local area or district</td></tr>
<tr><td>Probability</td><td colspan="2">Definite. More than 75% chance of occurrence.</td></tr>
<tr><td>Reversibility</td><td colspan="2">Partly reversible. Mitigation measures could reduce the risk of collisions.</td></tr>
<tr><td>Irreplaceable loss of resources</td><td colspan="2">Significant loss of resources.</td></tr>
<tr><td>Duration</td><td colspan="2">Long term. The risk of collision will be present for the life-time of the development.</td></tr>
<tr><td>Cumulative effect</td><td colspan="2">Moderate cumulative impact. The cumulative impact will depend largely on which species are killed. If Verreaux's Eagles or Martial Eagles are killed, the regional impact could be significant (see also Section 9 below).</td></tr>
<tr><td>Intensity/magnitude</td><td colspan="2">Medium. The wind turbines could cause mortality of some priority species.</td></tr>
<tr><td>Significance Rating</td><td colspan="2">High significance.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td></td><td>Pre-mitigation impact rating</td><td>Post mitigation impact rating</td></tr>
<tr><td>Extent</td><td>2</td><td>2</td></tr>
<tr><td>Probability</td><td>4</td><td>2</td></tr>
<tr><td>Reversibility</td><td>2</td><td>2</td></tr>
<tr><td>Irreplaceable loss</td><td>3</td><td>3</td></tr>
<tr><td>Duration</td><td>3</td><td>3</td></tr>
<tr><td>Cumulative effect</td><td>3</td><td>3</td></tr>
<tr><td>Intensity/magnitude</td><td>3</td><td>2</td></tr>
<tr><td>Significance rating</td><td>-51 (high negative)</td><td>-30 (medium negative)</td></tr>
<tr><td>Mitigation measures</td><td colspan="2">• Once the turbines have been constructed, post-construction monitoring should be implemented to compare actual collision rates with predicted collision rates.
• If actual collision rates indicate significant mortality levels at specific turbines, curtailment of these turbines should be implemented.
• A 200m no-development zone is recommended around all water points.
• A 3km no development buffer zone is recommended around the Verreaux's Eagle nest at FP2 - 29°52'56.53"S 22°33'19.06"E.
• A 300m no development buffer zone is recommended around the Southern Pale Chanting Goshawk nest at FP3 - 29°56'34.42"S 22°32'55.35"E.</td></tr>
</table>

9. CUMULATIVE IMPACTS

A cumulative impact, in relation to an activity, is the impact of an activity that may not be significant on its own but may become significant when added to the existing and potential impacts arising from similar or other activities in the area.

Currently there is no agreed method for determining significant adverse cumulative impacts on ornithological receptors. The Scottish Natural Heritage (2005) recommends a five-stage process to aid in the ornithological assessment:

- Define the species/habitat to be considered;
- Consider the limits or 'search area' of the study;
- Decide the methods to be employed;
- Review the findings of existing studies; and
- Draw conclusions of cumulative effects within the study area.

9.1 Species to be considered

The potential cumulative impacts on the priority species listed in Table 6-1 were considered.

9.2 Area considered in the cumulative assessment

The Kronos MTS forms the hub of a proposed renewable energy node (See Figure 19 below). Within this 35km radius, the habitat and land-use is very uniform.

APPENDIX 4 lists the renewable energy applications which is currently (2d quarter 2016) registered with the Department of Environmental Affairs (DEA) within a 35km radius around Kronos MTS.[15]

9.3 Current impacts

Below is a summary of the typical threats currently facing avifauna in the Karoo environment (Marnewick *et al*. 2015):

9.3.1 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.

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[15] https://www.environment.gov.za/mapsgraphics#renewable. The information on the status and scope of these projects was obtained from various reports sourced from the internet and Environmental Assessment Practitioners. Every effort was made to obtain the most recent information, but it may not reflect the most recent status. In some instances, no information was available.

9.3.2 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. Outbreaks of brown locust are controlled by means of spraying to prevent damage to crops, resulting in the poisoning of birds that eat the dead locusts.

9.3.3 Road-kills

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

9.3.4 Renewable energy developments

Several wind and solar developments have been approved for development within a 35km radius around Kronos MTS (see Figure 19). This has implications for several priority species, both in terms of collision mortality for some species, especially raptors, and displacement due to permanent habitat transformation (especially solar developments), which affects all the priority species to some degree.

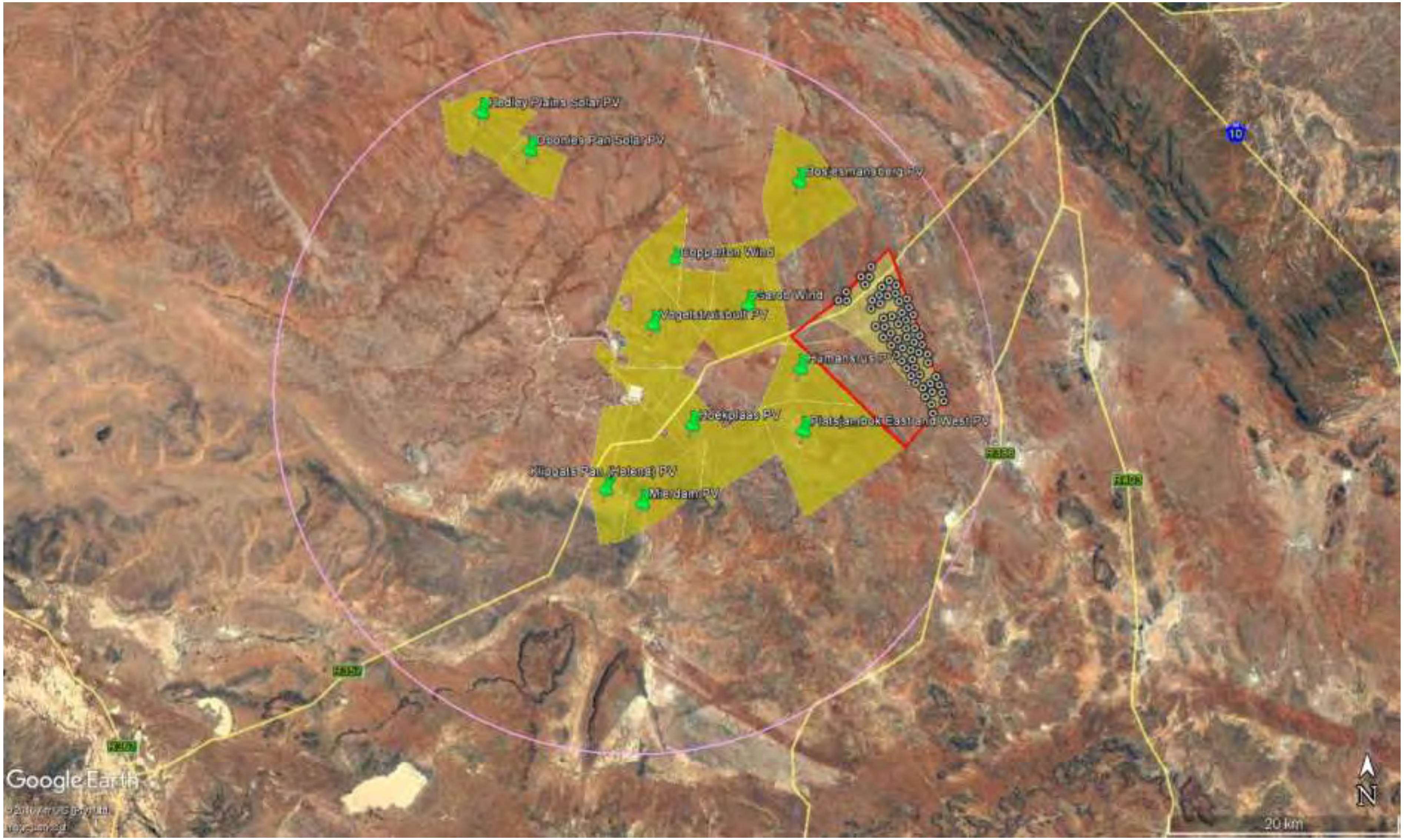

Figure 19: Renewable energy developments proposed in a 35km radius around Kronos MTS.

9.3.5 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.

9.3.6 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 Verreauxs' Eagle, Tawny Eagle and Martial Eagle, which also exhibit extended parental care. Severe hailstorms kill many priority species and could become more frequent.

9.3.7 Shale gas fracking

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.

9.3.8 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).

9.4 Methods

The cumulative impact of the proposed WEF was assessed individually for each priority species (see Table 9-2 below).

The factors considered in assessing the potential species-specific impacts are:

- Level of current impact on priority species in study area (all impacts);
- Susceptibility to WEF impacts i.e. collisions with turbines and displacement through habitat transformation;
- The percentage of habitat which is likely to be impacted by the proposed WEF.

Table 9-1 below sets out the criteria applied to rank potential cumulative impacts:

Table 9-1: Framework for assessing significance of cumulative effects

Significance	Effect
Severe	Effects that the decision-maker must take into account because the receptor/resource is irretrievably compromised, resulting in a fatal flaw.
Major	Effects that may become a key decision-making issue, potential fatal-flaw.
Moderate	Effects that are unlikely to affect the viability of the project, but mitigation might be required.
Minor	Effects which might be locally/site significant, but probably insignificant for the greater study area.
Not Significant	Effects that are within the ability of the resource to absorb such change both at local/site level and within the greater study area.

9.5 Assumptions and limitations: cumulative impacts

The information on proposed WEFs in the study area was received from Sivest and from the official DEA website. The assessment was made on this basis, but it cannot be guaranteed that these are the only proposed WEF developments.

9.6 Assessment

See Table 9-2 below for a systematic exposition of the expected cumulative impacts of the proposed Aletta WEF on priority species.

Table 9-2: The expected cumulative impact of the Aletta WEF om priority species within the 35km development node

Priority species	**Taxonomic name**	**Level of current and future impacts on species**	**Susceptibility to WEF impacts**	**Preferred habitat in the development node**	**Approximate size of preferred habitat in development node (ha)**	**Existing renewable energy applications: Extent of habitat in development node potentially**	**Aletta WEF: extent of habitat in the development node potentially affected (ha)**	**Expected cumulative impact of Aletta WEF: Pre-mitigation**	**Expected cumulative impact of Aletta WEF: Post-mitigation**
Karoo Korhaan	*Eupodotis vigorsii*	Low: Powerlines, solar, overgrazing, climate change	Low	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Minor	Not significant
Northern Black Korhaan	*Afrotis afraoides*	Low: Powerlines, solar, overgrazing, climate change	Low	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Moderate	Minor
Kori Bustard	*Ardeatis kori*	High: Powerlines,solar, overgrazing, climate change	Low	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Moderate	Minor
Lanner Falcon	*Falco biarmicus*	Low: Powerlines, poisoning, road kills, solar, WEF	Medium?	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Moderate	Minor
Ludwig's Bustard	*Neotis ludwigii*	High: Powerlines, solar, overgrazing, climate change	Low	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Moderate	Minor
Martial Eagle	*Polemaetus bellicosus*	High: Powerlines, persecution, solar, overgrazing, WEFs, climate change	Medium?	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Minor	Not significant
Secretarybird	*Sagittarius serpentarius*	High: Powerlines, solar , overgrazing, WEFs, climate change	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Moderate	Minor
Verreaux's Eagle	*Aquila verreauxii*	High: Powerlines, persecution, WEFs, climate change	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Major	Not significant
Booted Eagle	*Aquila pennatus*	Medium: Solar, overgrazing, WEFs, climate change	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Minor	Not significant
Sclater's Lark	*Spizocorys sclateri*	Low: Powerlines, solar, overgrazing, climate change	Low	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Not significant	Not significant
Black-chested Snake-Eagle	*Circaetus pectoralis*	Medium: Solar, overgrazing, WEFs, climate change	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 264	13 029 (3.35%)	5 600 (1.44%)	Minor	Minor
Southern Pale Chanting Goshawk	*Melierax canorus*	Low: Powerlines, solar, overgrazing, climate change	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 265	13 029 (3.35%)	5 600 (1.44%)	Moderate	Minor
Greater Kestrel	*Falco rupicoloides*	Low: Solar, overgrazing, climate change	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 266	13 029 (3.35%)	5 600 (1.44%)	Minor	Minor
Spotted Eagle-Owl	*Bubo africanus*	Medium: Powerlines, solar, overgrazing, WEFs, climate change, road kills	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 267	13 029 (3.35%)	5 600 (1.44%)	Minor	Minor
Jackal Buzzard	*Buteo rufofuscus*	Medium: Solar, overgrazing, WEFs, climate change	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 268	13 029 (3.35%)	5 600 (1.44%)	Minor	Minor
Lappet-faced Vulture	*Torgos tracheliotis*	High: Powerlines, persecution, solar, overgrazing, WEFs, climate change	High	Bushmanland Basin Shrubland and Bushmanland Arid	388 269	13 029 (3.35%)	5 600 (1.44%)	Minor	Minor
Burchell's Courser	*Cursorius rufus*	Medium: Solar, overgrazing, WEFs, climate change	Low?	Bushmanland Basin Shrubland and Bushmanland Arid	388 270	13 029 (3.35%)	5 600 (1.44%)	Not significant	Not significant
Double-banded Courser	*Rhinoptilus africanus*	Medium: Solar, overgrazing, WEFs, climate change	Low?	Bushmanland Basin Shrubland and Bushmanland Arid	388 271	13 029 (3.35%)	5 600 (1.44%)	Not significant	Not significant

9.7 Conclusions

The cumulative impact of the proposed Aletta WEF on priority avifauna, after appropriate mitigation has been implemented, will range from minor to insignificant.

9.8 No-Go Alternative

The no-go alternative will result in the current status quo being maintained as far as the avifauna is concerned. Given the extensive farming practices which are currently used in the region, it can be surmised that the existing anthropogenic impacts on avifauna is relatively low. Although it cannot be confirmed, interviews with the landowner at the neighbouring farm Nelspoortjie indicate that active persecution of large raptors for alleged stock killing is not commonly practised. Hunting of priority avifauna is also not a major impact. Overall, the very low human population in the study area is definitely advantageous to avifauna in general. The no-go option would maintain the ecological integrity of the study area as a whole far as avifauna is concerned.

10. ASSESSMENT OF ALTERNATIVES

There are two potential alternatives planned for the Aletta on-site substation (see Figure 5). Table 10 – 1 below provides a comparative assessment of the two alternatives from an avifaunal impact perspective.

Table 10 – 1: Comparative assessment of substation localities at the proposed Aletta Wind Farm

PREFERRED	The alternative will result in a low impact / reduce the impact
FAVOURABLE	The impact will be relatively insignificant
NOT PREFERRED	The alternative will result in a high impact / increase the impact
NO PREFERENCE	The alternative will result in equal impacts

Alternative	**Preference**	**Reasons (incl. potential issues)**
SUBSTATION ALTERNATIVES		
Substation Alternative 1	The alternative will result in equal impacts	The habitat at the proposed turbine site is highly homogenous. The impact that the substation will have on the available habitat is therefore likely to be similar, irrespective of where the substation is located.
Substation Alternative 2	The alternative will result in equal impacts	The habitat at the proposed turbine site is highly homogenous. The impact that the substation will have on

Alternative	Preference	Reasons (incl. potential issues)
		the available habitat is therefore likely to be similar, irrespective of where the substation is located.

11. CONCLUSIONS

The proposed BioTherm Aletta (Copperton) Wind Farm will have a variety of impacts on avifauna which range from low to high. The impacts are (1) displacement of priority species due to disturbance during construction phase (2) displacement of priority species due to habitat destruction during construction phase (3) displacement of priority species due to disturbance during operational phase (4) and collisions of priority species with the turbines in the operational phase.

Displacement of priority species due to disturbance during construction phase is likely to be a temporary medium negative impact, but can be reduced to low with the application of mitigation measures. Mitigation measures are the restriction of construction activities to the construction footprint area, no access to the remainder of the property during the construction period, measures to control noise and dust, maximum use of existing access roads, the implementation of a 3km no development buffer zone around a Verreaux's Eagle nest, and a 300m no development buffer zone around a Southern Pale Chanting Goshawk nest.

Displacement of priority species due to habitat destruction during construction phase is likely to be a medium negative impact and will remain so, despite the application of mitigation measures. Mitigation measures comprise strict adherence to the recommendations of the specialist ecological study and maximum use of existing access roads with the construction of new roads kept to a minimum.

Displacement of priority species due to disturbance during the operational phase is likely to be of low significance and it could be further reduced through the application of mitigation measures. Mitigation measures are the restriction of operational activities to the plant area, no access to other parts of the property unless it is necessary for wind farm related work, post-construction monitoring, and if densities of key priority species are proven to be significantly reduced due to the operation of the wind farm, engagement of the wind farm management to devise ways of reducing the impact on these species.

Collisions of priority species with the turbines in the operational phase are likely to be a high negative impact but it could be reduced to medium negative through the application of mitigation measures. Mitigation measures are the implementation of post-construction monitoring and, if actual collision rates indicate high mortality levels, curtailment of selective turbines. Lastly, the implementation of a 3km no development buffer zone around a Verreaux's Eagle nest, a 200m no turbine zone around waterpoints and a 300m no development buffer zone around a Southern Pale Chanting Goshawk nest are recommended.

See Figure 20 below for a sensitivity map indicating proposed buffer zones.

Finally, it is concluded that, after taking into account the expected impact of proposed renewable energy projects within a 35km radius around Kronos MTS, that the cumulative impact of the proposed Aletta WEF on priority avifauna, after appropriate mitigation has been implemented, will range from minor to insignificant.

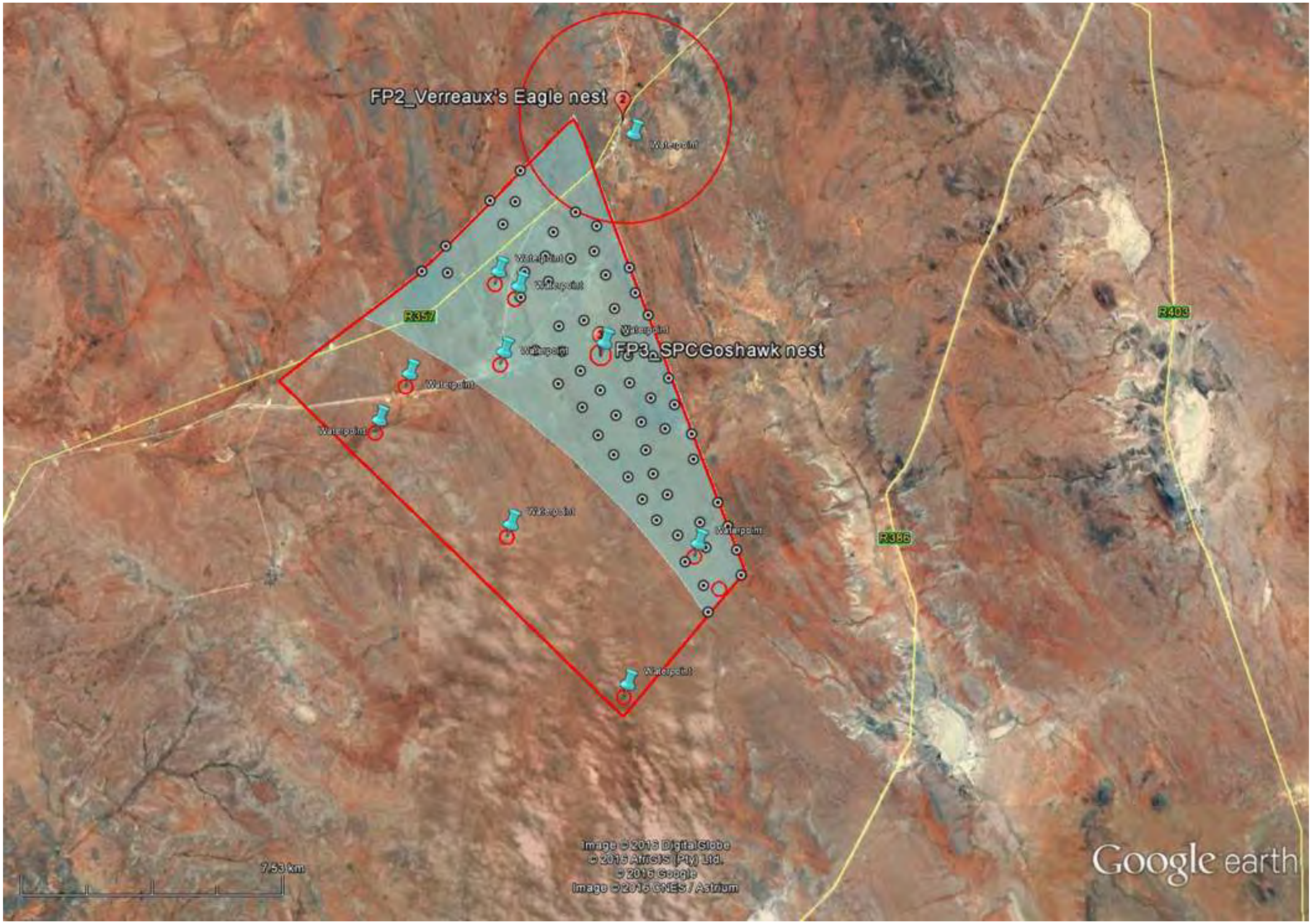

Figure 20: Sensitivity map of the study area, indicating proposed buffer zones (red circles).

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APPENDIX 1: BIRD HABITAT

Figure 1: Typical Bushmanland Basin Shrubland in the study area.

Figure 2: A typical waterpoint at a borehole at the turbine site.

Figure 3: An isolated clump of trees at a borehole. Trees are very scarce and generally only found at waterpoints.

Figure 4: A Verreaux's Eagle nest on a telephone pole which was monitored as focal point.

APPENDIX 2: PRE-CONSTRUCTION METHODOLOGY

Objectives

The objective of the pre-construction monitoring at the proposed Aletta Wind Project was to gather baseline data over a period of 12-months on the following aspects pertaining to avifauna:

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

Methods

The monitoring protocol for the site is designed according to the latest version (2014) 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.*

Monitoring surveys were conducted at the proposed turbine site and a control site by four field monitors during the following periods:

- 24 – 31 August 2015
- 4 – 10 January 2016
- 19 - 24 March 2016
- 29 June – 5 July 2016

Monitoring was conducted in the following manner:

- One drive transect was identified totalling 19.6km on the turbine site and one drive transect in the control site with a total length of 10km.
- 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. Transects were counted three times per sampling session.
- In addition, seven walk transects of 1km each were identified at the turbine site, and two at the control site, and counted 8 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 (calm; moderate; strong);

  - 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).

- Seven vantage points (VPs) were identified from which the majority of the proposed turbine area can be observed (the "VP area"), 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 measure the potential collision risk with the turbines. Priority species were identified using the November 2014 BirdLife South Africa (BLSA) list of priority species for wind farms.

A total of 5 potential focal points of bird activity were identified and monitored. The five focal points were a Martial Eagle nest on the Hydra – Kronos Tower 519 at Kronos Substation (FP1), a Verreaux's Eagle nest on a telephone pole just outside the proposed development area (FP2), a clump of trees at a borehole in the development area (FP3), a water trough at a borehole (FP4) and an ephemeral pan (FP5).

Figure 1 below indicates the proposed turbine area where monitoring was performed.

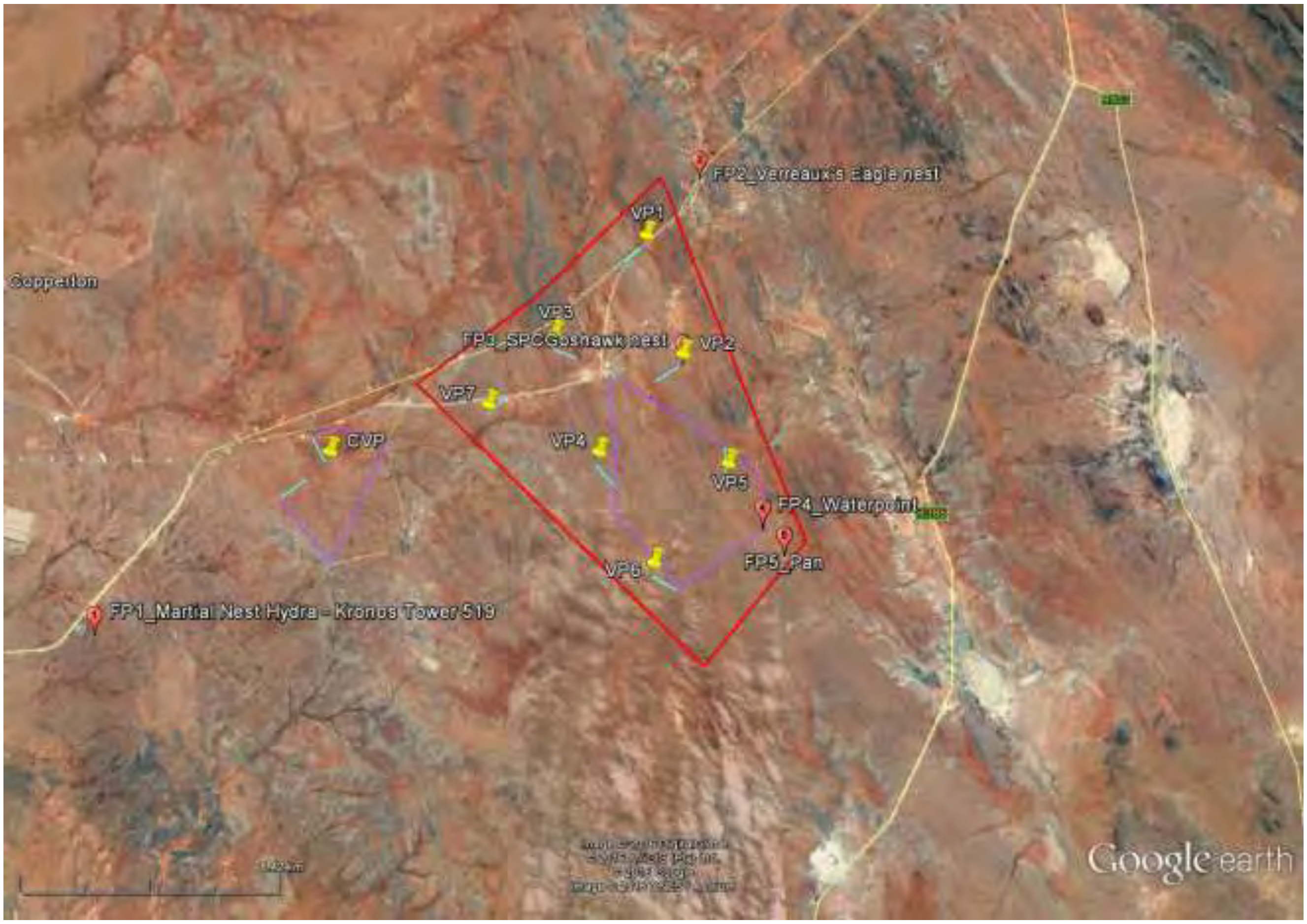


Figure 1: Area where monitoring took taking place, with position of VPs (yellow placemarks), focal points (red placemarks), drive transects (purple line), walk transects (blue lines) and assessment area (red polygon). The control area is located to the west of the assessment area.

APPENDIX 3: STATISTICAL ANALYSIS

COPPERTON / ALETTA SURVEY

STATISTICAL ANALYSIS: TURBINE SITE

1. Introduction

This report is based on data captured in the MS Excel file "*Aletta_VPs_4Surveys_20160712_V1.xls*". This file contains records for each individual flight of priority species birds that were recorded at a vantage point set up at the *Aletta* turbine site. Observations were recorded in "watch periods" 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 bird was 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 *28* watch periods of three hours each, spread over 7 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	Number of Days	Hours Observed
2015-08-24	2015-08-31	Winter 2015	8	84
2016-01-04	2016-01-10	Summer 2015/16	7	84
2016-03-19	2016-03-24	Autumn 2016	6	84
2016-06-29	2016-07-05	Winter 2016	7	84

Some basic statistics concerning the data set are presented in this report, including whether the data obtained are representative of the true occurrence of those birds identified as priority species and thus the validity of the estimates of the average number of birds observed.

2. Descriptive statistics

Several tables of descriptive statistics are computed and captured in this section. The watch periods were all of the same length, viz. three hours and thus counts and variability are expressed as per 3 hours. The following basic statistics were computed:

- 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 in Table A in the *Appendix*.
- Table B shows the times that the soaring and terrestrial birds flew 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 time in flight.
- Tables C – G (in the Appendix) provide summary statistics intended to give 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 Tables H and I in the *Appendix* for *Soaring* and *Terrestrial* birds separately and with calculations of updated average counts for consecutive watch periods.

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

3. Distribution of the data

The three notes that follow explain the terminology that will be used.

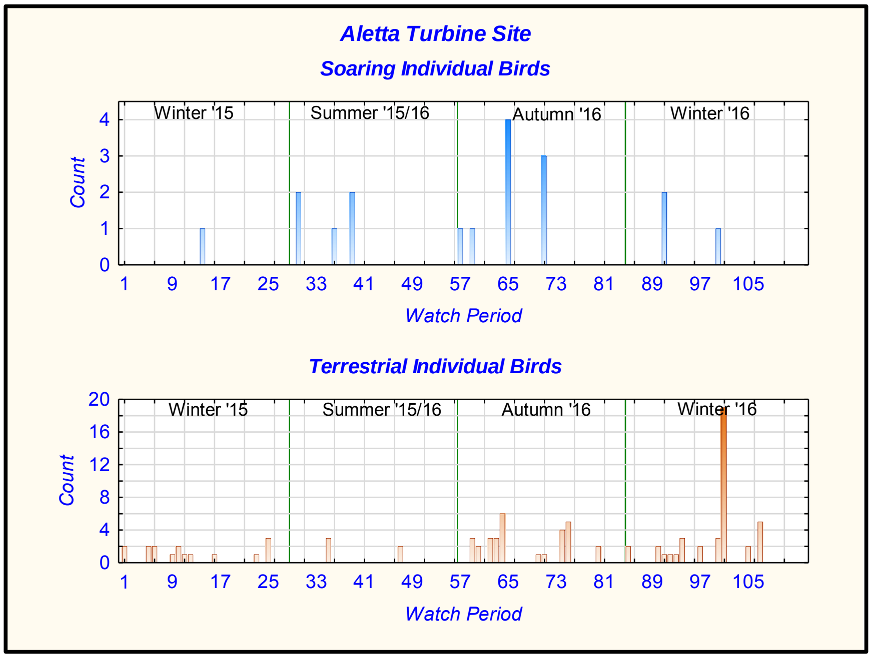
Note 1: The *average value* (also referred to as the *mean value*) is a measure of the location of the centre of gravity of a data distribution. The standard deviation is a measure of the variability around the mean value of such a distribution.

Note 2: A *confidence interval* for the mean at a selected confidence level implies that if it were possible to take the infinite number of all possible samples of size $n = 28$ (in the present case of sampling per season) and a *95%* confidence interval for the mean is computed in each case, then *95%* of those intervals are expected to contain the true mean value. The larger the standard deviation of a distribution, the wider the confidence interval for the mean will be.

Note 3: It is recognised that counts of events that took place in a fixed time period (e.g. the counts of birds in a watch period of fixed length) may have a Poisson distribution. The Poisson distribution has the property that its mean value and its variance (the squared standard deviation) are identical. This was investigated for the counts at hand but that test failed and accordingly the Poisson was not accepted as underlying distribution just as much as the same is true for the normal distribution.

The raw data counts for soaring and terrestrial birds are presented in Figure 1 for each of the watch periods *1* to *112*.

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



4. Basic Statistics

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 four seasons are computed from the data as presented in Tables H and I). The results are listed in Tables *2 – 5*.

The computation of a confidence interval assumes that certain assumptions are to be met by the underlying data distribution. In Tables *2 – 5* it is assumed that the data are from a normal distribution. This may not be true for the present data but it is assumed that the confidence interval will at least give a rough idea of the variability of the mean.

The number of individual birds are recorded for each flight. Tables *2* and *4* report the statistics for the number of *flights* recorded over all watch periods for soaring and terrestrial birds respectively. Tables *3* and *5* report the statistics for the total number of individual birds per watch period for the two flight classes.

Table *2*. Soaring birds, Flights: average, SD and 95% lower and upper confidence limits for the number of flights per 3h watch period.

Season	Watch periods	Soaring birds: Flights				
		Count	Avge	Std.Dev.	95% LCL	95% UCL
Winter15	28	1	0.04	0.19	0.00	0.11
Summer15/16	28	4	0.14	0.45	0.00	0.32
Autumn16	28	8	0.29	0.81	0.00	0.60
Winter16	28	2	0.07	0.26	0.00	0.17
All Grps	112	15	0.13	0.49	0.04	0.23

The interpretation of the data in Tables 2 – 5, with reference to Table2, is as follows: each season had *28* watch periods allocated to it. The last row, column 3, shows that *15* flights of soaring birds were counted during the *112* watch periods, leading to an estimated overall average of *0.13* flights per *3*h watch period, a standard deviation of *0.49* and a *95%* confidence interval for the true mean of *0.04 – 0.23*. The data for the seasons are similarly interpreted.

Table *3*. Soaring birds, Individuals: average, SD and 95% lower and upper confidence limits for the number of individuals per 3h watch period.

Season	Watch periods	Soaring: Individuals				
		Count	Avge	Std.Dev.	95% LCL	95% UCL
Winter15	28	1	0.04	0.19	0.00	0.11
Summer15/16	28	5	0.18	0.55	0.00	0.39
Autumn16	28	9	0.32	0.94	0.00	0.69
Winter16	28	3	0.11	0.42	0.00	0.27
All Grps	112	18	0.16	0.59	0.05	0.27

Table *4*. Terrestrial birds, Flights: average, SD and 95% lower and upper confidence limits for the number of flights per 3h watch period.

Season	Watch periods	Terrestrial: Flights				
		Count	Avge	Std.Dev.	95% LCL	95% UCL
Winter15	28	12	0.43	0.63	0.18	0.67
Summer15/16	28	3	0.11	0.42	0.00	0.27
Autumn16	28	23	0.82	1.33	0.30	1.34
Winter16	28	25	0.89	1.47	0.32	1.46
All Grps	112	63	0.56	1.10	0.36	0.77

Table *5*. Terrestrial birds, Individuals: average, SD and 95% lower and upper confidence limits for the number of individuals per 3h watch period.

Season	Watch periods	Terrestrial: Individuals				
		Count	Avge	Std.Dev.	95% LCL	95% UCL
Winter15	28	16	0.57	0.88	0.23	0.91
Summer15/16	28	5	0.18	0.67	0.00	0.44
Autumn16	28	30	1.07	1.74	0.40	1.75
Winter16	28	41	1.46	3.67	0.04	2.89
All Grps	112	92	0.82	2.13	0.42	1.22

Considering the counts as presented in Figure 1, the count of *19* individual birds (observed at watch period *101* at VP7, see Table I) is a clear outlier. Its influence on the average and standard deviation (and hence the confidence interval) for *Winter 2016* and for *All Groups* is clear to see. The median for *Winter16* was *0.00* and without that count the average for *Winter16* was *0.81*.

5. Stability and Representativeness

Insight into the 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 a representative sample has been achieved).

To investigate the behaviour of this process the average number of *flights* per 3h watch period (as well as for *individual*s) are 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 2 for soaring birds and Figure 3 for terrestrial birds.

Figure *2*. Soaring birds: updated average for *Flight* and *Individual* counts, separately by season.

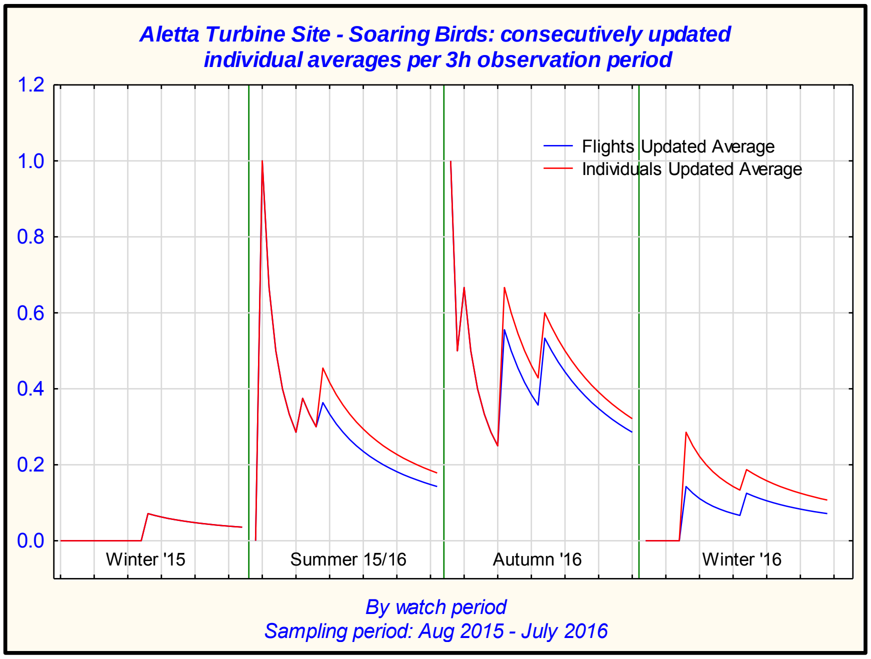
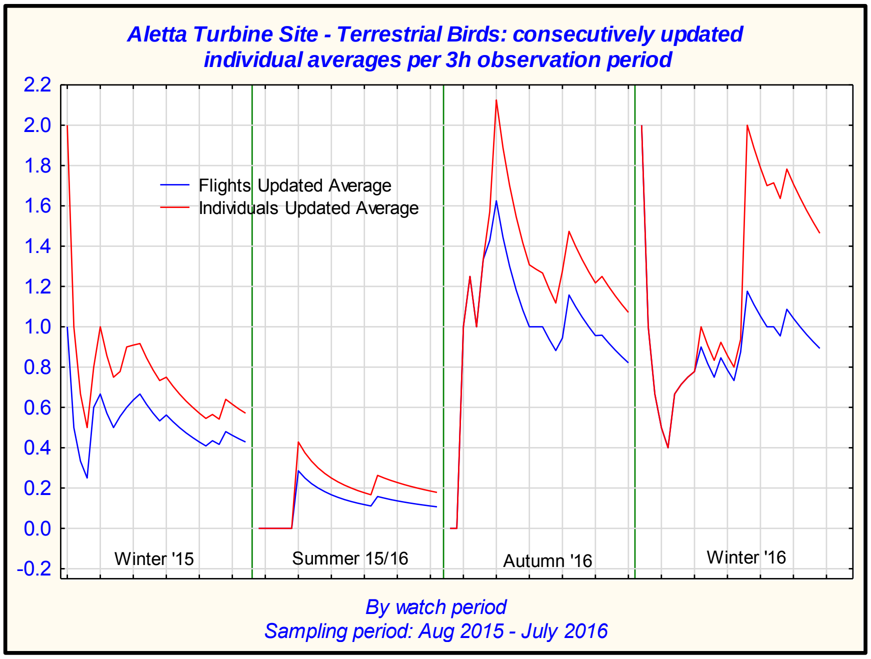


Figure *2* shows that the updated averages for flights and individual birds are identical in Winter 2015. The other seasons show a gradual downward trend due to no sightings in the last 10 or more consecutive watch periods of each season. This implies a reasonable amount of stability of the series of counts.

Figure *3*. **Terrestrial birds: updated average for *Flight* and *Individual* counts, separately by season.**



In the case of terrestrial birds, Figure *3*, the Winter of 2015 and Summer of 2015/16 updated averages for both flights and individual birds seem to stabilise reasonably well. The downward trend towards the end of the two last seasons is due to no new counts being recorded. As with the soaring birds these counts have also stabilised reasonably well.

Figure *4* is prepared for individual counts only by not recalculating the updated averages at the beginning of each season but continuing it over all seasons for the consecutive watch periods.

Figure *4*. Soaring and Terrestrial birds: updated average for *Individual* counts.

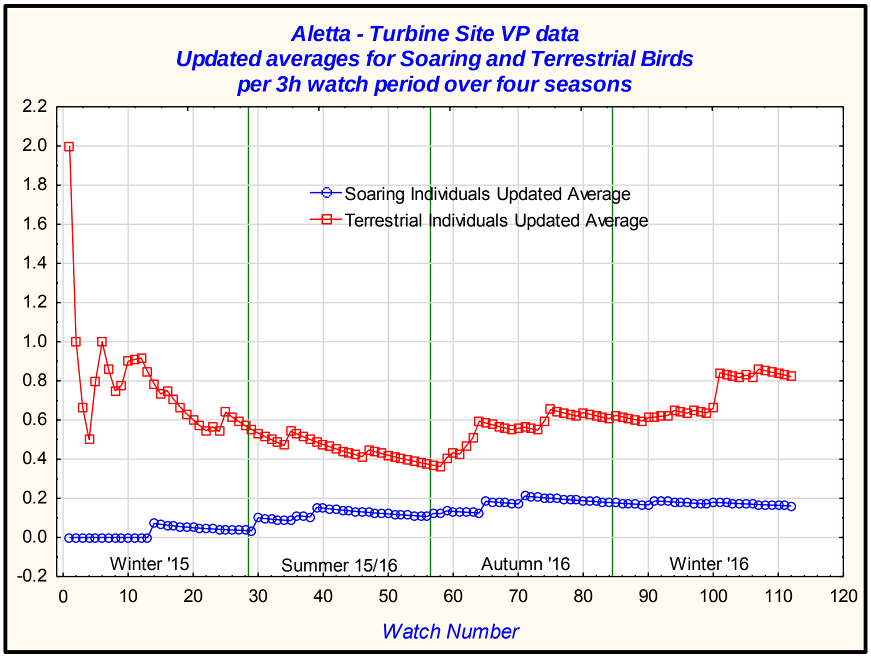


Figure 4 shows that the average counts stabilise well towards the end of the second season. The Autumn and Winter 2016 seasons have shown an increase in the number of counts as can also be seen from Figure 1 as well as from the averages given in Tables 2 – 5. The jump at the end for terrestrial individuals is due to the single outlying count mentioned in the last paragraph of section 4.

The information depicted in Figures *2 - 4* shows that it is not expected that further sampling will succeed in changing the estimated average number of flight or individual counts in a substantial way.

6. Sample size

Due to the importance of a sufficiently large sample and the fact that the graphs in Figures *2 – 4* present mainly an intuitive feeling about sample size, another (more quantitative way) to consider if the sample size is sufficient for the intended purpose (to estimate the average number of birds with acceptable precision) is now presented.

The standard deviations in Tables *2 – 5* are measures of the variability that exists in the counts observed. To achieve a computation for sample size we consider the variabilities for terrestrial individuals only. They are the majority group seen during the four seasons of the survey (*92* individuals compared to only *18* soaring individuals). A sample size sufficient for estimating the mean of the majority group will be the main interest.

The technical question is: how many watch periods (*n*) must be sampled in order to obtain an estimate with *precision* of "*d"* units (counts) that will contain the true mean value with prescribed probability, e.g. 95%. This is to say that the true mean count per watch period (or per 3h observation time as in this case) lies in an interval of $\bar{x} \pm d$ with certainty of 1 – (= *95*% for example). Here $\bar{x}$ is the sample estimate of the true mean value and *d* its desired precision. The interval ($\bar{x}-d$, $\bar{x}+d$) is known as (for example) the *95*% confidence interval for the true mean value (see Zar, *2010*, p. *105*). A practical approximation to an appropriate sample size may be derived by specifying a desirable precision, *d*, for the confidence interval. For a specified value of *d* the sample size may thus be shown to be obtainable from the formula:

(*1*)

$$n=(s*t_{\alpha/2}(n-1)/d)^{2},$$

where $t_{\alpha/2}(n-1)$ is the upper /2 = 2.5% point (for a 95% confidence interval) of Student's *t* distribution with *n – 1* degrees of freedom (*n* the sample size) and *s* an estimate of the true standard deviation of the counts (see Zar, *2010*, page *115*).

In the present case this computation is not required: it can be seen from Table 5 (which is the worst case scenario) for soaring individual terrestrial birds over all seasons that the precision achieved by sample of size *n = 112* is *d* = ½(*1.22 - 0.42*) = *0.40*. This means that a precision of better than ½ a bird is achieved with 95% certainty. This may be considered adequate precision.

In the second paragraph of Section 4 it was mentioned that the computation of the confidence interval and equivalently the use of formula (*1*), is dependent on certain assumptions (e.g. normality of the counts distribution). These assumptions are not met for the counts encountered in this survey. However, it should provide a reasonable indication of the estimated precisions and the validity of the statements made about sample sizes.

7. 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 both the soaring and terrestrial priority species of birds that occur in the area and that more data will not necessarily succeed in improving the estimates in a substantial way.

8. References

Dell, Inc., (2015), Dell STATISTICA (data analysis software system), Version 12. www.Software.dell.com.
Zar, J.H., (2010), *Biostatistical Analysis* (5th ed.), Prentice-Hall, Inc., Upper Saddle River: NJ 07458.

APPENDIX

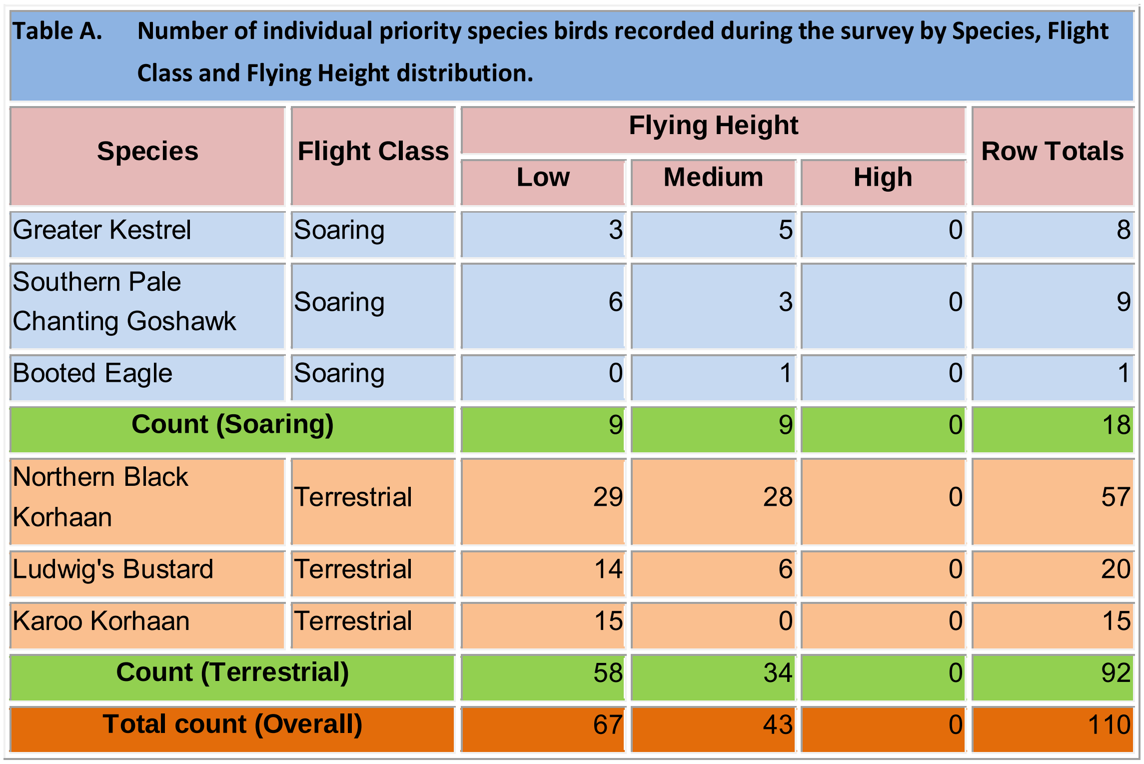


Table A. **Number of individual priority species birds recorded during the survey by Species, Flight Class and Flying Height distribution.**

Species	Flight Class	Flying Height			Row Totals
		Low	Medium	High	
Greater Kestrel	Soaring	3	5	0	8
Southern Pale Chanting Goshawk	Soaring	6	3	0	9
Booted Eagle	Soaring	0	1	0	1
Count (Soaring)		9	9	0	18
Northern Black Korhaan	Terrestrial	29	28	0	57
Ludwig's Bustard	Terrestrial	14	6	0	20
Karoo Korhaan	Terrestrial	15	0	0	15
Count (Terrestrial)		58	34	0	92
Total count (Overall)		67	43	0	110

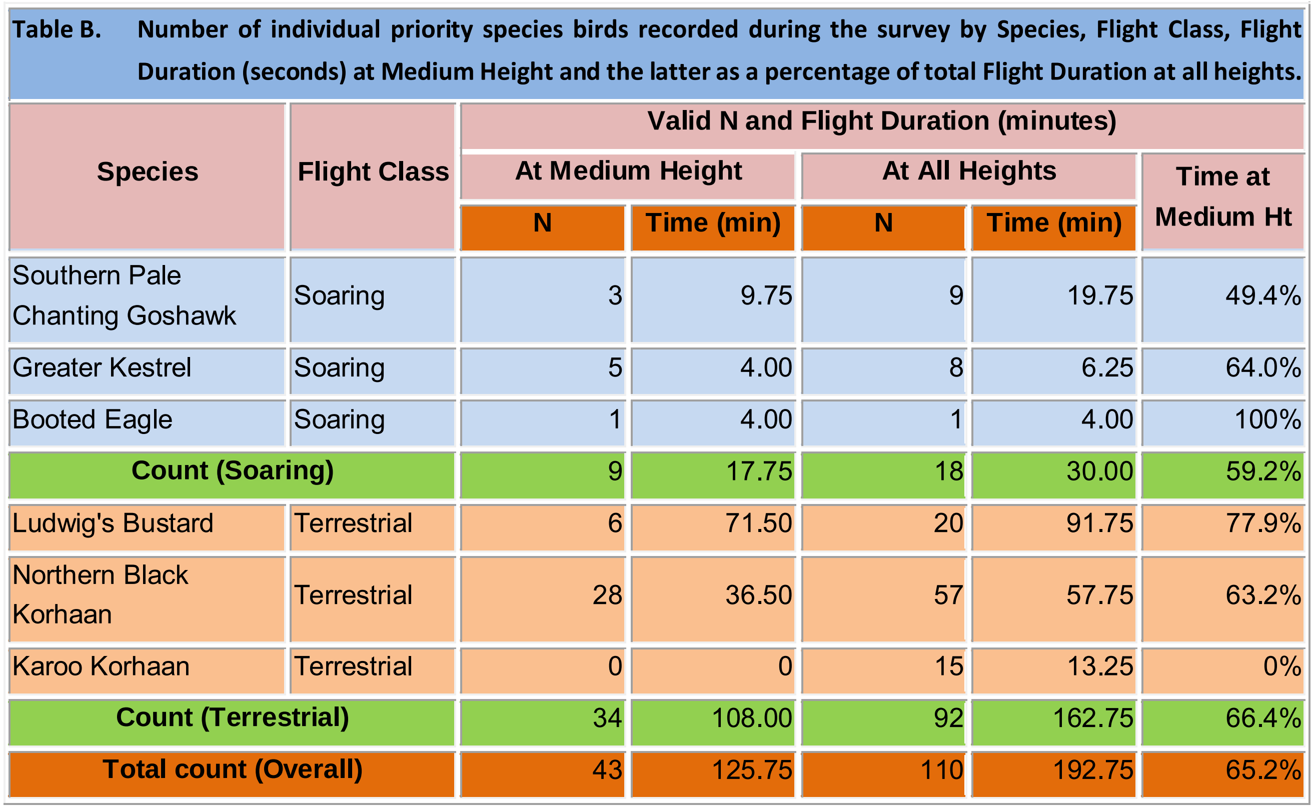


Table B. Number of individual priority species birds recorded during the survey by Species, Flight Class, Flight Duration (seconds) at Medium Height and the latter as a percentage of total Flight Duration at all heights.

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)	
Southern Pale Chanting Goshawk	Soaring	3	9.75	9	19.75	49.4%
Greater Kestrel	Soaring	5	4.00	8	6.25	64.0%
Booted Eagle	Soaring	1	4.00	1	4.00	100%
Count (Soaring)		9	17.75	18	30.00	59.2%
Ludwig's Bustard	Terrestrial	6	71.50	20	91.75	77.9%
Northern Black Korhaan	Terrestrial	28	36.50	57	57.75	63.2%
Karoo Korhaan	Terrestrial	0	0	15	13.25	0%
Count (Terrestrial)		34	108.00	92	162.75	66.4%
Total count (Overall)		43	125.75	110	192.75	65.2%

Table C: **Number of individual priority species birds recorded by Species, Flight Class and Season.**

Species	**Flight Class**	**Season**				**Row Totals**
		Winter15	**Summer 15/16**	**Autumn16**	**Winter16**	
Southern Pale Chanting Goshawk	Soaring	1	4	1	3	9
Booted Eagle	Soaring	0	1	0	0	1
Greater Kestrel	Soaring	0	0	8	0	8
Count (Soaring)		1	5	9	3	18
Karoo Korhaan	Terrestrial	4	4	7	0	15
Northern Black Korhaan	Terrestrial	12	1	19	25	57
Ludwig's Bustard	Terrestrial	0	0	4	16	20
Count (Terrestrial)		16	5	30	41	92
Total count (Overall)		17	10	39	44	110

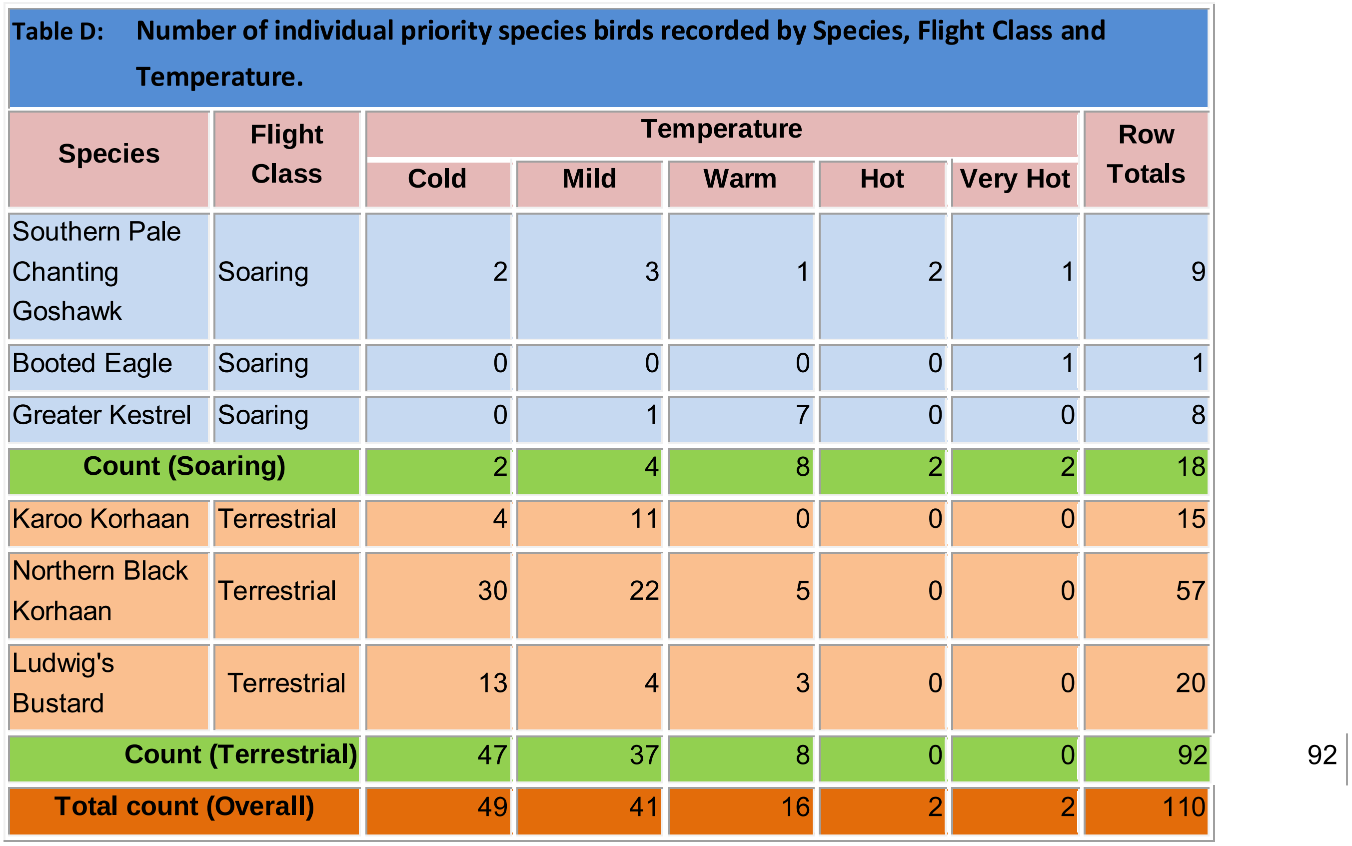


Table D: Number of individual priority species birds recorded by Species, Flight Class and Temperature.

Species	**Flight Class**	**Temperature**					**Row Totals**
		Cold	**Mild**	**Warm**	**Hot**	**Very Hot**	
Southern Pale Chanting Goshawk	Soaring	2	3	1	2	1	9
Booted Eagle	Soaring	0	0	0	0	1	1
Greater Kestrel	Soaring	0	1	7	0	0	8
Count (Soaring)		2	4	8	2	2	18
Karoo Korhaan	Terrestrial	4	11	0	0	0	15
Northern Black Korhaan	Terrestrial	30	22	5	0	0	57
Ludwig's Bustard	Terrestrial	13	4	3	0	0	20
Count (Terrestrial)		47	37	8	0	0	92
Total count (Overall)		49	41	16	2	2	110

92

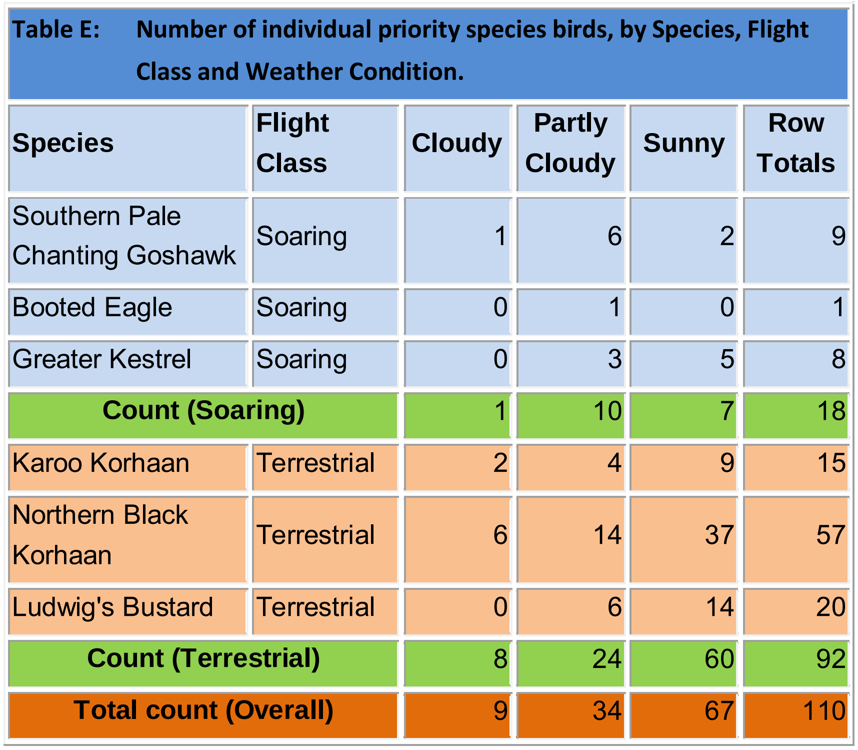


Table E: Number of individual priority species birds, by Species, Flight Class and Weather Condition.

Species	Flight Class	Cloudy	Partly Cloudy	Sunny	Row Totals
Southern Pale Chanting Goshawk	Soaring	1	6	2	9
Booted Eagle	Soaring	0	1	0	1
Greater Kestrel	Soaring	0	3	5	8
Count (Soaring)		1	10	7	18
Karoo Korhaan	Terrestrial	2	4	9	15
Northern Black Korhaan	Terrestrial	6	14	37	57
Ludwig's Bustard	Terrestrial	0	6	14	20
Count (Terrestrial)		8	24	60	92
Total count (Overall)		9	34	67	110

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

Species	Flight Class	Wind Direction								Row Totals
		N	NE	E	SE	S	SW	W	NW	
Southern Pale Chanting Goshawk	Soaring	0	1	0	0	0	0	1	7	9
Booted Eagle	Soaring	0	0	0	0	0	0	0	1	1
Greater Kestrel	Soaring	0	0	0	0	0	0	0	8	8
Count (Soaring)		0	1	0	0	0	0	1	16	18
Karoo Korhaan	Terrestrial	0	0	0	6	0	0	0	9	15
Northern Black Korhaan	Terrestrial	0	7	0	7	0	0	24	19	57
Ludwig's Bustard	Terrestrial	1	0	0	2	0	0	11	6	20
Count (Terrestrial)		1	7	0	15	0	0	35	34	92
Total count (Overall)		1	8	0	15	0	0	36	50	110

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
Southern Pale Chanting Goshawk	Soaring	1	3	0	3	0	2	9
Booted Eagle	Soaring	0	0	0	1	0	0	1
Greater Kestrel	Soaring	1	4	0	0	0	3	8
Count (Soaring)		2	7	0	4	0	5	18
Karoo Korhaan	Terrestrial	5	4	2	4	0	0	15
Northern Black Korhaan	Terrestrial	11	23	10	7	0	6	57
Ludwig's Bustard	Terrestrial	1	12	0	1	3	3	20
Count (Terrestrial)		17	39	12	12	3	9	92
Total count (Overall)		19	46	12	16	3	14	110

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	2015-08-24	Winter15	VP3	0.0	0.00	0.0	0.00
2	2015-08-24	Winter15	VP7	0.0	0.00	0.0	0.00
3	2015-08-24	Winter15	VP4	0.0	0.00	0.0	0.00
4	2015-08-24	Winter15	VP6	0.0	0.00	0.0	0.00
5	2015-08-24	Winter15	VP2	0.0	0.00	0.0	0.00
6	2015-08-24	Winter15	VP5	0.0	0.00	0.0	0.00
7	2015-08-25	Winter15	VP5	0.0	0.00	0.0	0.00
8	2015-08-25	Winter15	VP2	0.0	0.00	0.0	0.00
9	2015-08-25	Winter15	VP1	0.0	0.00	0.0	0.00
10	2015-08-26	Winter15	VP4	0.0	0.00	0.0	0.00
11	2015-08-26	Winter15	VP6	0.0	0.00	0.0	0.00
12	2015-08-26	Winter15	VP5	0.0	0.00	0.0	0.00
13	2015-08-26	Winter15	VP2	0.0	0.00	0.0	0.00
14	2015-08-26	Winter15	VP1	1.0	0.07	1.0	0.07
15	2015-08-27	Winter15	VP1	0.0	0.07	0.0	0.07
16	2015-08-27	Winter15	VP4	0.0	0.06	0.0	0.06
17	2015-08-27	Winter15	VP6	0.0	0.06	0.0	0.06
18	2015-08-28	Winter15	VP1	0.0	0.06	0.0	0.06
19	2015-08-28	Winter15	VP4	0.0	0.05	0.0	0.05
20	2015-08-28	Winter15	VP6	0.0	0.05	0.0	0.05
21	2015-08-29	Winter15	VP2	0.0	0.05	0.0	0.05
22	2015-08-29	Winter15	VP5	0.0	0.05	0.0	0.05
23	2015-08-29	Winter15	VP3	0.0	0.04	0.0	0.04
24	2015-08-29	Winter15	VP7	0.0	0.04	0.0	0.04
25	2015-08-30	Winter15	VP7	0.0	0.04	0.0	0.04
26	2015-08-30	Winter15	VP3	0.0	0.04	0.0	0.04

27	2015-08-31	Winter15	VP3	0.0	0.04	0.0	0.04
28	2015-08-31	Winter15	VP7	0.0	0.04	0.0	0.04
29	2016-01-04	Summer15/16	VP7	0.0	0.00	0.0	0.00
30	2016-01-04	Summer15/16	VP1	2.0	1.00	2.0	1.00
31	2016-01-05	Summer15/16	VP2	0.0	0.67	0.0	0.67
32	2016-01-05	Summer15/16	VP5	0.0	0.50	0.0	0.50
33	2016-01-05	Summer15/16	VP3	0.0	0.40	0.0	0.40
34	2016-01-05	Summer15/16	VP7	0.0	0.33	0.0	0.33
35	2016-01-06	Summer15/16	VP3	0.0	0.29	0.0	0.29
36	2016-01-06	Summer15/16	VP7	1.0	0.38	1.0	0.38
37	2016-01-06	Summer15/16	VP6	0.0	0.33	0.0	0.33
38	2016-01-06	Summer15/16	VP4	0.0	0.30	0.0	0.30
39	2016-01-06	Summer15/16	VP2	1.0	0.36	2.0	0.45
40	2016-01-06	Summer15/16	VP5	0.0	0.33	0.0	0.42
41	2016-01-07	Summer15/16	VP2	0.0	0.31	0.0	0.38
42	2016-01-07	Summer15/16	VP5	0.0	0.29	0.0	0.36
43	2016-01-07	Summer15/16	VP1	0.0	0.27	0.0	0.33
44	2016-01-07	Summer15/16	VP3	0.0	0.25	0.0	0.31
45	2016-01-07	Summer15/16	VP4	0.0	0.24	0.0	0.29
46	2016-01-07	Summer15/16	VP6	0.0	0.22	0.0	0.28
47	2016-01-08	Summer15/16	VP4	0.0	0.21	0.0	0.26
48	2016-01-08	Summer15/16	VP6	0.0	0.20	0.0	0.25
49	2016-01-08	Summer15/16	VP2	0.0	0.19	0.0	0.24
50	2016-01-08	Summer15/16	VP5	0.0	0.18	0.0	0.23
51	2016-01-09	Summer15/16	VP1	0.0	0.17	0.0	0.22
52	2016-01-09	Summer15/16	VP4	0.0	0.17	0.0	0.21
53	2016-01-09	Summer15/16	VP6	0.0	0.16	0.0	0.20
54	2016-01-10	Summer15/16	VP1	0.0	0.15	0.0	0.19
55	2016-01-10	Summer15/16	VP3	0.0	0.15	0.0	0.19
56	2016-01-10	Summer15/16	VP7	0.0	0.14	0.0	0.18
57	2016-03-19	Autumn16	VP1	1.0	1.00	1.0	1.00

58	2016-03-19	Autumn16	VP3	0.0	0.50	0.0	0.50
59	2016-03-20	Autumn16	VP4	1.0	0.67	1.0	0.67
60	2016-03-20	Autumn16	VP6	0.0	0.50	0.0	0.50
61	2016-03-20	Autumn16	VP3	0.0	0.40	0.0	0.40
62	2016-03-20	Autumn16	VP7	0.0	0.33	0.0	0.33
63	2016-03-21	Autumn16	VP2	0.0	0.29	0.0	0.29
64	2016-03-21	Autumn16	VP5	0.0	0.25	0.0	0.25
65	2016-03-21	Autumn16	VP4	3.0	0.56	4.0	0.67
66	2016-03-21	Autumn16	VP6	0.0	0.50	0.0	0.60
67	2016-03-22	Autumn16	VP1	0.0	0.45	0.0	0.55
68	2016-03-22	Autumn16	VP3	0.0	0.42	0.0	0.50
69	2016-03-22	Autumn16	VP7	0.0	0.38	0.0	0.46
70	2016-03-22	Autumn16	VP2	0.0	0.36	0.0	0.43
71	2016-03-22	Autumn16	VP4	3.0	0.53	3.0	0.60
72	2016-03-22	Autumn16	VP5	0.0	0.50	0.0	0.56
73	2016-03-22	Autumn16	VP6	0.0	0.47	0.0	0.53
74	2016-03-23	Autumn16	VP3	0.0	0.44	0.0	0.50
75	2016-03-23	Autumn16	VP7	0.0	0.42	0.0	0.47
76	2016-03-23	Autumn16	VP4	0.0	0.40	0.0	0.45
77	2016-03-23	Autumn16	VP6	0.0	0.38	0.0	0.43
78	2016-03-23	Autumn16	VP2	0.0	0.36	0.0	0.41
79	2016-03-23	Autumn16	VP5	0.0	0.35	0.0	0.39
80	2016-03-23	Autumn16	VP1	0.0	0.33	0.0	0.38
81	2016-03-24	Autumn16	VP1	0.0	0.32	0.0	0.36
82	2016-03-24	Autumn16	VP5	0.0	0.31	0.0	0.35
83	2016-03-24	Autumn16	VP2	0.0	0.30	0.0	0.33
84	2016-03-24	Autumn16	VP7	0.0	0.29	0.0	0.32
85	2016-06-29	Winter16	VP5	0.0	0.00	0.0	0.00
86	2016-06-29	Winter16	VP2	0.0	0.00	0.0	0.00
87	2016-06-29	Winter16	VP3	0.0	0.00	0.0	0.00
88	2016-06-29	Winter16	VP7	0.0	0.00	0.0	0.00
89	2016-06-30	Winter16	VP6	0.0	0.00	0.0	0.00

90	2016-06-30	Winter16	VP4	0.0	0.00	0.0	0.00
91	2016-06-30	Winter16	VP2	1.0	0.14	2.0	0.29
92	2016-06-30	Winter16	VP5	0.0	0.13	0.0	0.25
93	2016-07-01	Winter16	VP3	0.0	0.11	0.0	0.22
94	2016-07-01	Winter16	VP7	0.0	0.10	0.0	0.20
95	2016-07-01	Winter16	VP1	0.0	0.09	0.0	0.18
96	2016-07-02	Winter16	VP2	0.0	0.08	0.0	0.17
97	2016-07-02	Winter16	VP5	0.0	0.08	0.0	0.15
98	2016-07-02	Winter16	VP1	0.0	0.07	0.0	0.14
99	2016-07-02	Winter16	VP4	0.0	0.07	0.0	0.13
100	2016-07-03	Winter16	VP3	1.0	0.13	1.0	0.19
101	2016-07-03	Winter16	VP7	0.0	0.12	0.0	0.18
102	2016-07-03	Winter16	VP1	0.0	0.11	0.0	0.17
103	2016-07-03	Winter16	VP6	0.0	0.11	0.0	0.16
104	2016-07-04	Winter16	VP4	0.0	0.10	0.0	0.15
105	2016-07-04	Winter16	VP6	0.0	0.10	0.0	0.14
106	2016-07-04	Winter16	VP2	0.0	0.09	0.0	0.14
107	2016-07-04	Winter16	VP7	0.0	0.09	0.0	0.13
108	2016-07-04	Winter16	VP3	0.0	0.08	0.0	0.13
109	2016-07-05	Winter16	VP1	0.0	0.08	0.0	0.12
110	2016-07-05	Winter16	VP5	0.0	0.08	0.0	0.12
111	2016-07-05	Winter16	VP4	0.0	0.07	0.0	0.11
112	2016-07-05	Winter16	VP6	0.0	0.07	0.0	0.11

***** The updated averages are computed over the number of watch periods.

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	2015-08-24	Winter15	VP3	1.0	1.00	2.0	2.00
2	2015-08-24	Winter15	VP7	0.0	0.50	0.0	1.00
3	2015-08-24	Winter15	VP4	0.0	0.33	0.0	0.67
4	2015-08-24	Winter15	VP6	0.0	0.25	0.0	0.50
5	2015-08-24	Winter15	VP2	2.0	0.60	2.0	0.80
6	2015-08-24	Winter15	VP5	1.0	0.67	2.0	1.00
7	2015-08-25	Winter15	VP5	0.0	0.57	0.0	0.86
8	2015-08-25	Winter15	VP2	0.0	0.50	0.0	0.75
9	2015-08-25	Winter15	VP1	1.0	0.56	1.0	0.78
10	2015-08-26	Winter15	VP4	1.0	0.60	2.0	0.90
11	2015-08-26	Winter15	VP6	1.0	0.64	1.0	0.91
12	2015-08-26	Winter15	VP5	1.0	0.67	1.0	0.92
13	2015-08-26	Winter15	VP2	0.0	0.62	0.0	0.85
14	2015-08-26	Winter15	VP1	0.0	0.57	0.0	0.79
15	2015-08-27	Winter15	VP1	0.0	0.53	0.0	0.73
16	2015-08-27	Winter15	VP4	1.0	0.56	1.0	0.75
17	2015-08-27	Winter15	VP6	0.0	0.53	0.0	0.71
18	2015-08-28	Winter15	VP1	0.0	0.50	0.0	0.67
19	2015-08-28	Winter15	VP4	0.0	0.47	0.0	0.63
20	2015-08-28	Winter15	VP6	0.0	0.45	0.0	0.60
21	2015-08-29	Winter15	VP2	0.0	0.43	0.0	0.57
22	2015-08-29	Winter15	VP5	0.0	0.41	0.0	0.55
23	2015-08-29	Winter15	VP3	1.0	0.43	1.0	0.57
24	2015-08-29	Winter15	VP7	0.0	0.42	0.0	0.54
25	2015-08-30	Winter15	VP7	2.0	0.48	3.0	0.64
26	2015-08-30	Winter15	VP3	0.0	0.46	0.0	0.62
27	2015-08-31	Winter15	VP3	0.0	0.44	0.0	0.59

28	2015-08-31	Winter15	VP7	0.0	0.43	0.0	0.57
29	2016-01-04	Summer15/16	VP7	0.0	0.00	0.0	0.00
30	2016-01-04	Summer15/16	VP1	0.0	0.00	0.0	0.00
31	2016-01-05	Summer15/16	VP2	0.0	0.00	0.0	0.00
32	2016-01-05	Summer15/16	VP5	0.0	0.00	0.0	0.00
33	2016-01-05	Summer15/16	VP3	0.0	0.00	0.0	0.00
34	2016-01-05	Summer15/16	VP7	0.0	0.00	0.0	0.00
35	2016-01-06	Summer15/16	VP3	2.0	0.29	3.0	0.43
36	2016-01-06	Summer15/16	VP7	0.0	0.25	0.0	0.38
37	2016-01-06	Summer15/16	VP6	0.0	0.22	0.0	0.33
38	2016-01-06	Summer15/16	VP4	0.0	0.20	0.0	0.30
39	2016-01-06	Summer15/16	VP2	0.0	0.18	0.0	0.27
40	2016-01-06	Summer15/16	VP5	0.0	0.17	0.0	0.25
41	2016-01-07	Summer15/16	VP2	0.0	0.15	0.0	0.23
42	2016-01-07	Summer15/16	VP5	0.0	0.14	0.0	0.21
43	2016-01-07	Summer15/16	VP1	0.0	0.13	0.0	0.20
44	2016-01-07	Summer15/16	VP3	0.0	0.13	0.0	0.19
45	2016-01-07	Summer15/16	VP4	0.0	0.12	0.0	0.18
46	2016-01-07	Summer15/16	VP6	0.0	0.11	0.0	0.17
47	2016-01-08	Summer15/16	VP4	1.0	0.16	2.0	0.26
48	2016-01-08	Summer15/16	VP6	0.0	0.15	0.0	0.25
49	2016-01-08	Summer15/16	VP2	0.0	0.14	0.0	0.24
50	2016-01-08	Summer15/16	VP5	0.0	0.14	0.0	0.23
51	2016-01-09	Summer15/16	VP1	0.0	0.13	0.0	0.22
52	2016-01-09	Summer15/16	VP4	0.0	0.13	0.0	0.21
53	2016-01-09	Summer15/16	VP6	0.0	0.12	0.0	0.20
54	2016-01-10	Summer15/16	VP1	0.0	0.12	0.0	0.19
55	2016-01-10	Summer15/16	VP3	0.0	0.11	0.0	0.19
56	2016-01-10	Summer15/16	VP7	0.0	0.11	0.0	0.18
57	2016-03-19	Autumn16	VP1	0.0	0.00	0.0	0.00
58	2016-03-19	Autumn16	VP3	0.0	0.00	0.0	0.00

59	2016-03-20	Autumn16	VP4	3.0	1.00	3.0	1.00
60	2016-03-20	Autumn16	VP6	2.0	1.25	2.0	1.25
61	2016-03-20	Autumn16	VP3	0.0	1.00	0.0	1.00
62	2016-03-20	Autumn16	VP7	3.0	1.33	3.0	1.33
63	2016-03-21	Autumn16	VP2	2.0	1.43	3.0	1.57
64	2016-03-21	Autumn16	VP5	3.0	1.63	6.0	2.13
65	2016-03-21	Autumn16	VP4	0.0	1.44	0.0	1.89
66	2016-03-21	Autumn16	VP6	0.0	1.30	0.0	1.70
67	2016-03-22	Autumn16	VP1	0.0	1.18	0.0	1.55
68	2016-03-22	Autumn16	VP3	0.0	1.08	0.0	1.42
69	2016-03-22	Autumn16	VP7	0.0	1.00	0.0	1.31
70	2016-03-22	Autumn16	VP2	1.0	1.00	1.0	1.29
71	2016-03-22	Autumn16	VP4	1.0	1.00	1.0	1.27
72	2016-03-22	Autumn16	VP5	0.0	0.94	0.0	1.19
73	2016-03-22	Autumn16	VP6	0.0	0.88	0.0	1.12
74	2016-03-23	Autumn16	VP3	2.0	0.94	4.0	1.28
75	2016-03-23	Autumn16	VP7	5.0	1.16	5.0	1.47
76	2016-03-23	Autumn16	VP4	0.0	1.10	0.0	1.40
77	2016-03-23	Autumn16	VP6	0.0	1.05	0.0	1.33
78	2016-03-23	Autumn16	VP2	0.0	1.00	0.0	1.27
79	2016-03-23	Autumn16	VP5	0.0	0.96	0.0	1.22
80	2016-03-23	Autumn16	VP1	1.0	0.96	2.0	1.25
81	2016-03-24	Autumn16	VP1	0.0	0.92	0.0	1.20
82	2016-03-24	Autumn16	VP5	0.0	0.88	0.0	1.15
83	2016-03-24	Autumn16	VP2	0.0	0.85	0.0	1.11
84	2016-03-24	Autumn16	VP7	0.0	0.82	0.0	1.07
85	2016-06-29	Winter16	VP5	2.0	2.00	2.0	2.00
86	2016-06-29	Winter16	VP2	0.0	1.00	0.0	1.00
87	2016-06-29	Winter16	VP3	0.0	0.67	0.0	0.67
88	2016-06-29	Winter16	VP7	0.0	0.50	0.0	0.50
89	2016-06-30	Winter16	VP6	0.0	0.40	0.0	0.40
90	2016-06-30	Winter16	VP4	2.0	0.67	2.0	0.67

91	2016-06-30	Winter16	VP2	1.0	0.71	1.0	0.71
92	2016-06-30	Winter16	VP5	1.0	0.75	1.0	0.75
93	2016-07-01	Winter16	VP3	1.0	0.78	1.0	0.78
94	2016-07-01	Winter16	VP7	2.0	0.90	3.0	1.00
95	2016-07-01	Winter16	VP1	0.0	0.82	0.0	0.91
96	2016-07-02	Winter16	VP2	0.0	0.75	0.0	0.83
97	2016-07-02	Winter16	VP5	2.0	0.85	2.0	0.92
98	2016-07-02	Winter16	VP1	0.0	0.79	0.0	0.86
99	2016-07-02	Winter16	VP4	0.0	0.73	0.0	0.80
100	2016-07-03	Winter16	VP3	3.0	0.88	3.0	0.94
101	2016-07-03	Winter16	VP7	6.0	1.18	19.0	2.00
102	2016-07-03	Winter16	VP1	0.0	1.11	0.0	1.89
103	2016-07-03	Winter16	VP6	0.0	1.05	0.0	1.79
104	2016-07-04	Winter16	VP4	0.0	1.00	0.0	1.70
105	2016-07-04	Winter16	VP6	1.0	1.00	2.0	1.71
106	2016-07-04	Winter16	VP2	0.0	0.95	0.0	1.64
107	2016-07-04	Winter16	VP7	4.0	1.09	5.0	1.78
108	2016-07-04	Winter16	VP3	0.0	1.04	0.0	1.71
109	2016-07-05	Winter16	VP1	0.0	1.00	0.0	1.64
110	2016-07-05	Winter16	VP5	0.0	0.96	0.0	1.58
111	2016-07-05	Winter16	VP4	0.0	0.93	0.0	1.52
112	2016-07-05	Winter16	VP6	0.0	0.89	0.0	1.46

* The updated averages are computed over the number of watch periods.

COPPERTON / ALETTA SURVEY
STATISTICAL ANALYSIS: CONTROL SITE

Introduction

This report is based on data captured in the MS Excel file "*Aletta_Ctrl_VP_4Surveys_20160712_V1.xls*". This file contains records for each individual flight of priority species birds that were recorded at a vantage point set up at the *Aletta* control site. Observations were recorded in "watch periods" 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 bird was 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 *16* watch periods of three hours each spread equally over the four seasons as set out in Table *1*. Environmental and other relevant information were also recorded (e.g. Temperature, Wind Direction, Wind Speed and categories of height at which the birds flew).

Table *1*. The survey dates.

Start Date	End Date	Season	Number of Days	Hours observed
2015-08-25	2015-08-28	Winter 2015	*4*	*12*
2016-01-05	2016-01-11	Summer 2015/16	*4*	*12*
2016-03-19	2016-03-24	Autumn 2016	*4*	*12*
2016-07-01	2016-07-05	Winter 2016	*4*	*12*

Due to the small number of birds recorded (only *4* individual birds and no flights were recorded in this survey), only some very basic statistical results are reported.

Descriptive statistics

The data show that only one priority species soaring bird was observed viz. a Southern Pale Chanting Goshawk (*Melierax canorus*). Only three priority species terrestrial birds were observed viz. Karoo Korhaan (*Eupodotis vigorsii*), Kori Bustard (*Ardeotis kori*) and Ludwig's Bustard (*Neotis ludwigii*).

The scarcity of data makes statistical conclusions risky and thus no basic statistics are presented separately by season over the four seasons that the survey was conducted. Tables A – G in the Appendix list some data to provide an impression of the environmental and other conditions at the time of the four seasonal surveys.

Sample Size

The main issue of interest is to determine if the number of birds that is truly present in the control area is estimated with acceptable precision from the data obtained. In particular that the estimates obtained from the observed data are representative of the true situation and NOT based on too small a sample size. Table 2 shows how the counts materialised.

The question of sample size can only be answered statistically if some reasonable assumption can be made about the (statistical) distribution of the counts observed. The actual counts found during the four seasons of surveying are given in Table 2.

Table 2. The number of priority species (soaring and terrestrial birds) seen in each of the 16 consecutive 3h watch periods.

Watch No. →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Soaring	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Terrestrial	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0

The sufficiency of sample size is dependent on several factors of which the underlying distribution of the observed data (in this case the counts) is critical. Also, the variability in the data plays a vital role. The more variable the data the larger the sample size has to be to achieve a stated precision.

The counts listed in Table 2 are clearly not normally distributed (an assumption required in many applications of sample size determination). In this survey the sampling unit (SU) is a 3h watch period of which *16* were sampled over the four seasons. From Table 2 it is clear that the observation of a bird or birds in an SU is a *rare event*. This makes the assumption of an underlying Poisson distribution for the counts per SU a reasonably likely possibility. The Poisson is a discrete distribution that reflects the probability of achieving a given *count* per SU. A Poisson random variable (the count) can take on only integer values 0, 1, 2, …. . There are some further assumptions that have to be met for the Poisson distribution to be valid (see Kalbfleisch, 1985, pp. 128 - 133) but for practical purposes it may be assumed that bird counts over a 3h SU have a Poisson distribution. This distribution has been referred to as *the law of rare events.*

An interesting mathematical property of the Poisson distribution is that its variance is identical to its mean. The estimated averages and standard deviations for the *16* counts in Table *2* are given in Table *3* where it is seen that the estimated averages and variances conform well. This is somewhat comforting concerning the Poisson assumption for this data set.

Table 3. Mean values and variability (per 3h watch period) of counts in Table 2. The 95% lower (LCL) and upper (UCL) confidence limits are computed by assuming a Poisson distribution for the counts per SU.

Statistic →	Count	Mean	Variance	95% LCL	95% UCL	Precision
Soaring	1	0.0625	0.0625	0.00	0.35	0.18
Terrestrial	3	0.1875	0.1625	0.04	0.55	0.26

Confidence limits

If the Poisson distribution is assumed (with the true average number of birds per SU taken to be λ) and if N SUs were sampled (for example 3h watch periods are sampled $N = 16$ times), the sum of the 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 confidence interval for a parameter (such as λ) at a selected confidence level (say 95%) implies that if it were possible to repeat the sampling an infinite number of times and a 95% confidence interval for the parameter is computed for each such sample, then 95% of those intervals will contain the true mean value.

A ($1 - \beta$) confidence interval for the Poisson mean value (in this case λN) 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. That is the χ^2 - value with cumulative probability 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 $P(L_1 \le \lambda N \le L_2) = 1 - \beta$. Thus a $1 - \beta$ confidence interval for λ (which is 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 Table *2.*

Sample Size

Consider the question of how many 3h watch periods of 3h (i.e. sampling units, N) must be sampled in order to obtain an estimate of the expected 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 $(L_1 / N; \quad L_2 / N)$ and thus $d = \frac{1}{2}(L_2 - L_1) / N$. The expected average is estimated from the observed total count, X, and is given by $\hat{\lambda} = X / N$. This estimate is known NOT to be 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 yield representative estimates is one that will provide an acceptable value for the precision of the expected average count per SU, e.g. $d \le d_0$.

This means that N should be determined such that $d = \frac{1}{2}(L_2 - L_1) / N \le d_0$ or

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

Unfortunately, even though it appears as if the last equation provides an explicit solution for N, both L_1 and L_2 depend on X, the count, which in turn depends on N, the number of SUs used in the survey. Thus N is embedded in the right side of that equation and an explicit solution is not possible.

Conclusion

It could be asked, for the case at hand (where $N = 16$ and X is known), if the precision is acceptable. Table 3 shows the *95%* precision for soaring birds to be *0.18* and for terrestrial birds to be *0.26* per SU . Roughly (due to non-symmetry, but as an approximation) it is concluded that the true mean for soaring birds is *0.06 ± 0.18* and for terrestrials *0.19 ± 0.26* per *3*h watch period. This appears to be reasonably precise and therefore it is concluded that *16* sample units of 3h each provides adequate precision for the purpose of this study.

References

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APPENDIX

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

Species	Flight Class	Flying Height			Row Totals
		Low	Medium	High	
Southern Pale Chanting Goshawk	Soaring	1			1
Count (Soaring)		1			1
Karoo Korhaan	Terrestrial	1			1
Kori Bustard	Terrestrial		1		1
Ludwig's Bustard	Terrestrial		1		1
Count (Terrestrial)		1			3
Total count (Overall)		2	2		4

Table B. Number of individual priority species birds recorded during the survey by Species, Flight Class, Flight Duration (minutes) at Medium Height and the latter as a percentage of total Flight Duration 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)	
Southern Pale Chanting Goshawk	Soaring	0	0	1	2.5	0%
Count (Soaring)		0	0	1	2.5	0%
Karoo Korhaan	Terrestrial	0	0	1	0.75	0%
Kori Bustard	Terrestrial	1	4.0	1	4.0	100%
Ludwig's Bustard	Terrestrial	1	4.0	1	4.0	100%
Count (Terrestrial)		2	8.0	3	8.75	91.4%
Total count (Overall)		2	8.0	4	11.25	71.1%

Table C: Number of individual priority species birds recorded by Species, Flight Class and Season.

Species	Flight Class	Season				Row Totals
		Winter15	Summer 15/16	Autumn16	Winter16	
Southern Pale Chanting Goshawk	Soaring		1			1
Count (Soaring)			1			1
Karoo Korhaan	Terrestrial		1			1
Kori Bustard	Terrestrial			1		1
Ludwig’s Bustard	Terrestrial			1		1
Count (Terrestrial)			1	2		3
Total count (Overall)			2	2		4

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

Species	Flight Class	Temperature				Row Totals
		Cold	Mild	Warm	Hot	
Southern Pale Chanting Goshawk	Soaring		1			1
Count (Soaring)			1			1
Karoo Korhaan	Terrestrial		1			1
Kori Bustard	Terrestrial	1				1
Ludwig’s Bustard	Terrestrial			1		1
Count (Terrestrial)		1	1	1		3
Total count (Overall)		1	2	1		4

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

Species	Flight Class	Weather condition			
		Cloudy	Partly Cloudy	Sunny	Row Totals
Southern Pale Chanting Goshawk	Soaring			1	1
Count (Soaring)				1	1
Karoo Korhaan	Terrestrial			1	1
Kori Bustard	Terrestrial			1	1
Ludwig's Bustard	Terrestrial			1	1
Count (Terrestrial)				3	3
Total count (Overall)				4	4

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

Species	Flight Class	Wind Direction								Row Totals
		N	NE	E	SE	S	SW	W	NW	
Southern Pale Chanting Goshawk	Soaring			1						1
Count (Soaring)				1						1
Karoo Korhaan	Terrestrial				1					1
Kori Bustard	Terrestrial		1							1
Ludwig's Bustard	Terrestrial							1		1
Count (Terrestrial)			1		1			1		3
Total count (Overall)			1	1	1			1		4

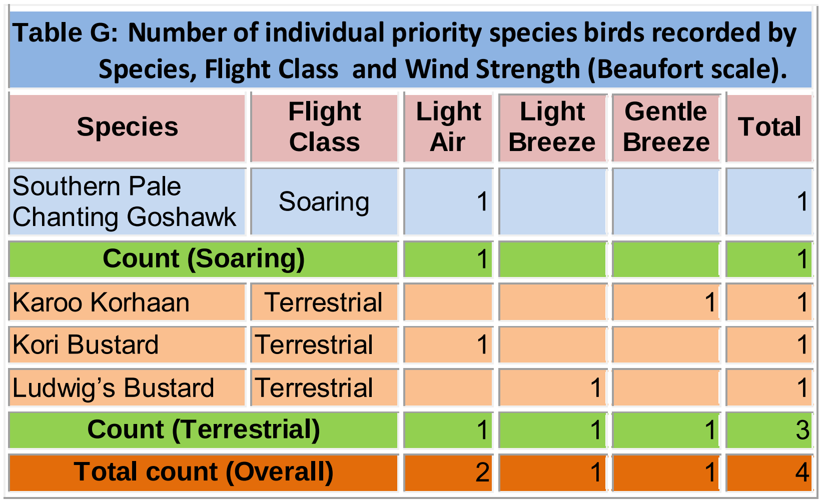

Table G: Number of individual priority species birds recorded by Species, Flight Class and Wind Strength (Beaufort scale).

Species	Flight Class	Light Air	Light Breeze	Gentle Breeze	Total
Southern Pale Chanting Goshawk	Soaring	1			1
Count (Soaring)		1			1
Karoo Korhaan	Terrestrial			1	1
Kori Bustard	Terrestrial	1			1
Ludwig’s Bustard	Terrestrial		1		1
Count (Terrestrial)		1	1	1	3
Total count (Overall)		2	1	1	4

APPENDIX 4: OTHER RENEWABLE ENERGY DEVELOPMENTS WITHIN 35KM RADIUS

Project	DEA reference	Type	MW	EIA status	Approximate footprint (ha)[16]	Bird impact assessment study	Recommendations
Helena (Klipgatspan)	14/12/16/3/3/2/767	PV	75	Unknown	430ha	Yes	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum used should be made of existing access roads and the construction of new roads should be kept to a minimum. • Monitoring should be implemented to search the ground between arrays of solar panels on a weekly basis (every two weeks at the longest) for at least one year to determine the magnitude of collision fatalities. Searches should be done on foot. Searches should be conducted randomly or at systematically selected arrays of solar panels to the extent that equals 33% or more of the project area. Detection trials should be integrated into the searches.

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[16] This information was extracted from various documents sourced on the internet. In some instances, no information could be obtained and an estimate was then made.

							• The EMP should provide for the on-going inputs of an avifaunal specialist to oversee the operational phase monitoring and assist with the on-going management of bird impacts that may emerge as the operational phase monitoring programme progresses. • The exact protocol to be followed for the operational phase monitoring should be compiled by the avifaunal specialist in consultation with the plant operator and Environmental Control Officer before the commencement of operations. The exact scope and nature of the operational phase monitoring will be informed on an ongoing basis by the result of the monitoring and the EMP will be updated accordingly. • Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including minor modifications of panel and mirror design to reduce the illusory characteristics of solar panels. What is considered to be significant will have to be established on a species specific basis by the avifaunal specialist.

Mierdam	2/12/20/2320/2	PV	40	EA issued	450ha	No, part of biodiversity assessment	• A formal monitoring and reporting strategy/protocol should be developed for monitoring the impact on the vegetation and biodiversity in general in the area during construction.
Platsjambok West	12/12/20/2320/5	PV	75	EA issued	450ha		Both alternative sites for the eastern PV component on the Platsjambok Farm are located in very close proximity to the sensitive quartzite ridges, and would present a physical barrier between thus area and the other part of the site where a number of grassy pans are located which is also considered important from an avifaunal perspective. The presence of the PV arrays in this location could create an important barrier and disturbance impact in a currently very un-impacted part of the site that may disrupt important linkages between these two habitats. For this reason, although the eastern PV component on the Platsjambok site is not considered a fatal flaw, it is strongly recommended that the eastern PV component be shifted to the south of the current alternatives, away from a ‘movement corridor’ between the quartzite ridges and the pans, thus not being located in close proximity to the most sensitive areas on the site.
Platsjambok East	2/12/20/2320/4	PV	75	EA issued	450ha		Both alternative sites for the eastern PV component on the Platsjambok Farm are located in very close proximity to the sensitive quartzite ridges, and would present a physical barrier between thus area and the other part of the site where a number of grassy pans are located which is also considered important from an avifaunal perspective. The presence of the PV arrays in this location could create an

							important barrier and disturbance impact in a currently very un-impacted part of the site that may disrupt important linkages between these two habitats. For this reason, although the eastern PV component on the Platsjambok site is not considered a fatal flaw, it is strongly recommended that the eastern PV component be shifted to the south of the current alternatives, away from a 'movement corridor' between the quartzite ridges and the pans, thus not being located in close proximity to the most sensitive areas on the site.
Hoekplaas	14/12/16/3/3/2/708	PV	75	EA issued	140ha	Yes	• The construction footprint shall be kept to the minimum size required for development. • Construction timeframes shall be reduced as much as possible. • To protect the Martial Eagle nest site located on the western edge of Hoekplaas, it shall be necessary to relocate the nest site to a more distant, less disturbed area (e.g. Jenkins et al. 2007, 2013). The extent and distribution of other renewable energy developments planned for the immediate vicinity probably precludes a short-range relocation, and a dedicated structure, strategically situated off the power line network aggregated around the Kronos substation, may be the best option. The requirements of such an undertaking shall be further investigated during future visits to the site as part of the pre-construction monitoring programme.

							• Development shall be excluded from areas/microhabitats identified during the bird monitoring programme as being of particular value to threatened/priority species (e.g. Red Lark, Sclater’s Lark). • Noise and disturbances associated with maintenance activities at the facility shall be kept to a minimum once it becomes operational. • The minimum area shall be used for fencing, given that these may present a collision risk for collision-prone birds. • A comprehensive impact monitoring programme shall be implemented of which the results shall be used to inform and refine a dynamic approach to mitigation. • Should the results from the monitoring programme show that the cumulative impacts from the multiple renewable energy projects in the Copperton area are causing high negative impacts on bird species on a local and regional scale (i.e. beyond a radius of 10km from Hoekplaas), DEA shall be contacted to discuss the implementation of an integrated mitigation approach by all renewable energy facilities contributing to the cumulative negative impact on avifauna. • Specialist advice shall be sought in devising effective avian deterrents to minimise associated damage should conflict arise with local bird

							populations due to fouling of critical components, etc. • Decommissioning timeframes shall be reduced as much as possible. • Noise and disturbances associated with decommissioning activities shall be kept to the minimum.
Humansrus	14/12/16/3/3/2/708	PV	75	EA issued	220ha	No, part of biodiversity study	• Any raptor or other species of conservation concern which may be nesting within or in the immediate vicinity of the facility should be identified before construction commences. This can • occur during the preconstruction walk-through of the facility for other fauna and flora related issues. If any significant finds are made, then some adjustment of the timing or location of certain • activities may be required to allow breeding to be completed. • Precautions should be taken to ensure that staff do not wander from the construction site and do not disturb any nesting species in the vicinity of the site. • There should also be environmental induction required for all construction staff to ensure that avifauna are not harmed during construction and that species such as owls are not persecuted • out of superstition or other reason. • All litter generated at the site should be handled in an environmentally sensitive manner to ensure

							that there is not organic litter at the site which might attract avifauna and that plastic and • other materials are not allowed to blow about the site, as some types of litter such as string can become entangled around birds legs.
Garob (Nelspoortje)	14/12/16/3/3/2/279/AM2	Wind	140	EA issued	5 520ha	Yes	• Micro-siting of turbines to avoid sensitive areas • Strict control of machinery and staff to prevent unnecessary damage to vegetation. • Curtailment of turbines if need be.
Vogelstruisbult	14/12/16/3/3/2/708	PV	75	EA issued	450ha?	Unknown	
Bosjesmansberg	14/12/16/3/3/2/547	PV	300	Unknown	800ha	Unknown	
Doonies Pan	14/12/16/3/3/2/609	PV	75	Unknown	450ha?	Unknown	
Hedley Plains	14/12/16/3/3/2/608	PV	75	Unknown	450ha?	Unknown	
Copperton Wind Energy Facility	12/12/20/2099		Up to 200MW	EA issued	3 219ha	Yes	• On-site demarcation of ‘no-go’ areas identified during pre-construction monitoring (see below) to minimise disturbance impacts associated with the construction of the facility. • Minimizing the disturbance impacts associated with the operation of the facility by scheduling maintenance activities to avoid disturbances in sensitive areas (identified through operational monitoring). • Ensuring that any lighting on the turbines is kept to a minimum, and is coloured (red or green) and intermittent, rather than permanent and white, to reduce confusion effects for nocturnal migrants. • Painting one blade of each turbine black to maximize conspicuousness to oncoming birds. The evidence for this as an effective mitigation

							measure is not conclusive, but it is suggestive. It might be best to adopt an experimental approach to blade marking, identifying a sample of pairs of potentially high risk turbines in pre-construction monitoring, and marking the blades on one of each pair. Post-construction monitoring should allow empirical testing of efficacy, which would inform subsequent decisions about the need to mark blades more widely in this and other wind farms. • Carefully monitoring the local avifauna pre- and post-construction (see below), and implementing appropriate additional mitigation as and when significant changes are recorded in the number, distribution or breeding behaviour of any of the priority species listed in this report, or when collision or electrocution mortalities are recorded for any of the priority species listed in this report. An essential weakness of the EIA process here is the dearth of knowledge about the actual movements of key species (bustards, eagles, other raptors) through the impact area. Such knowledge must be generated as quickly and as accurately as possible in order for this and other wind energy proposals in the area to proceed in an environmentally sustainable way. • Ensuring that the results of pre-construction monitoring are applied to project specific impact mitigation in a way that allows for the potential

							cumulative effects on the local/regional avifauna of any other wind energy projects proposed for this area, including the Mainstream facility proposed for an area • nearby. Viewed in isolation, the present project may pose only a limited threat to the avifauna of the area. However, in combination with a larger, neighbouring facility, it may contribute to the formation of a significant barrier to energy efficient travel between resource areas for regionally important bird populations, and/or significant levels of mortality in these populations in collisions with what may become a substantial array of many 100s of turbines (Masden et al. 2010). • Additional mitigation might include re-scheduling construction or maintenance activities on site, shutting down problem turbines either permanently or at certain times of year or in certain conditions. The requirement for these measures would need to be determined after pre- and post- construction monitoring.