AVIFAUNAL IMPACT ASSESSMENT

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED BRYPAAL SOLAR POWER PROJECT AND ASSOCIATED INFRASTRUCTURE IN THE NORTHERN CAPE PROVINCE

April 2018

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EXECUTIVE SUMMARY

Boscia Environmental Solutions (Boscia) has been appointed by Vintage Energy (Pty) Ltd to conduct an Environmental Authorisation Application for the proposed Brypaal Solar Power Project (BSPP) and Associated Infrastructure on the Remainder of Portion 4 of 134 of the farm Brypaal, Sinyanda District, Northern Cape. The proposed development will include the construction of a 100MW PV Facility, with substations, access roads, temporary housing, admin officer, cabling between project components, assembly plant and laydown area. The total surface area available for the development is 1032ha, but the actual development footprint will cover approximately 300ha. The proposed location is on remainder of Portion 4 of the farm Brypaal No.134, approximately 60 km south south-west of Kakamas in the Kai! Garib Local Municipality in the Northern Cape of South Africa.

A total of 91 bird species could potentially occur in the broader area. Of these, 28 bird species are classified as priority species and 6 of these are Red Data species. A total of 29 species were recorded during two rounds of seasonal surveys at the study area, of which 12 are priority species. The overall abundance of priority species at the site was low, with an average of 0.58 and 0.63 birds/km being recorded in summer and autumn respectively. For all birds combined, the IKA for summer was 8.13 birds/km, and 5.33 birds/km for autumn. The counts show an overall decrease from summer to autumn counts, which may be the results of deteriorating veld conditions during that period. Although the area had some rains just prior to the autumn counts, it was too early to have had an impact on the vegetation after a long and dry summer. Of interest is that resident species such as Spike-heeled Lark and Sabota Lark showed very showed very little fluctuation in abundance between seasons, but nomadic species such as Grey-backed Sparrowlark and Stark's Lark were far more abundant during the summer counts, indicating responses to veld conditions. Scaly-feathered Finch described by Hockey et al. (2005) as "resident, locally nomadic" were also more abundant during the summer, and entirely absent during autumn. Somewhat inexplicably, the highly sedentary Karoo Korhaan, the only Red Data species encountered regularly during counts, were more abundant during the autumn counts.

The proposed solar project will have some pre-mitigation impacts on avifauna at a site and local level which will range from High to Low.

The impact of displacement due to disturbance during the construction phase is rated as Medium and will remain at a Medium level after mitigation. The impact of displacement of priority species due to habitat transformation associated with the operation of the plant and associated infrastructure is rated as High. This impact can be partially reversed through mitigation, putting it at a Medium level, after mitigation. The remaining envisaged impacts, i.e. mortalities in the operational phase due to collisions with the solar panels and entrapment in perimeter fences are both rated as Low and should be mitigatable to a Very Low level with appropriate mitigation. The impact of the proposed 400kV grid connection is assessed to be Low and can be further mitigated to a Very Low level, due to the short length of the proposed overhead line.

The relatively small size of the footprint leads one to the conclusion that the cumulative impact of the facility on priority avifauna should in all likelihood be Very Low, taking into account the lack of other renewable projects within a 30km radius around the development area.

RECOMMENDATION

From an avifaunal impact perspective, the proposed development could go ahead, provided the proposed mitigation measures are strictly implemented. No further monitoring will be required during the operational phase.

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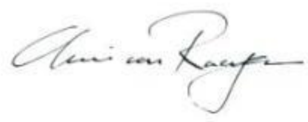
DEA Reference No.	14/12/16/3/3/2/1019		
Report Reference No.	2017/BES/SR/13		
Title	Avifaunal Impact Assessment.		
Author	Chris van Rooyen *(Pr.Sci.Nat)*		April 2018

DETAILS OF THE SPECIALIST AND EXPERTISE TO COMPILE A SPECIALIST REPORT

Chris van Rooyen

Chris has 20 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and wind generation 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 the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman

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

SPECIALIST DECLARATION

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Boscia Environmental 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 Brypaal Solar Project.

Full Name: Chris van Rooyen

Position: Director

1 OVERVIEW

1.1 Brypaal Solar Power Project

Boscia Environmental Solutions (Boscia) has been appointed by Vintage Energy (Pty) Ltd to conduct an Environmental Authorisation Application for the proposed Brypaal Solar Power Project (BSPP) and Associated Infrastructure on the Remainder of Portion 4 of 134 of the farm Brypaal, Sinyanda District, Northern Cape. The proposed development will include the construction of a 100MW PV Facility, with substations, access roads, temporary housing, admin officer, cabling between project components, assembly plant and laydown area. The total surface area available for the development is 1032ha, but the actual development footprint will cover approximately 300ha. The proposed location is on remainder of Portion 4 of the farm Brypaal No.134, approximately 60 km south south-west of Kakamas in the Kai! Garib Local Municipality in the Northern Cape of South Africa (see Figure 1).

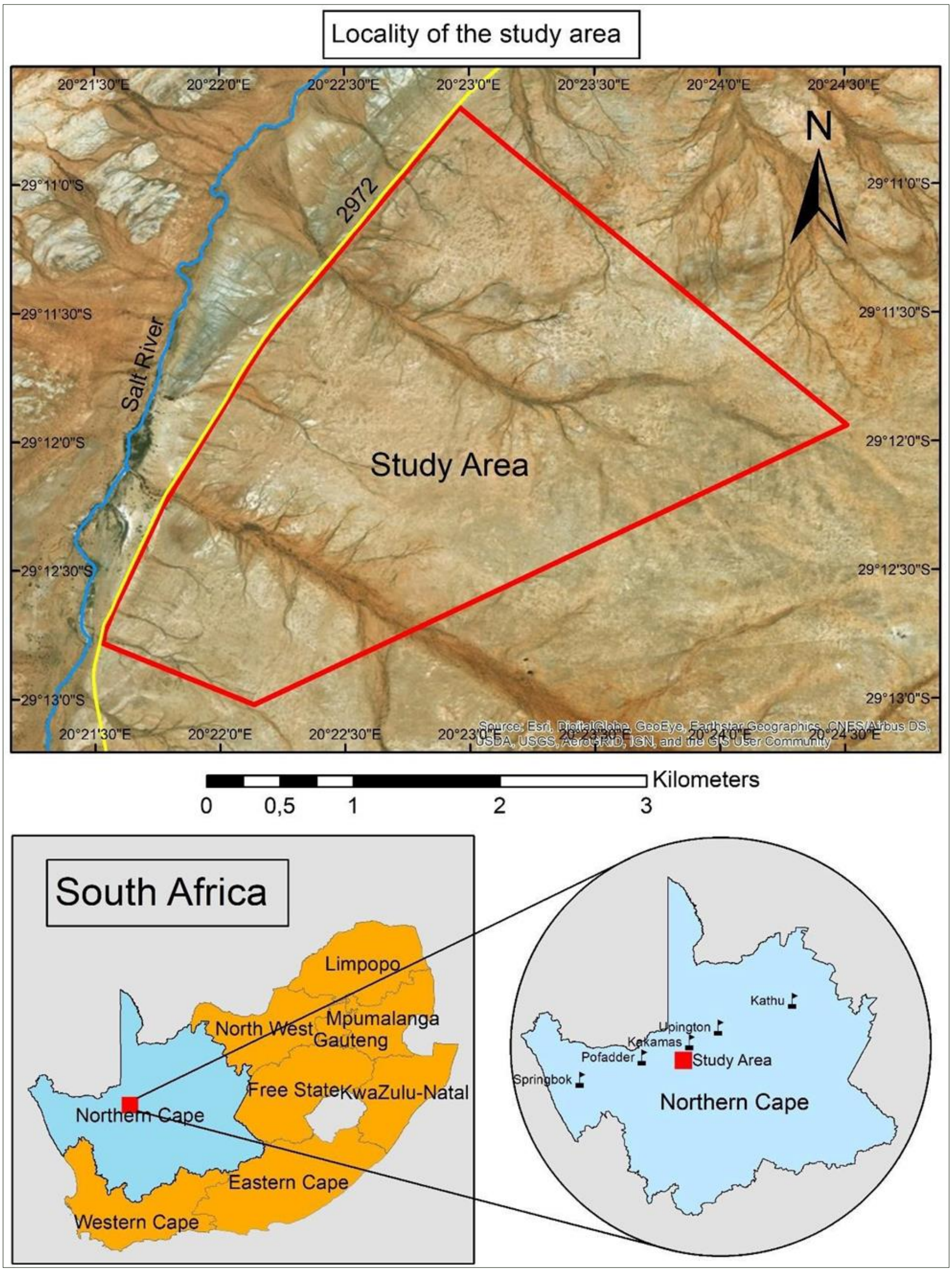


Figure 1: The location of the study area

Chris van Rooyen Consulting was appointed by Boscia to conduct an avifaunal impact study to assess the impact of the proposed solar farm on avifauna.

1.1.1 Project description

The proposed Solar Facility will have a peak power generating capacity of approximately 100 MW, and will consist of the following:

- Module Mounting structures 2 tier;
- String Inverters – 60 KVA;
- PV Modules – 250 WP;
- Meteor stations;
- Power reducer Boxes;
- Power Plant Controllers;
- Cluster Controllers;
- LV Substations;
- MV Substations;
- Access roads (temporary & permanent roads);
- Permanent office/workshop building.

A temporary laydown area was identified [workshops, mobile offices, mobile ablution facilities, material storage area, vehicle parking area, water tanks for drinking, construction and dust suppression) fencing, etc.]. The main activities during the construction phase area:

- Permanent living quarters for operational phase workers (only for residential staff). The rest of the staff will stay in Kakamas;
- Equipment (Trucks & front-end loaders, excavators, cranes, etc.);
- Topsoil/Overburden stockpiles/fill material. Topsoil stripping and stockpiling will be required only for the service roads and sub-station foundations. No concrete slabs or foundations are required for the screw-in pylons;
- Opencast quarries/excavations for cut and fill material. Very limited for roads and sub-station only, the rest of the construction site will follow a non-destructive-surface-topography approach because no foundations are required for the screw-in pylons;
- Water storage facilities (reservoir, tanks, etc.) mainly for construction phase;
- Water Desalination plant (pipelines towards water storage and power plant). Very small, just for standby water supply. The rest of the operational water will be transported from Kakamas or extracted from boreholes. Limited water is required for the washing of the PV-panels because nano-technology will be applied to the surface of the panels, which keeps it virtually clean for very long periods of time and washing of the panels will be required only once a year or even longer intervals;
- Waste handling facilities (for construction & operational phase). Solid, hydrocarbon and liquid waste to be sorted on site and keep in certified appropriate containers and to be removed to certified land fill sites.
- Surface run-off control systems. A non-destructive surface topography will be followed during the construction phase, drainage systems will be avoided, therefore surface runoff structures for instance trenches, canals, etc. will not be implemented and no large scale desalination plants

and evaporation ponds will be constructed because of low water requirements for operational phase.

- A 400kV high voltage overhead grid connection of approximately 500 m between the substation at the solar facility and the Aries – Kokerboom 400 KV line.

Total footprint of the 100 MW PV solar farm will be approximately 320 ha. The terms of the land owner agreement for this project provides allowance for a 36 month construction period and foresees the use as a PV Solar facility for up to 25 years. During this period, it is anticipated that the PV modules may be replaced, however the primary plant and electrical infrastructure would be suitable for this intended project life.

1.1.2 Project layout

See Figure 2 below for a map indicating the footprint of the facility.

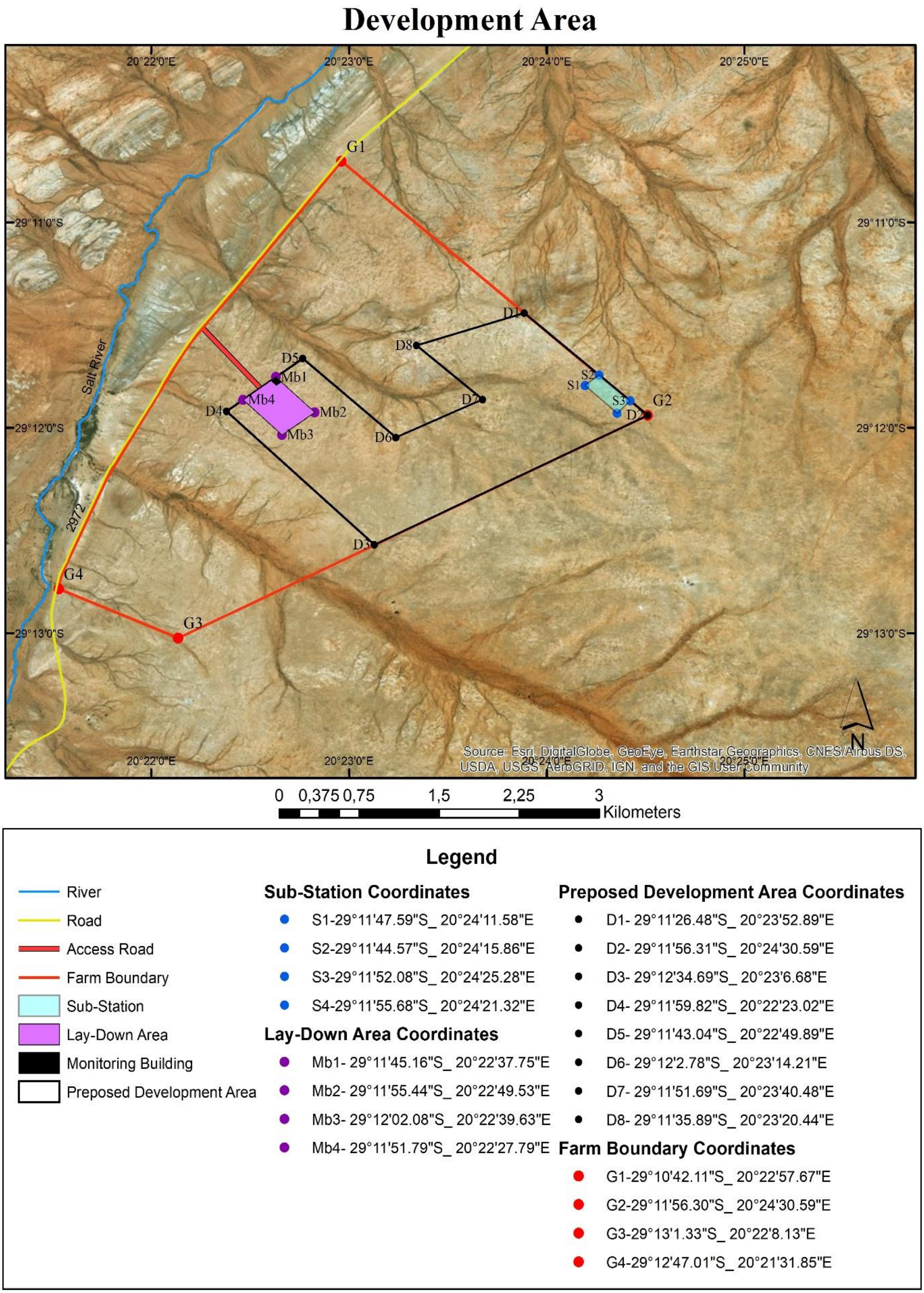


Figure 2: A map showing the footprint of the proposed facility.

2 PROJECT SCOPE

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

- Describe the affected environment from an avifaunal perspective;
- Discuss gaps in baseline data and other limitations;
- List and describe the expected impacts associated with the solar facilities and associated infrastructure;
- Assess the potential impacts;
- Recommend mitigation measures to reduce the impact of the expected impacts.

3 OUTLINE OF METHODOLOGY AND INFORMATION REVIEWED

The following information sources were consulted in order to conduct this study:

- Bird distribution data from the Southern African Bird Atlas Project 2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed development is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. In order to get a more representative impression of the birdlife, a consolidated data set was obtained for a total of 9 pentads some of which intersect and others that are in the vicinity of the development. The SABAP2 data covers the period 2007 to 2018.
- The SABAP 2 data was supplemented with the Southern African Bird Atlas Project 1, for the 2920AB quarter degree grid cell (QDGC). QDGCs are grid cells that cover 15 minutes of latitude by 15 minutes of longitude (15. × 15.), which correspond to the area shown on a 1:50 000 map. SABAP1 covers the late 1980s to early 1990s.
- A classification of the vegetation types in the development area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- The national threatened status of all priority species was determined with the use of the most recent edition of the Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor *et al*. 2015), and the latest authoritative summary of southern African bird biology (Hockey *et al.* 2005).
- The global threatened status of all priority species was determined by consulting the latest (2017.3) IUCN Red List of Threatened Species).
- The Important Bird and Biodiversity Areas of South Africa (Marnewick *et al.* 2015) was consulted for information on potentially relevant Important Bird Areas (IBAs).
- Satellite imagery was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- A desktop investigation was conducted to source information on the impacts of solar facilities on avifauna.
- A visit to the site and general area was conducted on 9 February 2018, followed up by on-site surveys from 28 February to 2 March 2018 and again from 10 – 12 April 2018. Surveys were conducted according to the best practice guidelines for avifaunal impact studies at solar developments, compiled by BirdLife South Africa (BLSA) in 2017 (Jenkins *et al*. 2017). Please see Appendix 1 for the methodology used in the surveys.

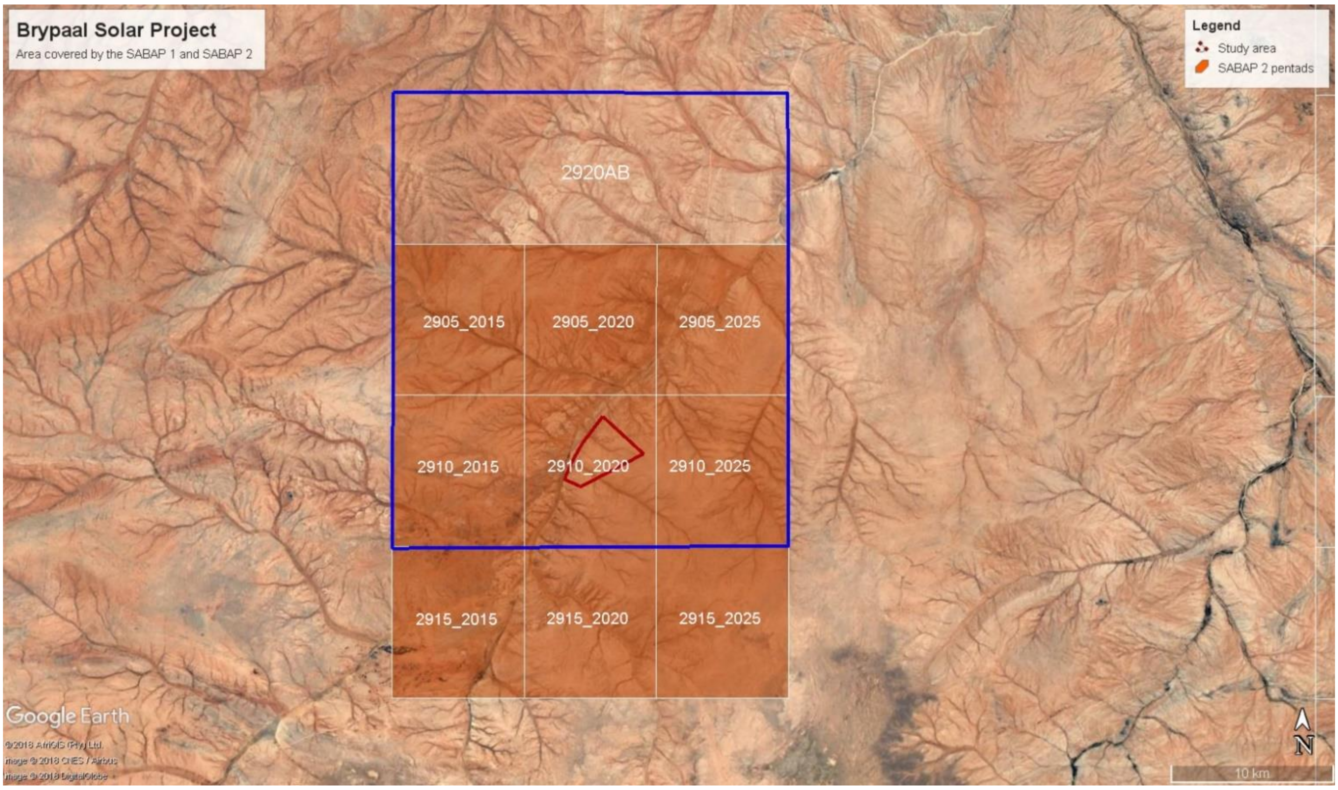


Figure 3: Area covered by the nine SABAP 2 pentads, and the 2920AB SABAP1 quarter degree grid cell (purple outline).

4 ASSUMPTIONS AND LIMITATIONS

This study assumed that the sources of information used in this report are reliable. In this respect, the following must be noted:

- A total of only two SABAP 2 full protocol lists has been completed to date for the 9 pentads where the development area is located (i.e. bird listing surveys lasting a minimum of two hours each). The SABAP2 data was therefore regarded as inconclusive of the avifauna which could occur at the proposed development area and was supplemented by data collected during the on-site surveys, and by data collected during the Southern African Bird Atlas Project 1 for the 2920AB quarter degree grid cell.
- The focus of the study is primarily on the potential impacts on priority species which were defined as follows:
    - South African Red Data species;
    - South African endemics and near-endemics;
    - Raptors
- The impact of solar installations on avifauna is a new field of study, with only one scientific study published to date (McCrary *et al*. 1986), and one unpublished scientific study on the impact of PV facilities on avifauna in South Africa (Visser 2016). Strong reliance was therefore placed on expert opinion and data from existing monitoring programmes at solar facilities in the USA where monitoring has been ongoing since 2013. The pre-cautionary principle was applied throughout as the full extent of impacts on avifauna at solar facilities is not presently known.
- The assessment of impacts is based on the baseline environment as it currently exists at the proposed development area.
- Cumulative impacts include all solar PV projects within a 30km radius that currently have open applications or have been approved by the Competent Authority.
- 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.

- The study area is defined as the 1032ha which makes up the farm Remainder of Portion 4 of 134 of the farm Brypaal. The development footprint is defined as the 320 hectares where the solar panels and associated infrastructure will be constructed (see Figure 2). The broader area is defined as the area encompassed by the 2920AB QDGC and the 9 pentads where the study area is located (see Figure 3).

5 LEGISLATIVE CONTEXT

There is no specific legislation pertaining specifically to the impact of solar facilities on avifauna. Guidelines for assessing and monitoring the impact of solar power generating facilities on birds in southern Africa (Jenkins *et al.* 2017), compiled by BirdLife South Africa, was followed in the compilation of this report.

5.1 Agreements and conventions

Table 1 below lists agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna (BirdLife International 2018).

Table 1: Agreements and conventions which South Africa is party to and which is relevant to the conservation of avifauna.

Convention name	Description	Geographic scope
African-Eurasian Waterbird Agreement (AEWA)	The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Programme (UNEP), AEWA brings together countries and the wider international conservation community in an effort to establish coordinated conservation and management of migratory waterbirds throughout their entire migratory range.	Regional
Convention on Biological Diversity (CBD), Nairobi, 1992	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	Global
Convention on the Conservation of Migratory Species of Wild Animals, (CMS), Bonn, 1979	As an environmental treaty under the aegis of the United Nations Environment Programme, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. CMS brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	Global
Convention on the International Trade in Endangered Species of Wild Flora and Fauna,	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their	Global

(CITES), Washington DC, 1973	survival.	
Ramsar Convention on Wetlands of International Importance, Ramsar, 1971	The Convention on Wetlands, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.	Global
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia	The Signatories will aim to take co-ordinated measures to achieve and maintain the favourable conservation status of birds of prey throughout their range and to reverse their decline when and where appropriate.	Regional

5.2 National legislation

5.2.1 Constitution of the Republic of South Africa, 1996

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

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

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

- (i) prevent pollution and ecological degradation;
- (ii) promote conservation; and
- (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

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

The National Environmental Management Act 107 of 1998 (NEMA) creates the legislative framework for environmental protection in South Africa and is aimed at giving effect to the environmental right in the Constitution. It sets out a number of guiding principles that apply to the actions of all organs of state that may significantly affect the environment. Sustainable development (socially, environmentally and economically) is one of the key principles, and internationally accepted principles of environmental management, such as the precautionary principle and the polluter pays principle, are also incorporated.

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

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

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

6 BASELINE ASSESSMENT

6.1 Important Bird Areas

There are no Important Bird Areas (IBA) within a 50km radius around the proposed BSPP. It is therefore highly unlikely that the proposed development will have a negative impact on any IBA.

6.2 Habitat classes

Vegetation structure, rather than the actual plant species, is more significant for bird species distribution and abundance (Harrison *et al.* 1997). The description of the vegetation types occurring in the development area largely follows the classification system presented in the Atlas of southern African birds (Harrison *et al*. 1997). The criteria used 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. The description of vegetation presented in this study therefore concentrates on factors relevant to the bird species present and is not an exhaustive list of plant species present.

6.2.1 Biomes and vegetation types

The study area forms part of the Nama Karoo Biome, and the Bushmanland Bioregion (Mucina & Rutherford 2006). The study area comprises mainly Bushmanland Arid Grassland, Bushmanland Sandy Grassland and Bushmanland Basin Shrubland. The Bushmanland Arid Grassland is characterised by irregular plains dominated by *Stipagrostis* species. In some regions the vegetation structure is altered by low shrubs of *Salsola* species. Bushmanland Sandy Grassland is characterised by sandy grassland plains dominated by *Stipagrostis* and *Schmidtia* species. There is also a common occurrence of drought-resistant shrubs, and after rainfall the display of ephemeral spring flora including *Grielum humifusum* and *Gazania lichtensteinii*. The Bushmanland Basin Shrubland is characterised by irregular plains dominated by shrubs including *Rhigozum, Salsola*, *Pentzia* and *Eriocephalus* as well as different *Stipagrostis* grass species. After rainfall *Gazania* and *Leysera* species may also be present (Mucina & Rutherford, 2006).

The differences in vegetation at the site reflects the substrate conditions including soil depth, texture, and geology. The areas with coarse material (for instance the deep, sandy soils in the drainage systems) are dominated by shrubby vegetation, while the areas with fine material or abundant geological outcrops (for instance the calcic soils) are dominated by grasses (Boscia 2018).

Figure 4: Shrubby vegetation in a drainage line at the study area

Figure 5: The study area is situated on a vast grassy plain.

The study area forms part of the semi-arid Bushmanland region and falls within the very late summer rainfall region (Schulze, 1997). According to meteorological statistics from the South African Weather Services (Weather Bureau, 2016) the average annual rainfall for this area, from 1992 up to 2015, was between 140 mm and 250 mm per annum.

The variation in average temperatures within this area is extreme with maximum temperatures during the summer reaching up to 40.8 °C and minimum temperatures as low as -3 °C. The overall topography of the site is relatively homogenous and ranges from 857m to 880m above mean sea level with the highest part of the landscape to the south-east and the lowest part to the north-west. The study area is predominantly used for livestock farming. The infrastructure present within the boundaries of the study area is limited to a feeding and water trough, border fences and a gravel pit. There is also a small earth dam (not considered as a pan system) in the northern corner of the site. Parallel to the north-western border of the site (located outside the study area) is the Loeriesfontein- Kakamas road. (Boscia 2018). There is also the 400kV Aries - Kokerboom transmission line running approximately 900m from the site, parallel to the north-eastern border of the study area.

Whilst the distribution and abundance of the bird species in the development area are mostly associated with natural vegetation, as this comprises virtually all the habitat, it is also necessary to examine external modifications to the environment that might have relevance for priority species. Anthropogenic avifaunal-relevant habitat modifications which could potentially influence the avifaunal community that were recorded in or close to the study area are a water trough, a dam, fences and a high voltage transmission line. These are discussed in more detail below.

6.2.2 Surface water

Surface water is of specific importance to avifauna in this semi-arid environment. The study area contains an open water trough that provide drinking water to livestock. Open water troughs are important sources of surface water and could potentially be used extensively by various bird species, including large raptors, to drink and bath. There is also a small dam in the northernmost corner of the study area. The dam was dry when the surveys were conducted, but it could hold water after good rains, when it could be attractive to various bird species, including large raptors, to drink and bath. It could also serve as an attraction to waterbirds when it contains water. The development area itself contains no surface water.

6.2.3 High voltage lines

High voltage lines are an important potential roosting and breeding substrate for large raptors in the area. Existing high-voltage lines are used extensively by large raptors in arid regions of South Africa e.g. in 2005 an aerial survey of the Ferrum – Garona 275kV line which starts at Kathu and terminates at Garona Substation approximately 16km north of Groblershoop, found a total of 19 Martial Eagle and 7 Tawny Eagle nests on transmission line towers (Van Rooyen 2007). High voltage lines therefore hold a special importance for large raptors, but also for Sociable Weavers which often construct their giant nests within the lattice work or cross-arms of high voltage structures. The study area does not contain any high voltage lines, but the Aries – Kokerboom 400kV line runs just north-east of the study area (see Figure 6). Martial Eagle was observed to perch on the towers during the surveys. The line was inspected for potential raptor nesting activity, but only an inactive corvid nest was recorded.

Figure 6: The Aries – Kokerboom 400kV high voltage line

6.2.4 Fences

The study area is fenced off on all sides with barbed wire fences (see Figure 7). Farm fences provide important perching substrate for a wide range of birds in this treeless environment where natural perches are scarce, as a staging post for territorial displays by small birds and also for perch hunting for raptors such as Greater Kestrel, Rock Kestrel and Southern pale Chanting Goshawk.

Figure 7: The study area is surrounded by fences on all sides.

6.3 Avifauna

6.3.1 Southern African Bird Atlas 1 and 2

The SABAP1 and SABAP2 data indicate that a total of 91 bird species could potentially occur in the broader area – Appendix 2 provides a comprehensive list of all the species, including those recorded during the pre-construction monitoring. Of these, 28 species are classified as priority species (see Section 4 for definition of a priority species) and 6 of these are Red Data species. The probability of a priority species occurring in the study area is indicated in Table 2.

Table 2 below lists all the priority species and the possible impact on the respective species by the proposed solar energy infrastructure. The following abbreviations and acronyms are used:

- EN = Endangered
- VU = Vulnerable
- NT = Near-threatened

6.3.2 Pre-construction surveys

A visit to the study area was conducted on 9 February 2018, followed up by on-site surveys from 28 February to 2 March 2018 (summer) and again from 10 – 12 April 2018 (autumn). Surveys were conducted according to the best practice guidelines for avifaunal impact studies at solar developments, compiled by BirdLife South Africa (BLSA) in 2017 (Jenkins *et al*. 2017). Please see Appendix 1 for details of the methodology used in the surveys.

6.3.2.1 Priority species abundance

The abundance of priority species recorded during the two seasonal surveys are displayed in Table 3 and Figure 8 below.

Table 2: Index of kilometric abundance for all species recorded by means of walk transects during seasonal surveys at the study area. Priority species are indicated in red (incidental sightings excluded).

Species	Su: IKA	Au: IKA
Ant-eating Chat	0.42	0.17
Black-chested Prinia	0.13	0.00
Black-eared Sparrowlark	0.21	0.08
Bokmakierie	0.00	0.13
Cape Sparrow	0.17	0.04
Capped Wheatear	0.00	0.08
Chat Flycatcher	0.04	0.04
Double-banded Courser	0.08	0.08
Fawn-coloured Lark	0.04	0.04
Greater Kestrel	0.21	0.04
Grey-backed Sparrowlark	1.17	0.38
Karoo Chat	0.00	0.21
Karoo Korhaan	0.08	0.50
Lark-like Bunting	0.00	0.04
Namaqua Sandgrouse	0.58	0.38
Northern Black Korhaan	0.00	0.08
Pied Crow	0.25	0.08
Rufous-eared Warbler	0.00	0.25
Sabota Lark	0.58	0.54
Scaly-feathered Finch	0.58	0.00
Sickle-winged Chat	0.08	0.00
Spike-heeled Lark	3.04	2.71
Stark's Lark	0.92	0.08
Tractrac Chat	0.13	0.00

Table 3: Priority species potentially occurring at the site, conservation status, priority criteria, SABAP reporting rates, probability of occurrence, habitat use and potential impacts.

											Habitat				Impact					
Species	**Taxnomic name**	**SABAP2 reporting rate**	**SABAP1 reporting rate**	**Red Data status Global**	**Red Data status Regional**	**Endemic - South Africa**	**Endemic - Southern Africa**	**Priority species**	**Probability of occurrence**	**Recorded during pre-construction surveys**	**Nama Karoo**	**Surface water**	**Fences**	**High voltage lines**	**PV panel collisions**	**Displacement - disturbance**	**Displacement - habitat loss**	**Drowning**	**Powerline collisions**	**Entrapment in fences**
Bustard, Ludwig's	*Neotis ludwigii*		13	EN	EN		Near-endemic	√	High		√					√	√		√	√
Bustard, Kori	*Ardeotis kori*		0	NT	NT			√		√									√	√
Buzzard, Jackal	*Buteo rufofuscus*		11			Near endemic	Endemic	√	Low		√	√	√	√		√	√	√		
Canary, Black-headed	*Serinus alario*		8.3			Near endemic	Endemic	√	High	√	√		√		√	√				
Chat, Anteating	*Myrmecocichla formicivora*	50	25				Endemic	√	High		√		√		√	√				
Eagle, Booted	*Aquila pennatus*		33					√	High	√	√	√		√			√	√		
Eagle, Martial	*Polemaetus bellicosus*		33	VU	EN			√	High	√	√	√		√			√	√		
Eagle-owl, Spotted	*Bubo africanus*		13					√	High		√		√	√	√	√				
Falcon, Lanner	*Falco biarmicus*	50	17	LC	VU			√	High		√	√	√	√	√	√		√		
Falcon, Pygmy	*Polihierax semitorquatus*		50					√	Low		√			√	√	√				
Flamingo, Greater	*Phoenicopterus ruber*		5.6	LC	NT			√	Medium			√				√			√	
Goshawk, Southern Pale Chanting	*Melierax canorus*	100	29				Near-endemic	√	High		√	√	√	√	√	√		√		
Kestrel, Greater	*Falco rupicoloides*		54					√	High	√	√		√	√	√	√				
Kestrel, Rock	*Falco rupicolus*		13					√	High		√		√	√		√				
Korhaan, Karoo	*Eupodotis vigorsii*		29	LC	NT		Endemic	√	High	√	√					√	√		√	√
Korhaan, Northern Black	*Afrotis afraoides*		21				Endemic	√	High		√					√	√		√	√
Lark, Karoo Long-billed	*Certhilauda subcoronata*	50	13				Endemic	√	High		√		√		√	√	√			
Lark, Large-billed	*Galerida magnirostris*		17			Near endemic	Endemic	√	High	√	√		√		√	√	√			
Mousebird, White-backed	*Colius colius*	50	5.6				Endemic	√	Low		√				√	√	√			
Owl, Barn	*Tyto alba*		17					√	High		√		√	√	√	√				
Scrub-robin, Karoo	*Cercotrichas coryphoeus*		13				Endemic	√	High		√				√	√				
Shelduck, South African	*Tadorna cana*	100	17				Endemic	√	Medium			√			√		√		√	
Shoveler, Cape	*Anas smithii*		5.6				Near-endemic	√	Medium			√			√				√	
Sickle-winged Chat	*Cercomela sinuata*	0	0				Endemic	√	High	√	√		√		√	√	√			
Sparrowlark, Black-eared	*Eremopterix australis*	50	33			Near endemic	Endemic	√	High	√	√				√	√	√			
Warbler, Rufous-eared	*Malcorus pectoralis*	100	29				Endemic	√	High		√				√	√	√			
Weaver, Sociable	*Philetairus socius*		71				Endemic	√	Low		√			√	√	√				
White-eye, Orange River	*Zosterops pallidus*		8.3				Endemic	√	Very Low		√				√	√	√			

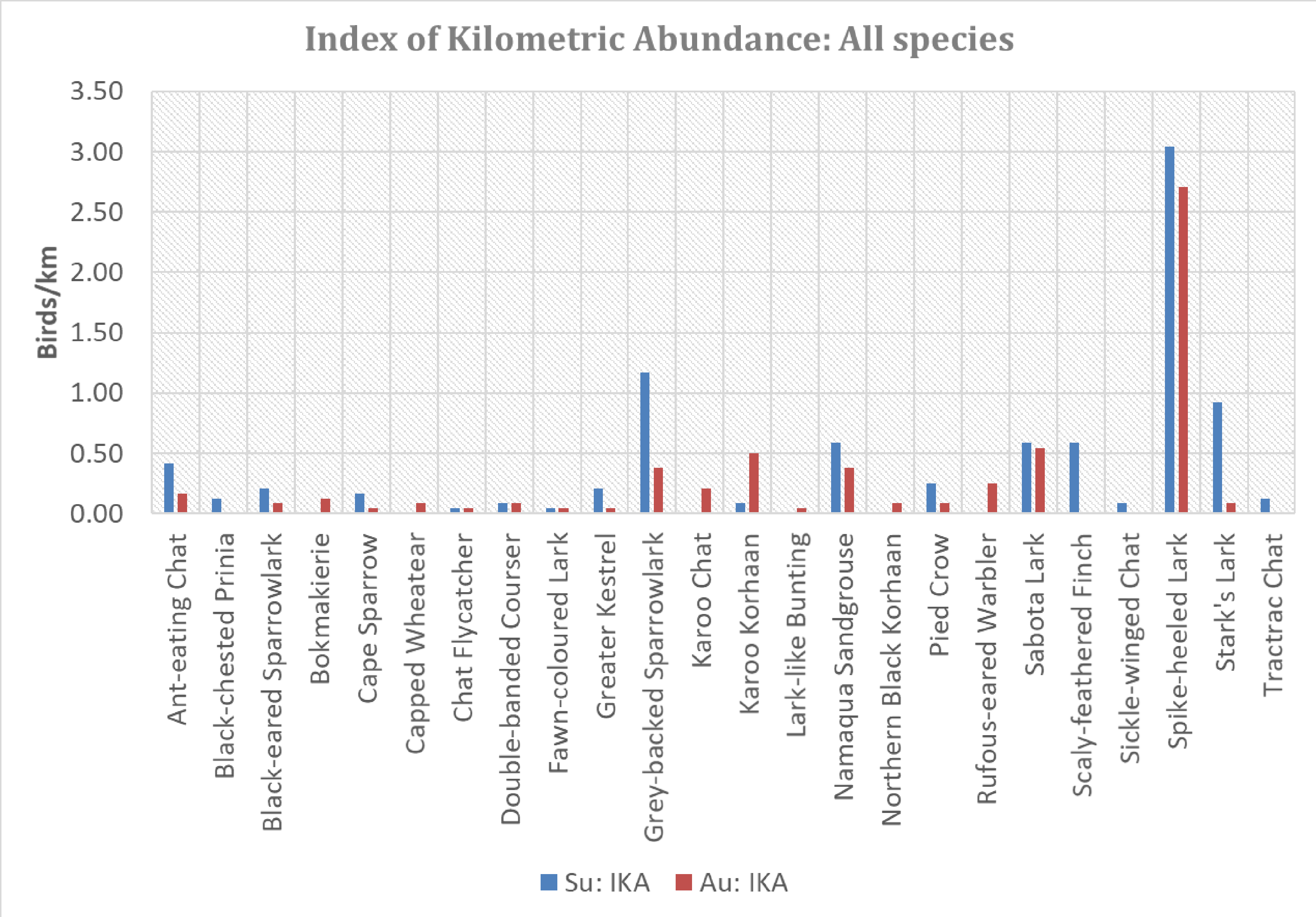


Figure 8: Index of kilometric abundance (IKA) for all species recorded during walk transects at the study area during summer and autumn.

6.3.2.2 Discussion

The overall abundance of priority species at the site was low, with an average of 0.58 and 0.63 birds/km being recorded in summer and autumn respectively. For all birds combined, the IKA for summer was 8.13 birds/km, and 5.33 birds/km for autumn.

The counts show an overall decrease from summer to autumn counts, which may be the results of deteriorating veld conditions during that period. Although the area had some rains just prior to the autumn counts, it was too early to have had an impact on the vegetation after a long and dry summer. Of interest is that resident species such as Spike-heeled Lark *Chersomanes albofasciata* and Sabota Lark *Calendulauda sabota* showed very showed very little fluctuation in abundance between seasons, but nomadic species such as Grey-backed Sparrowlark *Eremopterix verticalis* and Stark's Lark *Spizocorys starki* were far more abundant during the summer counts, indicating responses to veld conditions. Scaly-feathered Finch *Sporopipes squamifrons* described by Hockey et al. (2005) as "resident, locally nomadic" were also more abundant during the summer, and entirely absent during autumn.

Somewhat inexplicably, the highly sedentary Karoo Korhaan, the only Red Data species encountered regularly during counts, were more abundant during the autumn counts.

6.4 Impacts of solar PV facilities and associated infrastructure on avifauna

Increasingly, human-induced climate change is recognized as a fundamental driver of biological processes and patterns. Historic climate change is known to have caused shifts in the geographic ranges of many plants and animals, and future climate change is expected to result in even greater redistributions of species (National Audubon Society 2015). In 2006 WWF Australia produced a report on the envisaged impact of climate change on birds worldwide (Wormworth, J. & Mallon, K. 2006). The report found that:

- Climate change now affects bird species' behaviour, ranges and population dynamics;
- Some bird species are already experiencing strong negative impacts from climate change;
- In future, subject to greenhouse gas emissions levels and climatic response, climate change will put large numbers bird species at risk of extinction, with estimates of extinction rates varying from 2 to 72%, depending on the region, climate scenario and potential for birds to shift to new habitat.

Using statistical models based on the North American Breeding Bird Survey and Audubon Christmas Bird Count datasets, the National Audubon Society assessed geographic range shifts through the end of the century for 588 North American bird species during both the summer and winter seasons under a range of future climate change scenarios (National Audubon Society 2015). Their analysis showed the following:

- 314 of 588 species modelled (53%) lose more than half of their current geographic range in all three modelled scenarios.
- For 126 species, loss occurs without accompanying range expansion.
- For 188 species, loss is coupled with the potential to colonize new areas.

Climate sensitivity is an important piece of information to incorporate into conservation planning and adaptive management strategies. The persistence of many birds will depend on their ability to colonize climatically suitable areas outside of current ranges and management actions that target climate change adaptation.

South Africa is among the world's top 10 developing countries required to significantly reduce their carbon emissions (Seymore *et al.* 2014), and the introduction of low-carbon technologies into the country's compliment of power generation will greatly assist with achieving this important objective (Walwyn & Brent 2015). Given that South Africa receives among the highest levels of solar radiation on earth (Fluri 2009; Munzhedi *et al*. 2009), it is clear that solar power generation should feature prominently in future efforts to convert to a more sustainable energy mix in order to combat climate change, also from an avifaunal impact perspective. However, while the expansion of solar power generation is undoubtedly a positive development for avifauna in the longer term in that it will help reduce the effect of climate change and thus habitat transformation, it must also be acknowledged that renewable energy facilities, including solar PV facilities, in themselves have some potential for negative impacts on avifauna.

A literature review reveals a scarcity of published, scientifically examined information regarding large-scale PV plants and birds. The reason for this is mainly that large-scale PV plants are a relatively recent phenomenon. The main source of information for these types of impacts are from compliance reports and a few government-sponsored studies relating to recently constructed solar plants in the south-west United States. In South Africa, only one unpublished scientific study has been completed on the impacts of PV plants in a South African context (Visser 2016).

In summary, the potential impacts of PV plants on avifauna which have emerged so far include the following:

- Displacement due to disturbance and habitat transformation associated with the construction of the solar PV plant and associated infrastructure;
- Collisions with the solar panels;
- Entrapment in perimeter fences;
- Collisions with the associated power lines; and
- Electrocutions on the associated power lines.

6.4.1 Impacts associated with PV plants

6.4.1.1 Impact trauma (collisions)

This impact refers to collision-related fatality i.e. fatality resulting from the direct contact of the bird with a project structure(s). This type of fatality has been occasionally documented at solar projects of all technology types (McCrary et al. 1986; Hernandez et al. 2014; Kagan et al. 2014). In some instances, the bird is not killed outright by the collision impact, but succumbs to predation later, as it cannot avoid predators due to its injured state.

Sheet glass used in commercial and residential buildings has been well established as a hazard for birds. When the sky is reflected in the sheet glass, birds fail to see the building as an obstacle and attempt to fly through the glass, mistaking it for empty space (Loss et al. 2014). Although very few cases have been reported it is possible that the reflective surfaces of solar panels could constitute a similar risk to avifauna.

An extremely rare but potentially related problem is the so-called "lake effect" i.e. it seems possible that reflections from solar facilities' infrastructure, particularly large sheets of dark blue photovoltaic panels, may attract birds in flight across the open desert, who mistake the broad reflective surfaces for water (Kagan et al. 2014)1. The unusually high percentage of waterbird mortalities at the Desert Sunlight PV facility (44%) may support the "lake effect" hypothesis (West 2014). Although in the case of Desert Sunlight, the

[1] This could either result in birds colliding directly with the solar panels or getting stranded and unable to take off again because many aquatic bird species find it very difficult and sometimes impossible to take off from dry land e.g. grebes and cormorants. This exposes them to predation, even if they do not get injured through direct collisions with the panels.

proximity of evaporation ponds may act as an additional risk increasing factor, in that birds are both attracted to the water feature and habituated to the presence of an accessible aquatic environment in the area. This may translate into the misinterpretation of diffusely reflected sky or horizontal polarised light source as a body of water. However, due to limited data it would be premature to make any general conclusions about the influence of the lake effect or other factors that contribute to fatality of water-dependent birds. The activity and abundance of water-dependent species near solar facilities may depend on other site-specific or regional factors, such as the surrounding landscape (Walston et al. 2015). However, until such time that enough scientific evidence has been collected to discount the “lake effect” hypothesis, it must be considered as a potential source of impacts.

Weekly mortality searches at 20% coverage were conducted at the 250MW, 1300ha California Valley Solar Ranch PV site (Harvey & Associates 2014a and 2014b). According to the information that could be sourced from the internet (two quarterly reports), 152 avian mortalities were reported for the period 16 November 2013 – 15 February 2014, and 54 for the period 16 February 2014 – 15 May 2014, of which approximately 90% were based on feathers spots which precluded a finding on the cause of death. These figures give an estimated unadjusted 1 030 mortalities per year, which is obviously an underestimate as it does not include adjustments for carcasses removed by scavengers and missed by searchers. The authors stated clearly that these quarterly reports do not include the results of searcher efficiency trials, carcass removal trials, or data analyses, nor does it include detailed discussions.

In a report by the National Fish and Wildlife Forensic Laboratory (Kagan et al. 2014), the cause of avian mortalities was estimated based on opportunistic avian carcass collections at several solar facilities, including the 550MW, 1 600ha Desert Sunlight PV plant. Impact trauma emerged as the highest identifiable cause of avian mortality, but most mortality could not be traced to an identifiable cause.

Walston et al. (2015) conducted a comprehensive review of avian fatality data from large scale solar facilities (all technology types) in the USA. Collision as cause of death (19 birds) ranked second at Desert Sunlight PV plant and California Valley Solar Ranch (CVSR) PV plant, after unknown causes. Cause of death could not be determined for over 50% of the fatality observations and many carcasses included in these analyses consisted only of feather spots (feathers concentrated together in a small area) or partial carcasses, thus making determination of cause of death difficult. It is anticipated that some unknown fatalities were caused by predation or some other factor unrelated to the solar project. However, they found that the lack of systematic data collection and standardization was a major impediment in establishing the actual extent and causes of fatalities across all projects.

The only scientific investigation of potential avifaunal impacts that has been performed at a South African PV facility was completed in 2016 at the 96MW Jasper PV solar facility (28°17′53″S, 23°21′56″E) which is located on the Humansrus Farm, approximately 4 km south-east of Groenwater and 30km east of Postmasburg in the Northern Cape Province (Visser 2016). The Jasper PV facility contains 325 360 solar panels over a footprint of 180 hectares with the capacity to deliver 180 000 MWh of renewable electricity annually. The solar panels face north at a fixed 20° angle, reaching a height of approximately 1.86 m relative to ground level with a distance of 3.11 m between successive rows of panels. Mortality surveys were conducted from the 14th of September 2015 until the 6th of December 2015, with a total of seven mortalities recorded among the solar panels which gives an average rate of 0.003 birds per hectare surveyed per month. All fatalities were inferred from feather spots. The study concluded inter alia that the short study period, and lack of comparable results from other sources made it difficult to provide a meaningful assessment of avian mortality at PV facilities. It further stated that despite these limitations, the few bird fatalities that were recorded might suggest that there is no significant collision-related mortality at the study site. The conclusion was that to fully understand the risk of solar energy development on birds, further collation and analysis of data from solar energy facilities across spatial and temporal scales, based on scientifically rigorous research designs, is required (Visser 2016).

The results of the available literature lack compelling evidence of collisions as a cause of large-scale mortality among birds at PV facilities. However, it is clear from this limited literature survey that the lack of systematic and standardised data collection is a major problem in the assessment of the causes and extent of avian mortality at all types of solar facilities, regardless of the technology employed. Until statistically tested results emerge from existing compliance programmes and more dedicated scientific research, conclusions will inevitably be largely speculative and based on professional opinion.

6.4.1.2 Entrapment in perimeter fences

Visser (2016) recorded a fence-line fatality (Orange River Francolin *Scleroptila gutturalis*) resulting from the bird being trapped between the inner and outer perimeter fence of the facility. This was further supported by observations of large-bodied birds unable to escape from between the two fences (e.g. Red-crested Korhaan *Lophotis ruficrista*) (Visser 2016). Considering that one would expect the birds to be able to take off in the lengthwise direction (parallel to the fences), it seems likely that the birds panicked when they were approached by observers and thus flew into the fence.

6.4.1.3 Displacement due to disturbance and habitat transformation associated with the construction of the solar PV facility

Ground-disturbing activities affect a variety of processes in arid areas, including soil density, water infiltration rate, vulnerability to erosion, secondary plant succession, invasion by exotic plant species, and stability of cryptobiotic soil crusts. These processes have the ability – individually and together – to alter habitat quality, often to the detriment of wildlife, including avifauna. Any disturbance and alteration to the desert landscape, including the construction and decommissioning of utility-scale solar energy facilities, has the potential to increase soil erosion. Erosion can physically and physiologically affect plant species and can thus adversely influence primary production and food availability for wildlife (Lovich & Ennen 2011).

Solar energy facilities require substantial site preparation (including the removal of vegetation) that alters topography and, thus, drainage patterns to divert the surface flow associated with rainfall away from facility infrastructure. Channelling runoff away from plant communities can have dramatic negative effects on water availability and habitat quality in arid areas. Areas deprived of runoff from sheet flow support less biomass of perennial and annual plants relative to adjacent areas with uninterrupted water-flow patterns (Lovich & Ennen 2011).

The activities listed below are typically associated with the construction and operation of solar facilities and could have direct impacts on avifauna (County of Merced 2014):

- Preparation of solar panel areas for installation, including vegetation clearing, grading, cut and fill;
- Excavation/trenching for water pipelines, cables, fibre-optic lines, and the septic system;
- Construction of piers and building foundations;
- Construction of new dirt or gravel roads and improvement of existing roads;
- Temporary stockpiling and side-casting of soil, construction materials, or other construction wastes;
- Soil compaction, dust, and water runoff from construction sites;
- Increased vehicle traffic;
- Short-term construction-related noise (from equipment) and visual disturbance;
- Degradation of water quality in drainages and other water bodies resulting from project runoff;
- Maintenance of fire breaks and roads; and
- Weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.

These activities could have an impact on birds breeding, foraging and roosting in or in close proximity through disturbance and transformation of habitat, which could result in temporary or permanent displacement.

In a study comparing the avifaunal habitat use in PV arrays with adjoining managed grassland at airports in the USA, DeVault et al. (2014) found that species diversity in PV arrays was reduced compared to the

grasslands (37 vs 46), supporting the view that solar development is generally detrimental to wildlife on a local scale.
In order to identify functional and structural changes in bird communities in and around the development footprint, Visser (2016) gathered bird transect data at the 180 hectares, 96MW Jasper PV solar facility in the Northern Cape, representing the solar development, boundary, and untransformed landscape. She found both bird density and diversity per unit area was higher in the boundary and untransformed landscape, however, the extent therefore was not considered to be statistically significant. This indicates that the PV facility matrix is permeable to most species. However, key environmental features, including available habitat and vegetation quality are most likely the overriding factors influencing species' occurrence and their relative density within the development footprint. Her most significant finding was that the distribution of birds in the landscape changed, from a shrubland to open country and grassland bird community, in response to changes in the distribution and abundance of habitat resources such as food, water and nesting sites. These changes in resource availability patterns were detrimental to some bird species and beneficial to others. Shrubland specialists appeared to be negatively affected by the presence of the PV facility. In contrast, open country/grassland and generalist species, were favoured by its development (Visser 2016).

It is highly likely that the same pattern of reduced avifaunal densities and possible changes in densities and composition favouring grassland species will manifest itself at the proposed BSPP.

6.4.2 Impacts associated with powerlines

6.4.2.1 Electrocutions

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

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004). The electrocution risk is largely determined by the pole/tower design.

6.4.2.2 Collisions

Collision mortality is the biggest threat posed by transmission lines to birds in southern Africa (Van Rooyen 2004). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (Van Rooyen 2004, Anderson 2001). In a her PhD study, Shaw (2013) provides a concise summary of the phenomenon of avian collisions with transmission lines:

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

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

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

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

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (see **Figure 8** below - Jenkins *et al.* 2010).

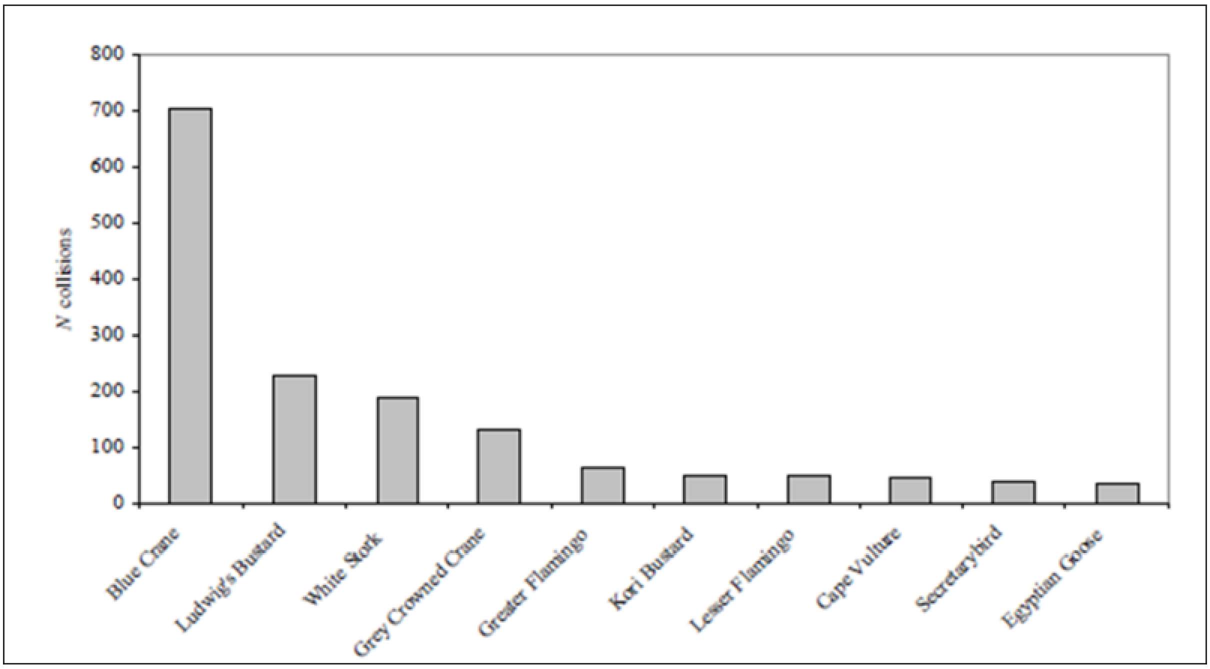


Figure 9: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

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

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

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

6.4.2.3 Displacement due to habitat destruction and disturbance associated with the construction of the powerlines and substation

During the construction phase and maintenance of power lines and substations, some habitat destruction and transformation inevitably takes place. This happens with the construction of access roads, the clearing of servitudes and the levelling of substation yards. These activities have an impact on birds breeding, foraging and roosting in or in close proximity of the substation and power line servitudes through transformation of habitat, which could result in temporary or permanent displacement.

Apart from direct habitat destruction, the above-mentioned construction and maintenance activities also impact on birds through disturbance; this could lead to breeding failure if the disturbance happens during a critical part of the breeding cycle. Construction activities in close proximity to breeding locations could be a source of disturbance and could lead to temporary breeding failure or even permanent abandonment of nests.

7 Assessment of the proposed Brypaal Solar Power Project

7.1 Displacement due to disturbance associated with the construction and de-commissioning of the solar plant and associated infrastructure (construction and de-commissioning)

The construction (and de-commissioning) of the PV plant and associated infrastructure will result in a significant amount of movement and noise, which will lead to displacement of avifauna from the development footprint. It is highly likely that most priority species potentially occurring on the site will vacate the development footprint for the duration of these activities.

7.2 Displacement due to habitat transformation associated with the PV plant and associated infrastructure (operation)

The construction of the PV plant and associated infrastructure will result in the radical transformation of the existing natural habitat. The vegetation will be cleared prior to construction commencing. Once operational, less sunlight will reach the vegetation below the solar panels, which is likely to result in stunted vegetation growth and possibly complete eradication of some plant species. The natural vegetation is likely to persist in the rows between the solar panels, but it will be different to what was available before the construction of the plant, in that it will be short grassland with few (if any) shrubs.

Small to medium-sized birds are often capable of surviving in small pockets of suitable habitat and are therefore generally less affected by habitat fragmentation than larger species. It is, therefore, possible that the smaller and medium-sized species (e.g. passerines) recorded at the site will continue to use the habitat available within the solar facility, albeit at reduced densities for some, especially as far as shrubland specialists are concerned e.g. Rufous-eared Warbler *Malcorus pectoralis*. Larger priority species which require contiguous, un-fragmented tracts of suitable habitat (e.g. large raptors, korhaans and bustards) are likely to occur at vastly reduced densities in the proposed plant or may even be totally displaced. The only larger priority species which was regularly encountered during surveys at the site, was the Karoo Korhaan. The species is described by Hockey *et al.* (2005) as “common and wide-spread in the Nama Karoo” and the impact of displacement on the regional population, should it occur, should therefore be minimal.

In the case of some priority raptors (e.g. Southern Pale Chanting Goshawk, Lanner Falcon and Pygmy Falcon) the potential availability of carcasses or injured birds due to collisions with the solar panels, and enhanced prey visibility (e.g. insects, reptiles and rodents) in the short grassland between the solar panels may attract them to the area. Jeal (2017) recorded large numbers of Barn Owls at the Bokpoort parabolic trough CSP facility near Groblershoop in the Northern Cape, roosting in the ‘torque tubes’ that support the parabolic mirrors – while this influx of owls may have been because of a lack of suitable roosting substrate in the surrounding range land, the enhanced prey visibility due to the sparse vegetation cover in the plant itself may also have played a role in attracting the owls. Greater Kestrel and Rock Kestrel could also be attracted to the solar panels as perches from where to hunt for rodent and insect prey.

Cape Sparrows *Passer melanurus*, Laughing Doves *Spilopelia senegalensis* and other small birds will very likely attempt to nest underneath the solar panels to take advantage of the shade, but this should not adversely affect the operation of the equipment. The support frames and structures below the panels are probably too low for Sociable Weavers to nest on them.

Table 2 lists the priority species that could potentially be displaced due to habitat transformation[2].

7.3 Collisions with the solar panels (operation)

The priority species that may possibly occur in the development area which could potentially be exposed to collision risk are listed in Table 2. In addition, the so-called “lake effect” could act as a potential attraction to waterbirds. It is not possible to tell whether this will happen until post-construction monitoring reveals actual mortality at the site, but the lack of major waterbodies with large waterbird populations in close vicinity to the proposed development area decreases the probability of the lake effect being a major source of mortality.

7.4 Entrapment in perimeter fences

Priority species such as Karoo Korhaan, Northern Black Korhaan, Kori Bustard and Ludwig’s Bustard may be vulnerable to entrapment between double perimeter fences. The possibility of using a single perimeter fence should be investigated. Alternatively, the two fences should be placed far apart enough for birds to able to take off if they somehow end up between the two fences. In addition, staff should be sensitised to not panic birds when they discover them trapped between the fences bit to approach them with caution to give them time to escape by taking off in a lengthwise direction.

7.5 Impact on the solar infrastructure

An impact that could potentially materialise is the pollution of the solar panels by faecal deposits of large birds, particularly Pied Crows and raptors, if they regularly perch on the panels. It is expected that the regular cleaning and maintenance activities should prevent this from becoming a problem.

7.6 Assessment of the associated powerlines

7.6.1 Electrocutions

[2] In some instances, the displacement will not be complete, but will result in lower densities.

Given the clearance distances between the phases, the proposed 400kV power line should not pose an electrocution risk to avifauna regardless of the structure type which will be used. The approximate clearance distances (spacing) between phases typically ranges between 7m and 8.5m for the proposed tower types. Due to the large size of the clearances on most overhead lines of above 132kV, electrocutions are generally ruled out as even the largest birds cannot physically bridge the gap between dangerous components. It can therefore be concluded that electrocutions on the proposed 400kV grid connection should not be possible through conventional mechanisms, regardless of the tower type that will ultimately be used.

7.6.2 Collisions

See Table 2 for potential candidates for collision mortality in the Nama Karoo habitat on the proposed power line. The species most at risk will be Ludwig's Bustard, Kori Bustard and Karoo Korhaan.

7.7 Impact Rating Criteria

The impact criteria used to assess the potential impacts are set-out in detail below.

7.7.1 Method for Assessing the Significance of Potential Impacts

This section outlines the proposed method for assessing the significance of the potential environmental impacts. For each impact, the **EXTENT** (spatial scale), **MAGNITUDE** (severity of impact) and **DURATION** (time scale) are described.

These criteria are used to ascertain the **SIGNIFICANCE** of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place. The mitigation described represent the full range of plausible and pragmatic measures but does not necessarily imply that they would be implemented.

The tables below indicate the scale used to assess these variables and defines each of the rating categories.

CRITERIA	CATEGORY	DESCRIPTION
Extent or spatial influence of impact	Regional	Beyond a 10km radius of the proposed site.
	Local	Within a 10km radius of the proposed site.
	Site specific	On site or within 100m of the proposed site.
Magnitude of impact (at the indicated spatial scale)	High	Natural and/ or social functions and/ or processes are *severely* altered
	Medium	Natural and/ or social functions and/ or processes are *notably* altered
	Low	Natural and/ or social functions and/ or processes are *slightly* altered
	Very Low	Natural and/ or social functions and/ or processes are *negligibly* altered
	Zero	Natural and/ or social functions and/ or processes remain *unaltered*
Duration of impact	Construction period	Up to 1 year
	Short Term	Up to 3 years after construction
	Medium Term	3-10 years after construction
	Long Term	More than 10 years after construction

The **SIGNIFICANCE** of an impact is derived by taking into account the temporal and spatial scales and magnitude. The means of arriving at the different significance ratings is explained in Table 6.

Table 5 Definition of significance ratings

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED
High	▪ High magnitude with a regional extent and long-term duration ▪ High magnitude with either a regional extent and medium-term duration or a local extent and long-term duration ▪ Medium magnitude with a regional extent and long-term duration
Medium	▪ High magnitude with a local extent and medium-term duration ▪ High magnitude with a regional extent and construction period or a site-specific extent and long-term duration ▪ High magnitude with either a local extent and construction period duration or a site-specific extent and medium-term duration ▪ Medium magnitude with any combination of extent and duration except site specific and construction period or regional and long term ▪ Low magnitude with a regional extent and long-term duration

Low	▪ High magnitude with a site-specific extent and construction period duration ▪ Medium magnitude with a site-specific extent and construction period duration ▪ Low magnitude with any combination of extent and duration except site specific and construction period or regional and long term ▪ Very low magnitude with a regional extent and long-term duration
Very low	▪ Low magnitude with a site-specific extent and construction period duration ▪ Very low magnitude with any combination of extent and duration except regional and long term
Neutral	▪ Zero magnitude with any combination of extent and duration

Once the significance of an impact has been determined, the **PROBABILITY** of this impact occurring as well as the **CONFIDENCE** in the assessment of the impact would be determined using the rating systems outlined in Table 7 and Table 8, respectively.

It is important to note that the significance of an impact should always be considered in conjunction with the probability of that impact occurring. Lastly, the **REVERSIBILITY** of the impact is estimated using the rating system outlined in Table 9.

Table 6: Definition of probability ratings

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95 % chance of the impact occurring.
Probable	Estimated 5 to 95 % chance of the impact occurring.
Unlikely	Estimated less than 5 % chance of the impact occurring.

Table 7 Definition of confidence ratings

CONFIDENCE RATINGS	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 8:Definition of reversibility ratings

REVERSIBILITY RATINGS	CRITERIA
Irreversible	The activity will lead to an impact that is in all practical terms permanent.
Reversible	The impact is reversible within 2 years after the cause or stress is removed.

Table 9: Definition of irreplaceability ratings

IRREPLACEABILITY RATINGS	CRITERIA
Low	The affected resource is not unique and or does not serve an critical function or is degraded
Medium	The affected resource is moderately important in terms of uniqueness and function or in pristine condition

High	The affected resource is important in terms of uniqueness and function and or in pristine condition and warrants conservation / protection

7.8 Impact Tables

7.8.1 PV site

Displacement due to disturbance: PV site			
Construction phase			
	Preferred Alternative		**No Go Alternative**
Short description	Displacement of priority avifauna due to disturbance associated with the construction of the solar plant and associated infrastructure		The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained
Assessment			
	Pre-Mitigation	**Post Mitigation**	
Nature	Negative	Negative	
Duration	Short term	Short term	
Extent	Site specific	Site specific	
Magnitude	High	Medium	
Probability	Probable	Probable	
Confidence	Sure	Sure	
Reversibility	Reversible	Reversible	
Resource irreplaceability	Low	Low	
Mitigatability	Low	Low	
Significance	Medium	Medium	
Mitigation	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned.		
Cumulative Impact assessment	There are no planned or existing renewable energy facilities within a 30km radius around the proposed BSPP. The cumulative impact of displacement due to disturbance on priority species as a result of the project should therefore be very low.		

Displacement due to habitat destruction: PV site

Operational phase			
	Preferred Alternative		No Go Alternative
Short description	Displacement of priority avifauna due to habitat transformation associated with the PV plant and associated infrastructure		The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained.
Assessment			
	Pre-Mitigation	**Post Mitigation**	
Nature	Negative	Negative	
Duration	Long term	Long term	
Extent	Site specific	Site specific	
Magnitude	Medium	Low	
Probability	Probable	Probable	
Confidence	Unsure	Unsure	
Reversibility	Partially reversible	Partially reversible	
Resource irreplaceability	Medium	Medium	
Mitigatability	Low	Low	
Significance	High	Medium	
Mitigation	• The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of transformed areas is concerned.		
Cumulative Impact assessment	There are no planned or existing renewable energy facilities within a 30km radius around the proposed Brypaal Solar Project. The cumulative impact of displacement due to habitat transformation on priority species as a result of the project should therefore be very low as the footprint is small and there is abundant habitat available in the surrounding area.		

Collisions with the solar panels: PV site		
Operational phase		
	Preferred Alternative	**No Go Alternative**
Short description	Collisions of priority avifauna with the solar panels resulting in the mortality of priority species.	The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained.
Assessment		
	Pre-Mitigation	**Post Mitigation**
Nature	Negative	Negative
Duration	Long term	Long term
Extent	Site specific	Site specific
Magnitude	Low	Very low
Probability	Probable	Probable
Confidence	Unsure	Unsure
Reversibility	Reversible	Reversible
Resource irreplaceability	Low	Low
Mitigatability	Medium?	Medium?
Significance	Low	Very low
Mitigation	• No mitigation is required due to the very low expected magnitude	
Cumulative Impact assessment	There are no planned or existing renewable energy facilities within a 30km radius around the proposed BSPP. The cumulative impact of collision mortality on priority species as a result of the project should therefore be very low.	

Entrapment in perimeter fences: PV site			
Operational phase			
	Preferred Alternative		**No Go Alternative**
Short description	Entrapment in perimeter fences resulting in the mortality of priority species.		The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained.
Assessment			
	Pre-Mitigation	**Post Mitigation**	
Nature	Negative	Negative	
Duration	Long term	Long term	
Extent	Local	Local	
Magnitude	Very low	Very low	
Probability	Probable	Unlikely	
Confidence	Unsure	Unsure	
Reversibility	High	High	
Resource irreplaceability	Low	Low	
Mitigatability	High	High	
Significance	Low	Very low	
Mitigation	A single perimeter fence should be used. Alternatively, the two fences should be at least 4 metres apart to allow medium to large birds enough space to take off.		
Cumulative Impact assessment	There are no planned or existing renewable energy facilities within a 30km radius around the proposed BSPP. The cumulative impact of mortality on priority species due to entrapment in fences as a result of the project should therefore be very low.		

Displacement due to disturbance: PV site			
Decommissioning phase			
	Preferred Alternative		No Go Alternative
Short description	The de-commissioning of the PV plant and associated infrastructure will result in a significant amount of movement and noise, which will lead to displacement of priority avifauna from the site due to disturbance. It is highly likely that most priority species will temporarily vacate the site footprint.		The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained.
Assessment			
	Pre-Mitigation	**Post Mitigation**	
Nature	Negative	Negative	
Duration	Short term	Short term	
Extent	Site specific	Site specific	
Magnitude	High	Medium	
Probability	Probable	Probable	
Confidence	Sure	Sure	
Reversibility	Reversible	Reversible	
Resource irreplaceability	Low	Low	
Mitigatability	Low	Low	
Significance	Low	Low	
Mitigation	• Activity should be restricted to the immediate footprint of the infrastructure. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum as far as practical. • The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the footprint and rehabilitation of disturbed areas is concerned.		
Cumulative Impact assessment	There are no planned or existing renewable energy facilities within a 30km radius around the proposed Brypaal Solar Project. The cumulative impact of displacement due to disturbance on priority species as a result of the project decommissioning should therefore be very low.		

7.8.2 Powerlines

Collisions: Grid connection			
Operational phase			
			No Go Alternative
Short description	Collisions of priority species with the earthwire of the proposed 400kV grid connection.		The no-go option will result in no additional impacts on avifauna and will result in the ecological status quo being maintained
Assessment			
	Pre-Mitigation	**Post Mitigation**	
Nature	Negative	Negative	
Duration	Long term	Long term	
Extent	Local	Local	
Magnitude	High	Medium	
Probability	Probable	Probable	
Confidence	Sure	Sure	
Reversibility	Low	Low	
Resource irreplaceability	High	High	
Mitigatability	Medium	Medium	
Significance	Low	Very Low	
Mitigation	The 400kV grid connection should be marked with Bird Flappers, on the earthwire for the entire length of the line.		
Cumulative Impact assessment	There are other HV lines present within the 30km radius around the proposed Brypaal Solar Power Project, either running to or from the Aries Substation which is situated approximately 50km south-east of the proposed solar development. The level of collision mortality on these lines is unknown, but it can be assumed that it is a regular occurrence. However, the short length of the proposed 400kV line should limit the potential for collision mortality, especially if properly mitigated with Bird Flight Diverters. The cumulative impact of the powerline in terms of potential collision mortality of priority species is therefore rated to be Low.		

7.9 Cumulative impacts

Cumulative effects are commonly understood to be impacts from different projects that combine to result in significant change, which could be larger than the sum of all the individual impacts. The assessment of cumulative effects therefore need to consider all renewable energy developments (wind and solar) within at least a 30-km radius of the proposed site. In this instance, there are no renewable energy projects within a 30km radius around the proposed BSPP (DEA 2018). The cumulative impact of the proposed proect is therefore considered to be Very Low, due to the small development footprint, which comprises only 0.1% of the available habitat in the 30km radius.

7.10 No-Go Alternative

The no-go alternative will result in the current status quo being maintained as far as the avifauna is concerned. The low human population in the area is definitely advantageous to avifauna. The no-go option would therefore eliminate any additional impact on the ecological integrity of the proposed development area as far as avifauna is concerned.

8 CONCLUSIONS

The proposed BSPP will have some pre-mitigation impacts on avifauna at a site and local level which will range from High to Low.

The impact of displacement due to disturbance during the construction phase is rated as Medium and will remain at a Medium level after mitigation. The impact of displacement of priority species due to habitat transformation associated with the operation of the plant and associated infrastructure is rated as High. This impact can be partially reversed through mitigation, putting it at a Medium level, after mitigation. The remaining envisaged impacts, i.e. mortalities in the operational phase due to collisions with the solar panels and entrapment in perimeter fences are both rated as Low and should be mitigatable to a Very Low level with appropriate mitigation. The impact of the proposed 400kV grid connection is assessed to be Low and can be further mitigated to a Very Low level, due to the short length of the proposed overhead line.

The relatively small size of the footprint leads one to the conclusion that the cumulative impact of the facility on priority avifauna should in all likelihood be Very Low, taking into account the lack of other renewable projects within a 30km radius around the development area.

9 RECOMMENDATIONS

From an avifaunal impact perspective, the proposed development could go ahead, provided the proposed mitigation measures are strictly implemented. No further monitoring will be required during the operational phase.

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APPENDIX 1: FIELD SURVEYS

1 Methodology

Monitoring was conducted in the following manner:

- A visit to the study area was conducted on 9 February 2018, followed up by on-site surveys from 28 February to 2 March 2018 (summer) and again from 10 – 12 April 2018 (autumn).
- Four walk transects were identified totalling 1km each in the proposed 300ha PV development area (see Figure 1 below).
- One observer walking slowly recorded all species on both sides of the transect. The observer stopped at regular intervals to scan the environment with binoculars.
- Each transect was counted six times over a period of three day, with counts taking place in the morning between 7h00 and 11h30, and again in the afternoon between 14h00 and 18h00. The order in which the transects were counted were rotated in order to get as broad a spread of conditions for each transect.
- The following variables were recorded:
  - Species;
  - Number of birds;
  - Date;
  - Start time and end time;
  - Estimated distance from transect (m);
  - Wind direction;
  - Wind strength (estimated Beaufort scale 1 - 7);
  - 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.
- All incidental sightings of priority species were recorded.
- The section of the Aries – Kokerboom 400kV transmission line running parallel to the study area was inspected for evidence of breeding raptors on the towers each season.

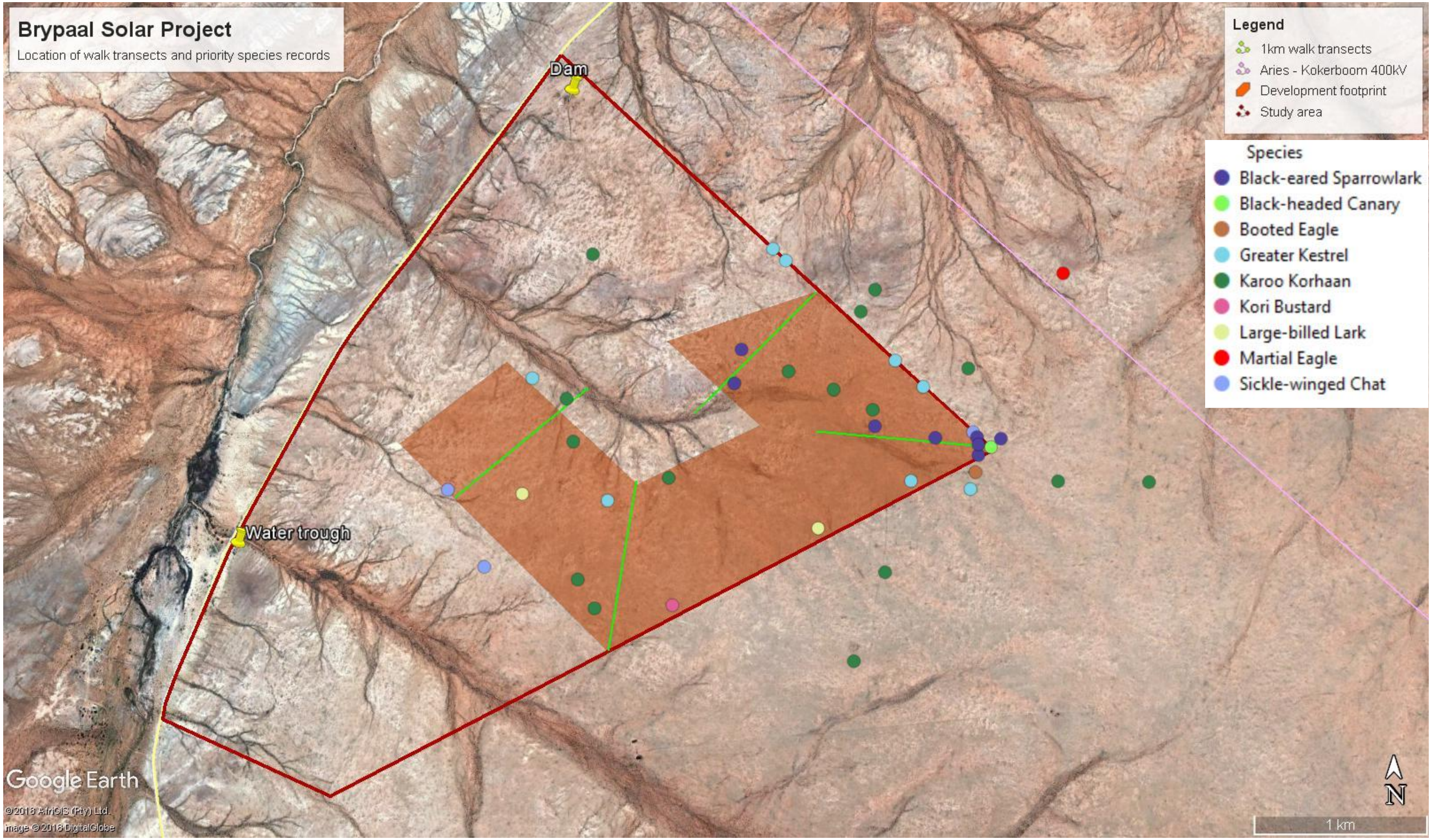

Figure 1: Walk transects used during field surveys, and the location of priority species records (incidental sightings included).

APPENDIX 2: AVIFAUNA POTENTIALLY OCCURRING AT THE STUDY AREA

Species	Taxnomic name	SABAP2 reporting rat	SABAP1 reporting rat	RD Global	RD Regional	Recorded during pre-cnstruction surveys	Endemic - South Africa	Endemic - Southern Africa	Priority species
Avocet, Pied	*Recurvirostra avosetta*	50	17						
Barbet, Acacia Pied	*Tricholaema leucomelas*	50	21					Near-endemic	
Bishop, Southern Red	*Euplectes orix*	50	11						
Bokmakierie	*Telophorus zeylonus*	50	13			√			
Bunting, Lark-like	*Emberiza impetuani*	100	38			√		Near-endemic	
Bustard, Kori	*Ardeotis kori*			NT	NT	√			√
Bustard, Ludwig's	*Neotis ludwigii*		13	EN	EN			Near-endemic	√
Buzzard, Jackal	*Buteo rufofuscus*		11				Near endemic	Endemic	√
Canary, Black-headed	*Serinus alario*		8			√	Near endemic	Endemic	√
Canary, Black-throated	*Crithagra atrogularis*		6						
Canary, White-throated	*Crithagra albogularis*	100	6					Near-endemic	
Canary, Yellow	*Crithagra flaviventris*	50	25					Near-endemic	
Chat, Anteating	*Myrmecocichla formicivo*	50	25			√		Endemic	√
Chat, Familiar	*Cercomela familiaris*	50	13						
Chat, Karoo	*Cercomela schlegelii*		13			√		Near-endemic	
Chat, Tractrac	*Cercomela tractrac*	100	13			√		Near-endemic	
Cisticola, Grey-backed	*Cisticola subruficapilla*		8					Near-endemic	
Coot, Red-knobbed	*Fulica cristata*		17						
Courser, Double-banded	*Rhinoptilus africanus*		17			√			
Crombec, Long-billed	*Sylvietta rufescens*		17						
Crow, Pied	*Corvus albus*	50	0			√			
Cuckoo, Diderick	*Chrysococcyx caprius*		17						
Dove, Laughing	*Streptopelia senegalensi*	50	75						
Dove, Namaqua	*Oena capensis*	100	50						
Drongo, Fork-tailed	*Dicrurus adsimilis*		17						
Eagle, Booted	*Aquila pennatus*		33			√			√
Eagle, Martial	*Polemaetus bellicosus*		33	VU	EN	√			√
Eagle-owl, Spotted	*Bubo africanus*		13						√
Eremomela, Yellow-bellied	*Eremomela icteropygialis*		13						
Falcon, Lanner	*Falco biarmicus*	50	17	LC	VU				√
Falcon, Pygmy	*Polihierax semitorquatus*		50						√
Finch, Red-headed	*Amadina erythrocephala*		6					Near-endemic	
Finch, Scaly-feathered	*Sporopipes squamifrons*		17			√		Near-endemic	
Fiscal, Common (Southern)	*Lanius collaris*		21						
Flamingo, Greater	*Phoenicopterus ruber*		6	LC	NT				√
Flycatcher, Chat	*Bradornis infuscatus*	50	17			√		Near-endemic	
Goose, Egyptian	*Alopochen aegyptiacus*	50	8						
Goshawk, Southern Pale Chanting	*Melierax canorus*	100	29					Near-endemic	√
Heron, Black-headed	*Ardea melanocephala*		13						
Kestrel, Greater	*Falco rupicoloides*		54			√			√
Kestrel, Rock	*Falco rupicolus*		13			√			√
Korhaan, Karoo	*Eupodotis vigorsii*		29	LC	NT	√		Endemic	√
Korhaan, Northern Black	*Afrotis afraoides*		21			√		Endemic	√
Lapwing, Blacksmith	*Vanellus armatus*	50	13						
Lapwing, Crowned	*Vanellus coronatus*		33						
Lark, Fawn-coloured	*Calendulauda africanoides*		0			√			

Appendix 2 Cont..

Species	Taxnomic name	SABAP2 reporting rat	SABAP1 reporting rat	RD Global	RD Regional	Recorded during pre-cnstruction surveys	Endemic - South Africa	Endemic - Southern Africa	Priority species
Lark, Karoo Long-billed	*Certhilauda subcoronata*	50	13					Endemic	√
Lark, Large-billed	*Galerida magnirostris*		17				Near endemic	Endemic	√
Lark, Sabota	*Calendulauda sabota*	100	8			√		Near-endemic	
Lark, Spike-heeled	*Chersomanes albofascia*	100	46			√		Near-endemic	
Lark, Stark's	*Spizocorys starki*	50	25			√		Near-endemic	
Martin, Brown-throated	*Riparia paludicola*		6						
Martin, Rock	*Hirundo fuligula*	100	67						
Masked-weaver, Southern	*Ploceus velatus*	100	13						
Mousebird, White-backed	*Colius colius*	50	6					Endemic	√
Owl, Barn	*Tyto alba*		17						√
Penduline-tit, Cape	*Anthoscopus minutus*		17					Near-endemic	
Pigeon, Speckled	*Columba guinea*		13						
Pipit, African	*Anthus cinnamomeus*		8						
Plover, Kittlitz's	*Charadrius pecuarius*		17						
Plover, Three-banded	*Charadrius tricollaris*	50	25						
Prinia, Black-chested	*Prinia flavicans*	100	75			√		Near-endemic	
Quelea, Red-billed	*Quelea quelea*	50	13						
Reed-warbler, African	*Acrocephalus baeticatus*	50	6						
Ruff	*Philomachus pugnax*		6						
Sandgrouse, Namaqua	*Pterocles namaqua*	50	42			√		Near-endemic	
Scrub-robin, Karoo	*Cercotrichas coryphoeus*		13					Endemic	√
Shelduck, South African	*Tadorna cana*	100	17					Endemic	√
Shoveler, Cape	*Anas smithii*		6					Near-endemic	√
Sickle-winged Chat	*Cercomela sinuata*					√		Endemic	√
Sparrow, Cape	*Passer melanurus*	100	83			√		Near-endemic	
Sparrow, House	*Passer domesticus*		54						
Sparrowlark, Black-eared	*Eremopterix australis*	50	33			√	Near endemic	Endemic	√
Sparrowlark, Grey-backed	*Eremopterix verticalis*	100	33			√		Near-endemic	
Sparrow-weaver, White-browed	*Plocepasser mahali*		21						
Stilt, Black-winged	*Himantopus himantopus*	50	13						
Stint, Little	*Calidris minuta*		6						
Sunbird, Dusky	*Cinnyris fuscus*	100	21					Near-endemic	
Swallow, Barn	*Hirundo rustica*		33						
Swamp-warbler, Lesser	*Acrocephalus gracilirostr*		6						
Swift, Little	*Apus affinis*	100	11						
Teal, Cape	*Anas capensis*	50	17						
Thick-knee, Spotted	*Burhinus capensis*		6						
Tit-babbler, Chestnut-vented	*Parisoma subcaeruleum*	50	17					Near-endemic	
Turtle-dove, Cape	*Streptopelia capicola*	100	71						
Wagtail, Cape	*Motacilla capensis*	50	17						
Warbler, Rufous-eared	*Malcorus pectoralis*	100	29			√		Endemic	√
Waxbill, Common	*Estrilda astrild*		6						
Weaver, Sociable	*Philetairus socius*		71					Endemic	√
Wheatear, Capped	*Oenanthe pileata*		13			√			
Wheatear, Mountain	*Oenanthe monticola*		83					Near-endemic	
White-eye, Orange River	*Zosterops pallidus*		8					Endemic	√