SPECIALIST ASSESSMENT REPORT: AVIFAUNA

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED SOLAFRICA SAND DRAAI CONCENTRATED SOLAR POWER (CSP) AND PV PROJECTS IN THE NORTHERN CAPE PROVINCE:

PARABOLIC TROUGH TECHNOLOGY

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EXECUTIVE SUMMARY

Solafrica Photovoltaic Energy Limited is proposing two Concentrated Solar Power (CSP) projects and one PV project with a combined footprint of approximately 1720ha. This avifaunal impact assessment deals with the 150 MW CSP plant, based on parabolic trough technology, with a footprint of approximately 700ha. The plant is proposed on the farm Sand Draai 391 in the Northern Cape Province of South Africa, approximately 20km from the town of Groblershoop on the Orange River.

A total of 68 bird species were recorded at the combined study area during two seasons of pre-construction monitoring, of which 12 are priority species. Data was captured through transect counts, incidental sightings, inspection of focal points and the recording of flight behaviour from vantage points.

The negative impact of the proposed Sand Draai parabolic trough facility on local priority avifauna will be medium to high, depending on the nature of the impact and the level of mitigation which is applied.

In the case of the plant, the displacement impact due to disturbance during construction is rated as high - negative to start with, and could be reduced to medium to high after application of mitigation measures, provided Alternative 1 is used. If Alternative 2 is used, the impact will remain high, primarily due to the potential impact on the breeding pair of Martial Eagles on tower 22 of the Garona – Gordonia 132kV line. In the case of habitat transformation during operation, the displacement impact on priority species is high – negative and will remain as such after the application of mitigation measures. The impact of direct mortality of priority species due to collisions with the parabolic troughs is likely to be medium to high, and will remain so despite mitigation.

In the case of the proposed pipeline and access road, the impact of disturbance during construction will be high if Alternative 1 is used, primarily due to the potential impact on the breeding pair of Martial Eagles on tower 22 of the Garona – Gordonia 132kV line, despite mitigation. If Alternative 2 is used, the impact will be medium to high.

The proposed 132kV circuit grid connection will have a high negative collision impact on avifauna during operation which could be reduced to medium to high through the application of anti-collision mitigation measures. The impact of displacement caused by the construction of the power line will be high negative if Alternative 2 is used, but it could be reduced to medium to high if Alternative 1 is used, with appropriate mitigation.

In summary therefore the best combination would be Alternative 1 for the plant, Alternative 2 for the road and pipeline and Alternative 1 for the power line.

The cumulative impact of the facility on regional priority avifauna will range from medium to low, depending on the level mitigation which is applied. While the impact on local priority avifauna is likely to be medium to high, the regional impact of the facility is likely to be considerably less, and it could therefore be authorised provided that all mitigation measures are implemented as detailed in the report.

Contents

1 DETAILS OF THE SPECIALISTS AND EXPERTISE TO COMPILE A SPECIALIST REPORT

Chris van Rooyen

Chris has nineteen years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in more than 100 power line and many wind and solar 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 currently (2013) accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman (Pr.Sci.Nat)

Albert has an M. Sc. in Conservation Biology from the University of Cape Town, and started his career in the natural sciences as a Geographic Information Systems (GIS) specialist at Council for Scientific and Industrial Research (CSIR). He is a registered Professional Natural Scientist in the field of zoological science with the South African Council of Natural Scientific Professionals (SACNASP). In 1998, he joined the Endangered Wildlife Trust where he headed up the Airports Company South Africa – 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 they are currently jointly coordinating pre-construction monitoring programmes at several renewable energy facilities. Albert also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Nico Laubscher

Nico holds a D.Sc. from the University of Potchefstroom and was head of the Statistics Division, National Research Institute for Mathematical Sciences of the CSIR from 1959 – 1975. He retired in 1989 as head of the Centre for Statistical Consultation at the University of Stellenbosch. Nico held several offices, including President of the South African Statistical Association, and editor of the South African Statistical Journal. Nico has 56 years' experience in statistical analysis and data science applications, including specialisation in model building with massive data sets, designing of experiments for process improvement and analysis of data so obtained, and statistical process control. He also has published peer reviewed papers in several leading statistical journals, including *Annals of Mathematical Statistics, American Statistical Journal, Technometrics* and *The American Statistician.* He currently operates as a private statistical consultant to industry and academia.

CV's are attached as Annexure A

2 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 Royal HaskoningDHV 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 Solafrica Sand Draai Concentrated Solar Power (CSP) And PV Projects in the Northern Cape Province.

Full Name: Chris van Rooyen
Title / Position: Director

See Annexure B for specialist declaration

3 INTRODUCTION

Solafrica Photovoltaic Energy Limited has appointed Royal HaskoningDHV (Royal Haskoning) to undertake the Environmental Impact Assessment for the construction of a combined proposed Concentrated Solar Power (CSP) and PV project with a combined footprint of approxiametly 1720ha. The proposed construction will consist of:

- One 150 MW CSP plant, based on parabolic trough technology, with a footprint of approximately 700ha;
- One 150MW CSP Plant, based on central receiver technology with a footprint of approximately 1000ha and a tower height of approximately 250m; and
- One 125 MW Photovoltaic plant, with a footprint of approximately 270ha.

This report deals specifically with the potential impacts of the parabolic trough technology.

The facilities will also include ancillary infrastructure in support of the power plants including: water abstraction systems, waste management systems, power lines, roads, storage facilities, administration and operation buildings, construction laydown areas and temporary housing facilities.

Three evaporation ponds will be located outside but nearby the solar field. The effluent will be piped or channelled to the evaporation ponds. The evaporation pond will consist of three (3) compartments that would enable maintenance on any of the three (3) compartments without disrupting the normal operations of the CSP plant. The three (3) compartments will have a small emergency overflow to each of the other compartments. The flow to each of the compartments will be controlled via a splitter box at the top end of the evaporation ponds. A limited amount of silt is to be expected to enter the ponds as no surface water will enter the system. Oil will be separated out of the effluent stream before it reaches the evaporation ponds. The evaporation ponds will not be shared amongst the various plants.

It is estimated that the ponds will need to accommodate the disposal of 130 000 to 150 000 m3/yr. Each evaporation pond will be 150m x 175m x 6m = 157,500 m3. The total area for the evaporation ponds is estimated at 8.5ha.

The above infrastructure is proposed on the farm Sand Draai 391 in the Northern Cape Province of South Africa, approximately 20km from the town of Groblershoop on the Orange River. Royal Haskoning has appointed Chris van Rooyen Consulting to investigate the potential impacts of the proposed facilities on avifauna.

See Figure 4 below for a map of the study area, indicating the layout of the proposed infrastructure.

Trough systems use linear parabolic concentrators to focus sunlight to a receiver along a focal line mounted on the collector. The solar energy is absorbed in a working fluid (typically a heat-transfer oil, or in advanced systems, steam). The working fluid is then piped to a central location to power a conventional steam turbine (Figure 1).

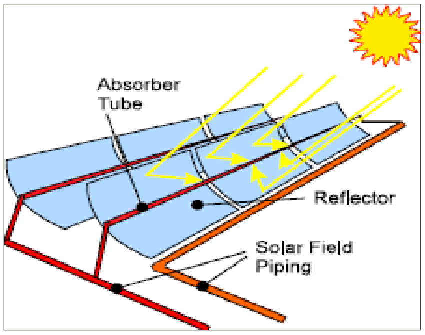

Figure 1: Solar trough system

Central receiver systems use a field of large two-axis tracking mirrors (also called heliostats) to reflect solar radiation onto a centrally located tower-mounted heat exchanger (receiver). The solar energy is absorbed by a working fluid (typically molten salt or air). This working fluid is then used to generate steam, powering a conventional turbine (Figure 2).

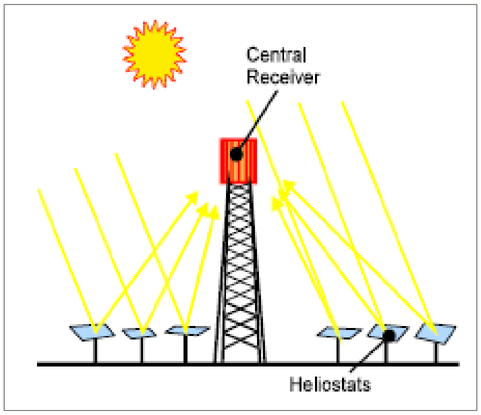

Figure 2: Power tower system

In **photovoltaic technology** the power conversion source is via photovoltaic modules that convert light directly to electricity. This differs from the other large-scale solar generation technology, concentrated solar power, which uses heat to drive a variety of conventional generator systems (Figure 3). Solar panels produce direct current (DC) electricity, so solar parks need conversion equipment to convert this to alternating current (AC), which is the form transmitted by the electricity grid. This conversion is done by inverters. To maximise their efficiency, solar power plants also incorporate maximum power point trackers, either within the inverters or as separate units. These devices keep each solar array string close to its peak power point.

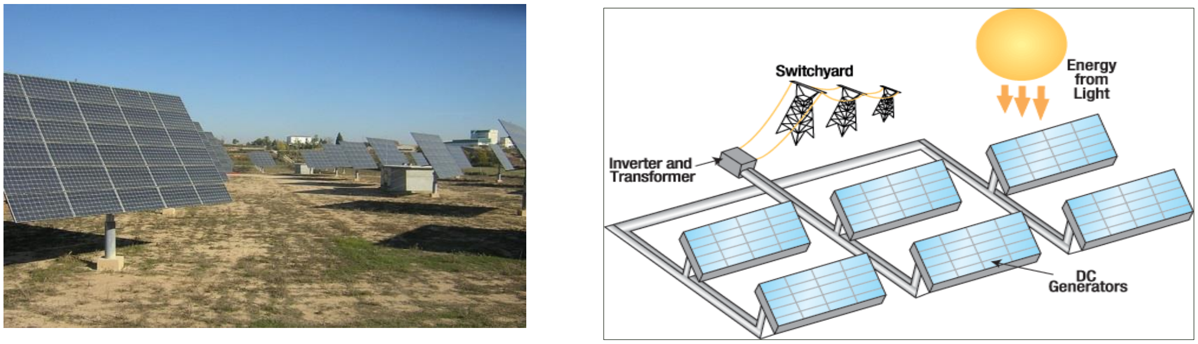

Figure 3: Photovoltaic Technology

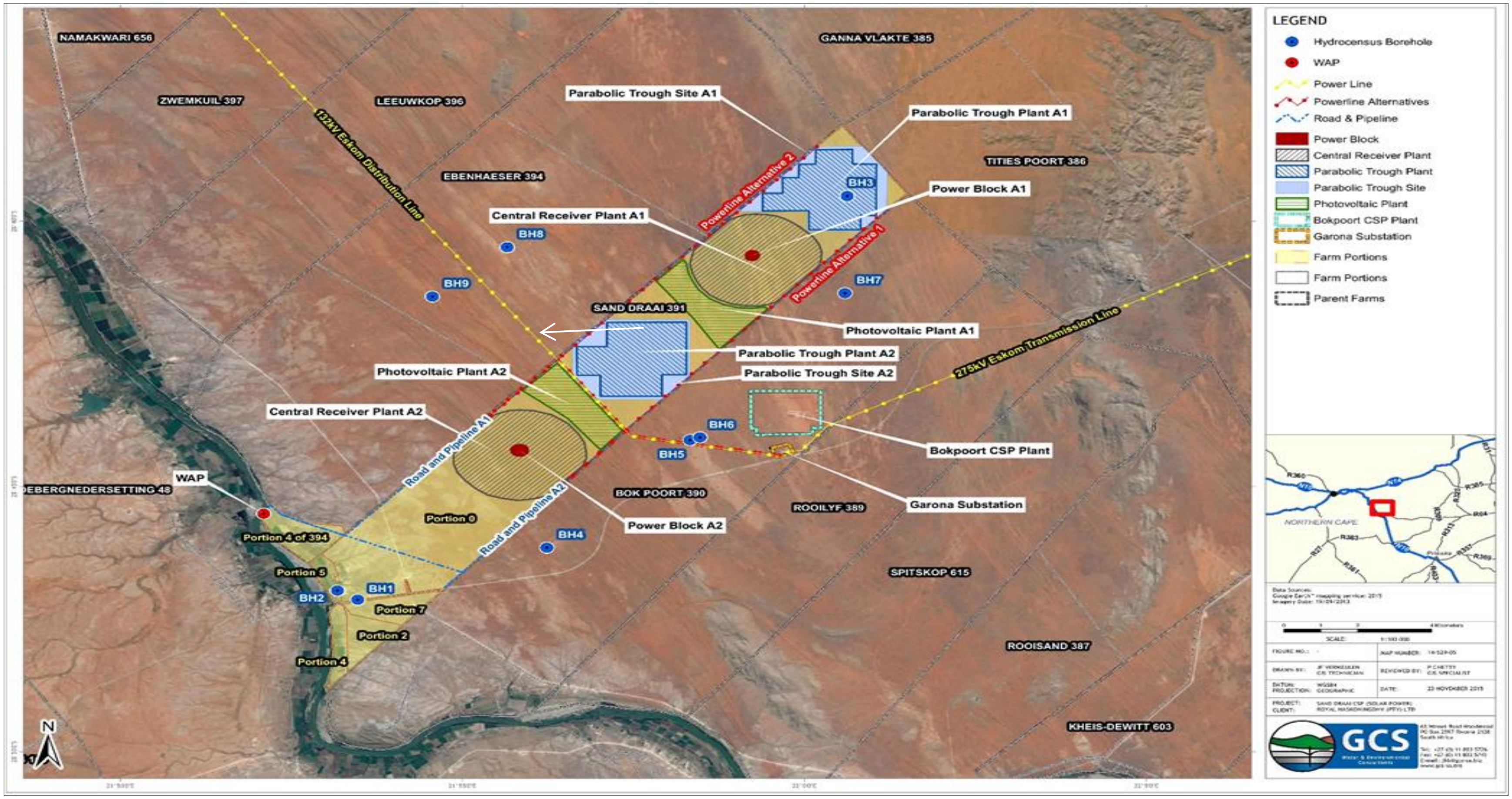

Figure 4: Proposed solar plants and associated infrastructure

4 PROJECT SCOPE

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

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

5 OUTLINE OF METHODOLOGY AND INFORMATION REVIEWED

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

- Bird distribution data of the Southern African Bird Atlas Project2 (SABAP 2) was obtained (http://sabap2.adu.org.za/), in order to ascertain which species occur in the pentads where the proposed line is located. A pentad grid cell covers 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. In order to get a more representative impression of the birdlife, a consolidated data set was obtained for the 9 pentads which overlap substantially with the proposed development. The nine pentad grid cells are the following: 2835_2150, 2835_2155, 2835_2200, 2840_2150, 2840_2155, 2840_2200, 2845_2150, 2845_2155, 2845_2200 (see Figure 5). A total of 11 full protocol lists have been completed to date to date for the 9 pentads where the study area is located (i.e. lists surveys lasting a minimum of two hours each). The SABAP2 data was therefore not regarded as a conclusive snapshot of the avifauna, but merely as a guideline, supplemented by actual data collected during surveys and general knowledge of the area.
- The power line bird mortality incident database of the Endangered Wildlife Trust (1996 to 2008) was consulted to determine which of the species occurring in the study area are typically impacted upon by power lines (Jenkins *et al.* 2010).
- A classification of the vegetation types in the study area was obtained from the Atlas of Southern African Birds 1 (SABAP1) and the National Vegetation Map compiled by the South African National Biodiversity Institute (Mucina & Rutherford 2006).
- Data on the location of large raptor nests in the Northern Cape for the period 1994 – 2009 was obtained from the Kalahari Raptor Project (Maritz 2009).
- 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 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 (2014.1) IUCN Red List of Threatened Species (http://www.iucnredlist.org/).
- The Birdlife South Africa (BLSA) website was consulted on Important Bird Areas of Southern Africa for information on relevant Important Bird Areas (IBAs) (http://www.birdlife.org.za/conservation/important-bird-areas).
- Satellite imagery from Google Earth was used in order to view the broader area on a landscape level and to help identify bird habitat on the ground.
- An intensive internet search was conducted to source information on the impacts of solar facilities on avifauna.
- Additional information on bird diversity and abundance at the site was obtained through a monitoring programme which was conducted in the period October 2015 to December 2015. Data was captured through transect counts, incidental sightings, inspection of focal points and the recording of flight behaviour from vantage points **(see Annexure C for a detailed exposition of the methodology followed).**

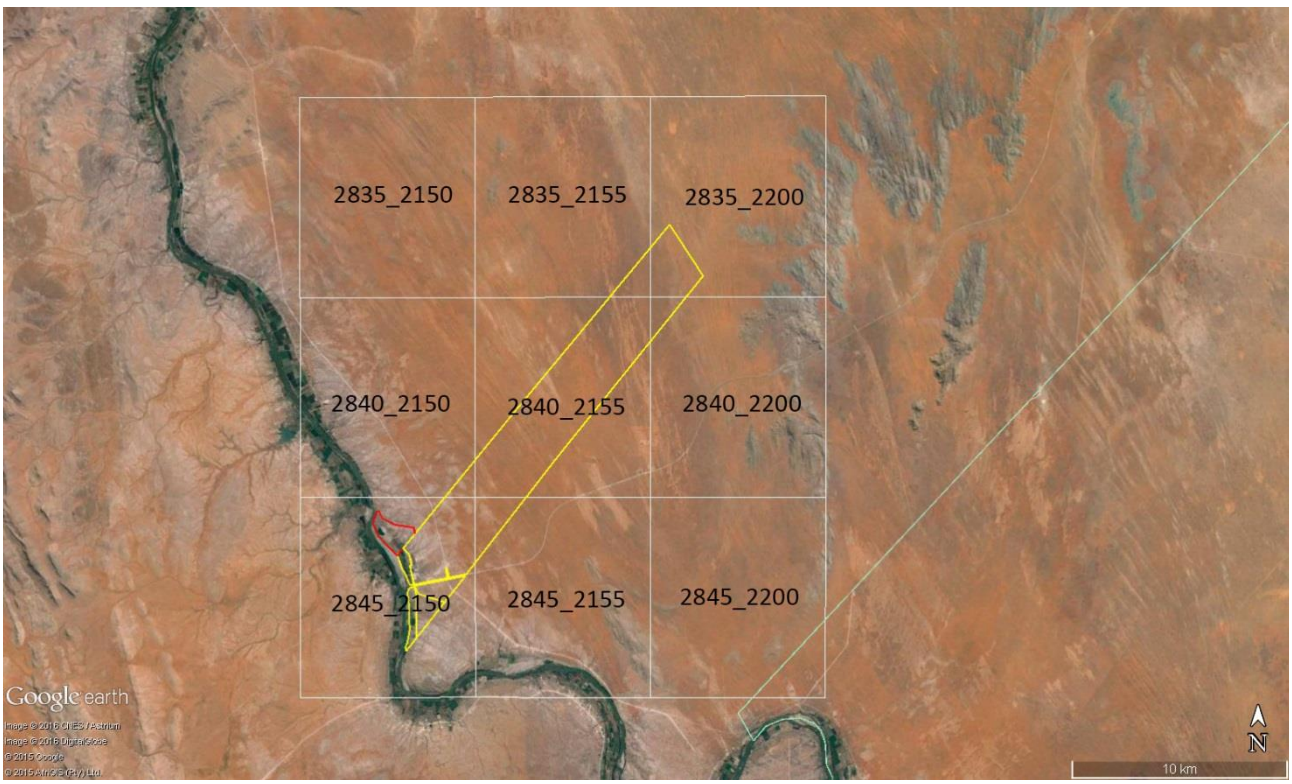

Figure 5: Area covered by the SABAP2 data. The study area is indicated by the yellow polygon.

6 ASSUMPTIONS AND LIMITATIONS

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

- 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;
  - Waterbirds; and
  - 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). Strong reliance was therefore placed on expert opinion and data from existing monitoring programmes at solar facilities in the USA which have recently (2013 - 2015) commenced with avifaunal monitoring. 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 in the study area. Future changes in the baseline environment are not taken into account. This aspect is dealt with under the section dealing with cumulative impacts.
- The study area was defined as the whole of the farm Sand Draai 391.
- 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. However, power line impacts can be predicted with a fair amount of certainty.

7 LEGISLATIVE CONTEXT

There is no specific legislation pertaining specifically to the impact of solar facilities on avifauna. There are best practice guidelines available which were compiled by Birdlife South Africa (BLSA) in 2012 (Smit 2012), which was followed in the compilation of this report. Efforts are currently (January 2016) underway to comprehensively revise these guidelines, however these new guidelines are still in draft form and have not yet been officially adopted by BLSA.

8 BASELINE ASSESSMENT

8.1 Biomes and vegetation types

The study area is situated approximately 20km northwest of the town of Groblershoop, in the Northern Cape Province. The study area is located in an ecotonal zone between two biomes, namely Savanna and Nama Karoo (Mucina &

Rutherford 2006). The study area contains three vegetation types, namely Bushmanland Arid Grassland, Kalahari Karroid Shrubland and Gordonia Duneveld. The first two are associated with Nama Karoo, and the latter with Savanna.

Vegetation structure, rather than the actual plant species, is more significant for bird species distribution and abundance (in Harrison *et al.* 1997). Therefore, the vegetation description below does not focus on lists of plant species, but rather on factors which are relevant to bird distribution. The description of the vegetation types occurring in the study 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.

Savanna (or woodland) is defined as having a grassy under-storey and a distinct woody upper-storey of trees and tall shrubs. Soil types are varied but are generally nutrient poor. The savanna biome contains a large variety of bird species (it is the most species-rich community in southern Africa) but very few bird species are restricted to this biome. In the study area, the savannah biome contains one vegetation type, namely Gordonia Duneveld, which is classified with Southern Kalahari in Harrison *et al.* 1997. Southern Kalahari vegetation occurs on deep Kalahari sands with rolling dunes, and consists of open shrubland with ridges of grassland and semi-deciduous *Acacia* and *Boscia albitrunca* trees along intermittent fossil watercourses and interdunal valleys. Tall trees are generally absent, except along some fossil rivers. Grass cover is highly variable dependent on rain and grazing. Summers are hot, winters cold, rainfall variable averaging <250mm and mostly in summer.

The **Nama Karoo** vegetation largely comprises low shrubs and grasses; peak rainfall occurs in summer with annual rainfall averaging less than 200mm. Trees e.g. *Acacia karroo* and alien species such as Mesquite *Prosopis glandulosa* are mainly restricted to watercourses where fairly luxurious stands can develop, especially along the Orange River. In the study area itself, the Nama Karoo contains two vegetation types, namely Kalahari Karroid Shrubland and Bushmanland Arid Grassland. Bushmanland Arid Grassland consists mainly of extensive to irregular plains sparely vegetated by grassland dominated by white grasses (*Stipagrostis* species) giving the landscape the character of semi-desert "steppe", with a few low shrubs in places.

Large trees are almost absent, but present in some fossil water courses. Kalahari Karroid Shrubland consists of low, karroid shrubland on flat, gravel plains and constitutes a transitional phase between Savanna (Southern Kalahari) and Nama Karoo with bird communities typical of both biomes. Trees are very sparse in the study area, with Shepherd's Tree *Boscia albitrunca* the most commonly recorded species.

Figures 6, 7 and 8 below illustrate the typical vegetation at the study area.

Figure 6: Gordonia Duneveld

Figure 7: Bushmanland Arid Grassland

Figure 8: Kalahari Karroid Shrubland

8.2 Waterbodies and rivers

Surface water is of specific importance to avifauna in this arid study area. The perennial Orange River is located approximately 2km south the study area, and the river channel, pools of water and riverine islands with riparian thickets, reed beds, flooded grasslands and sandbanks provide habitat for a multitude of waterbirds. However, there are no permanent or ephemeral rivers in the study area itself, except for a few small drainage lines in the extreme south of the study area, which drains into the Orange River. The study area does contain at least five boreholes (see Figure 9). Boreholes with open water troughs are important sources of surface water and are used extensively by various species, including large raptors and vultures, to drink and bath. However, the majority of the boreholes will be relocated if the construction of the solar plants goes ahead.

Figure 9: An open water trough in the study area

8.3 High voltage lines

High voltage lines are an important potential roosting and breeding substrate for large raptors in the study area. Existing high-voltage lines are used extensively by large raptors e.g. in 2005 the author did an aerial survey of the Ferrum – Garona 275kV line which starts at Kathu and terminates at Garona Substation approximately

16km north of Groblershoop, and 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. One high-voltage line, the Garona – Gordonia 132kV line running in an east – west direction through the study area, was inspected. A Martial Eagle nest was recorded at tower 22 (28°42'18.44"S 21°56'9.21"E), which is approximately 625m west of the western boundary of the study area (see Figure 10). At the time of the investigation (30 September 2015), an adult bird was in attendance at the nest, and a fresh pellet containing prey remains was collected below the nest, indicating that the nest is likely to be active.

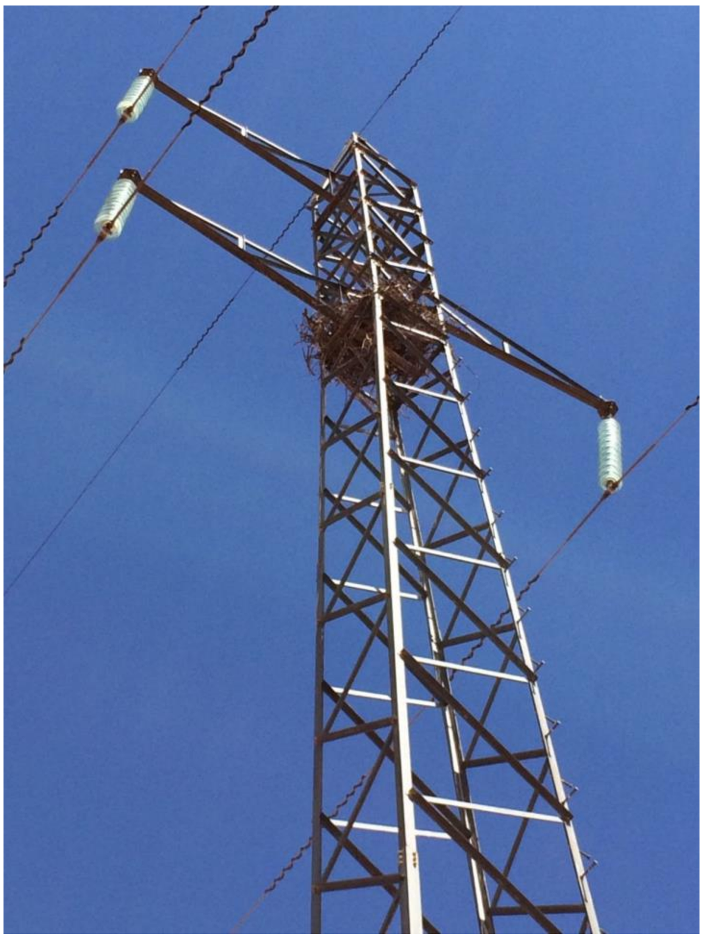

Figure 10: A Martial Eagle nest on tower 22 of the Garona – Gordonia 132kV line

9 AVIFAUNA IN THE STUDY AREA

A total of 68 species were recorded at the study area from all data sources (walk transects, VP watches and incidental sightings), of which 12 are priority species. Table 7–1 lists all species recorded in the study area, and the mode of recording.

See Table 7-2 for an index of kilometric abundance (IKA) of all species recorded during walk transects. Table 7-3 lists all priority species that could potentially occur at the site.

Table 7-1: All species recorded in the study area

Priority species	Taxonomic name	Priority class	Walk transects	VP counts	Incidental sightings
Black-chested Snake-Eagle	*Circaetus pectoralis*	Raptor	*		
Egyptian Goose	*Alopochen aegyptiaca*	CWAC		*	
Fiscal Flycatcher	*Sigelus silens*	Near endemic	*		*
Karoo Korhaan	*Eupodotis vigorsii*	NT			*
Kori Bustard	*Ardeotis kori*	NT	*		*
Lanner Falcon	*Falco biarmicus*	VU	*		
Martial Eagle	*Polemaetus bellicosus*	EN	*	*	*
Pygmy Falcon	*Polihierax semitorquatus*	Raptor	*		
Secretarybird	*Sagittarius serpentarius*	VU	*		
Southern Pale Chanting Goshawk	*Melierax canorus*	Raptor	*	*	*
Tawny Eagle	*Aquila rapax*	EN	*		
White-backed Vulture	*Gyps africanus*	CR		*	
		Priority species subtotal:	9	4	5

Non-priority species	**Taxonomic name**	**Priority class**	**Walk transects**	**VP counts**	**Incidental sightings**
Acacia Pied Barbet	*Tricholaema leucomelas*	-	*	*	*
African Red-eyed Bulbul	*Pycnonotus nigricans*	-	*	*	*
Anteating Chat	*Myrmecocichla formicivora*	-	*	*	*
Ashy Tit	*Parus cinerascens*	-	*	*	
Barn Swallow	*Hirundo rustica*	-	*		
Black-chested Prinia	*Prinia flavicans*	-	*	*	
Bokmakierie	*Telophorus zeylonus*	-	*	*	*
Brown-crowned Tchagra	*Tchagra australis*	-	*		*
Brubru	*Nilaus afer*	-	*		
Cape Sparrow	*Passer melanurus*	-	*	*	
Cape Turtle-Dove	*Streptopelia capicola*	-	*		
Capped Wheatear	*Oenanthe pileata*	-	*		
Chat Flycatcher	*Bradornis infuscatus*	-	*	*	
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	-	*	*	
Common Fiscal	*Lanius collaris*	-	*		
Common Scimitarbill	*Rhinopomastus cyanomelas*	-	*		*
Common Swift	*Apus apus*	-	*		

Non-priority species	**Taxonomic name**	**Priority class**	**Walk transects**	**VP counts**	**Incidental sightings**
Crimson-breasted Shrike	*Laniarius atrococcineus*	-	*		
Double-banded Courser	*Rhinoptilus africanus*	-			*
Dusky Sunbird	*Cinnyris fuscus*	-	*	*	
Eastern Clapper Lark	*Mirafra [apiata] fasciolata*	-	*	*	
Fawn-coloured Lark	*Calendulauda africanoides*	-	*	*	
Greater Striped Swallow	*Hirundo cucullata*	-	*		
Grey-backed Sparrowlark	*Eremopterix verticalis*	-	*	*	
Hadeda Ibis	*Bostrychia hagedash*	-	*	*	
House Sparrow	*Passer domesticus*	-	*		
Kalahari Scrub-Robin	*Cercotrichas paena*	-	*	*	
Karoo Long-billed Lark	*Certhilauda subcoronata*	-	*		
Lark-like Bunting	*Emberiza impetuani*	-	*		
Laughing Dove	*Streptopelia senegalensis*	-	*		
Long-billed Crombec	*Sylvietta rufescens*	-	*		
Namaqua Dove	*Oena capensis*	-	*		
Namaqua Sandgrouse	*Pterocles namaqua*	-	*	*	

Non-priority species	**Taxonomic name**	**Priority class**	**Walk transects**	**VP counts**	**Incidental sightings**
Northern Black Korhaan	*Afrotis afraoides*	-	*	*	*
Pale-winged Starling	*Onychognathus nabouroup*	-	*	*	
Pied Crow	*Corvus albus*	-	*		
Pink-billed Lark	*Spizocorys conirostris*	-	*		
Pririt Batis	*Batis pririt*	-	*	*	
Red-backed Shrike	*Lanius collurio*	-	*		*
Red-billed Quelea	*Quelea quelea*	-	*		
Red-crested Korhaan	*Lophotis ruficrista*	-	*		*
Red-faced Mousebird	*Urocolius indicus*	-	*		
Red-headed Finch	*Amadina erythrocephala*	-	*		
Rock Martin	*Hirundo fuligula*	-	*		
Rufous-eared Warbler	*Malcorus pectoralis*	-	*	*	
Sabota Lark	*Calendulauda sabota*	-			*
Scaly-feathered Finch	*Sporopipes squamifrons*	-	*	*	
Sociable Weaver	*Philetairus socius*	-	*	*	
Southern Masked-weaver	*Ploceus velatus*	-	*	*	
Southern Red Bishop	*Euplectes orix*	-	*		

Non-priority species	Taxonomic name	Priority class	Walk transects	VP counts	Incidental sightings
Speckled Pigeon	*Columba guinea*	-	*		
Spike-heeled Lark	*Chersomanes albofasciata*	-	*	*	*
Spotted Thick-knee	*Burhinus capensis*	-	*		
Swallow-tailed Bee-eater	*Merops hirundineus*	-			*
White-backed Mousebird	*Colius colius*	-	*	*	
White-browed Sparrow-Weaver	*Plocepasser mahali*	-	*		
Yellow Canary	*Crithagra flaviventris*	-	*	*	
Yellow-bellied Eremomela	*Eremomela icteropygialis*	-	*		
		Non-Priority species subtotal:	55	26	13
		Grand Total:	64	30	18

9.1 Transect counts

A total of 3 263 individual birds were recorded during walk transect counts at the turbine site. Of the total amount of birds counted, only 14 individuals were priority species. The remaining 3 249 individuals were all non-priority species.

An Index of Kilometric Abundance (IKA = birds/km) was calculated for each species recorded during walk transects. Table 7-2 and Figure 11 shows the relative abundance of species recorded during the pre-construction monitoring through walk transects.

Table 7-2: Index of kilometric abundance (IKA) of species recorded during walk transects

IKA Index		
Priority Species	**Mean**	**IKA**
Fiscal Flycatcher	0.13	0.02
Kori Bustard	0.13	0.02
Pygmy Falcon	0.13	0.02
Southern Pale Chanting Goshawk	0.13	0.02
Tawny Eagle	0.13	0.02
Black-chested Snake-Eagle	0.06	0.01
Lanner Falcon	0.06	0.01
Martial Eagle	0.06	0.01
Secretarybird	0.06	0.01
Non-priority Species	**Mean**	**IKA**
Grey-backed Sparrow-lark	35.38	5.05
Sociable Weaver	34.94	4.99
Namaqua Sandgrouse	13.81	1.97
Kalahari Scrub-Robin	8.94	1.28
Yellow Canary	8.69	1.24
Black-chested Prinia	8.13	1.16
Fawn-coloured Lark	8.13	1.16
Cape Turtle-Dove	7.94	1.13
Scaly-feathered Finch	6.25	0.89
Chestnut-vented Tit-Babbler	6.19	0.88
Red-faced Mousebird	5.44	0.78
Namaqua Dove	5.38	0.77
White-browed Sparrow-Weaver	4.63	0.66
Barn Swallow	4.00	0.57
Laughing Dove	3.63	0.52
Eastern Clapper Lark	3.50	0.50
Southern Red Bishop	3.13	0.45
Pied Crow	2.69	0.38
Bokmakierie	2.63	0.38
African Red-eyed Bulbul	2.50	0.36
Pink-billed Lark	2.50	0.36
Rufous-eared Warbler	2.19	0.31
Red-crested Korhaan	2.00	0.29
Ant-eating Chat	1.88	0.27
White-backed Mousebird	1.81	0.26
Pririt Batis	1.75	0.25

Southern Masked-weaver	1.75	0.25
Cape Sparrow	1.69	0.24
Spike-heeled Lark	1.31	0.19
Dusky Sunbird	1.25	0.18
Northern Black Korhaan	1.19	0.17
Pale-winged Starling	1.00	0.14
Chat Flycatcher	0.81	0.12
Yellow-bellied Eremomela	0.81	0.12
Ashy Tit	0.75	0.11
Common Scimitarbill	0.75	0.11
Long-billed Crombec	0.69	0.10
Greater Striped Swallow	0.44	0.06
Acacia Pied Barbet	0.38	0.05
Brubru	0.38	0.05
Common Fiscal	0.31	0.04
Red-billed Quelea	0.31	0.04
Brown-crowned Tchagra	0.13	0.02
Common Swift	0.13	0.02
Hadeda Ibis	0.13	0.02
House Sparrow	0.13	0.02
Lark-like Bunting	0.13	0.02
Red-headed Finch	0.13	0.02
Speckled Pigeon	0.13	0.02
Capped Wheatear	0.06	0.01
Crimson-breasted Shrike	0.06	0.01
Karoo Long-billed Lark	0.06	0.01
Red-backed Shrike	0.06	0.01
Rock Martin	0.06	0.01
Spotted Thick-knee	0.06	0.01

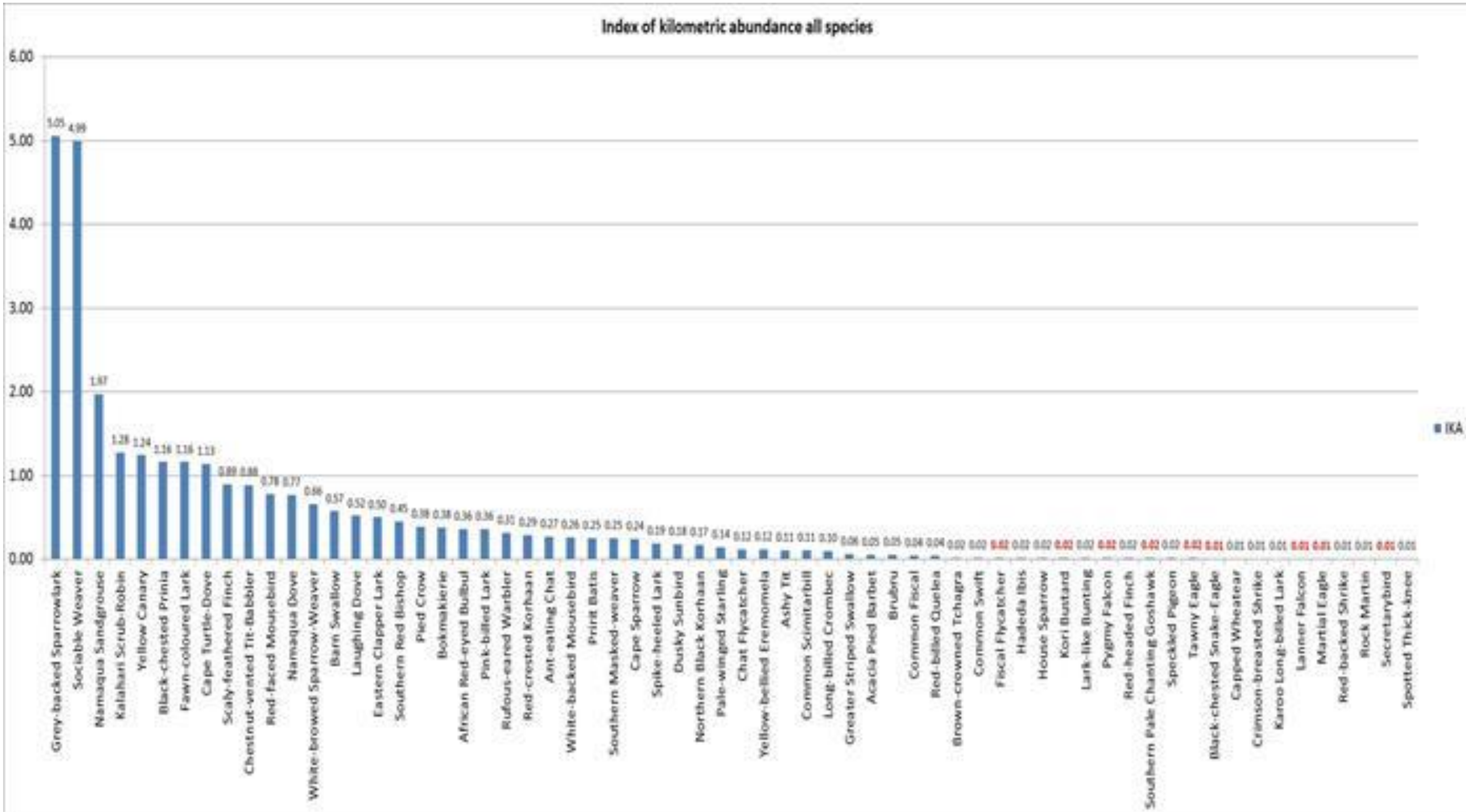

Figure 11: IKA for all species counted during the pre-construction monitoring. Priority species are indicated in red.

Table 7-3 below lists all the priority species that could potentially occur at the site and the potential impact on the respective species by the solar energy infrastructure. Species actually recorded during pre-construction surveys are shaded. The following abbreviations and acronyms are used:

En = Endangered
Vu = Vulnerable
NT = Near-threatened
LC = Least concern
End = South African Endemic
N-End = South African near endemic

Table 7-3: Priority species potentially occurring at the site. Species actually recorded during pre-construction surveys are shaded

Name	Scientific name	Status National	Status International	Savanna	Nama Karoo	Waterbodies	Transmission lines	Solar flux	Collisions	Displacement through disturbance	Displacement through habitat transformation
Kori Bustard	*Ardeatis kori*	NT	NT	x	x				x	x	x
Lanner Falcon	*Falco biarmicus*	Vu	LC	x	x	x	x	x	x	x	
Lappet-faced Vulture	*Torgos tracheliotis*	En	Vu	x	x	x	x	x		x	x
Ludwig's Bustard	*Neotos ludwigii*	En	En	x	x			x	x	x	x
Martial Eagle	*Polemaetus bellicosus*	En	Vu	x	x	x	x	x		x	x
Karoo Korhaan	*Eupodotis vigorsii*	NT	LC		x				x	x	x
Secretarybird	*Sagittarius serpentarius*	Vu	Vu	x		x			x	x	x
Tawny Eagle	*Aquila rapax*	En	LC	x	x	x	x	x		x	x
White-backed Vulture	*Gyps africanus*	En	En	x		x	x	x			x

Name	Scientific name	Status National	Status International	Savanna	Nama Karoo	Waterbodies	Transmission lines	Solar flux	Collisions	Displacement through disturbance	Displacement through habitat transformation
Double-banded Courser	*Rhinoptilus africanus*	NT	LC		x				x	x	x
Verreaux's Eagle	*Aquila verreauxii*	VU	LC	x	x	x		x			x
Fairy Flycatcher	*Stenostira scita*	N-End	LC	x	x			x	x	x	x
Fiscal Flycatcher	*Sigelus silens*	N-End	LC	x	x			x	x	x	x
Southern Pale Chanting Goshawk	*Melierax canorus*	LC	LC	x	x	x	x	x	x	x	x
Pygmy Falcon	*Polihierax semitorquatus*	LC	LC	x	x		x		x	x	x
Black-chested Snake-eagle	*Circaetus pectoralis*	LC	LC	x	x		x	x		x	x
Egyptian Goose	*Alopochen aegyptiaca*	LC	LC			x		x		x	x
Booted Eagle	*Hieraaetus pennatus*	LC	LC	x	x	x		x			
Spotted Eagle-Owl	*Bubo africanus*	LC	LC	x	x				x	x	x
Greater Kestrel	*Falco rupicoloides*	LC	LC	x	x		x	x	x	x	x
Rock Kestrel	*Falco rupicolus*	LC	LC	x	x		x	x	x	x	x

Name	Scientific name	Status National	Status International	Savanna	Nama Karoo	Waterbodies	Transmission lines	Solar flux	Collisions	Displacement through disturbance	Displacement through habitat transformation
Black-shouldered Kite	*Elanus caeruleus*	LC	LC	x			x	x	x	x	x
Barn Owl	*Tyto alba*	LC	LC	x	x				x	x	x
Pearl-spotted Owlet	*Glaucidium perlatum*	LC	LC	x					x	x	x
Greater Flamingo	*Phoenicopterus roseus*	NT	LC			x			x		
Lesser Flamingo	*Phoeniconaias minor*	NT	LC			x			x		

9.2 Vantage point watches

A total of 72 hours of vantage point watches (12 hours per survey per vantage point) was completed in order to record flight patterns of priority species at the site. In the two sampling periods, priority species were recorded flying over the VP areas for a total of 34 minutes and 45 seconds. A total of only 7 individual flights were recorded, containing a total of 13 individual birds. Of these, 2 (28.5%) flights were at low altitude (0-20m), 1 (14.3%) was at medium altitude (20 -250m) and 4 (57.1%) were at a high altitude (>250m). The passage rate for priority species over the VP area (all flight heights) was 0.18 birds/hour. See Figure 12 below for the duration of flights within the VP area for each priority species, at each height class[1].

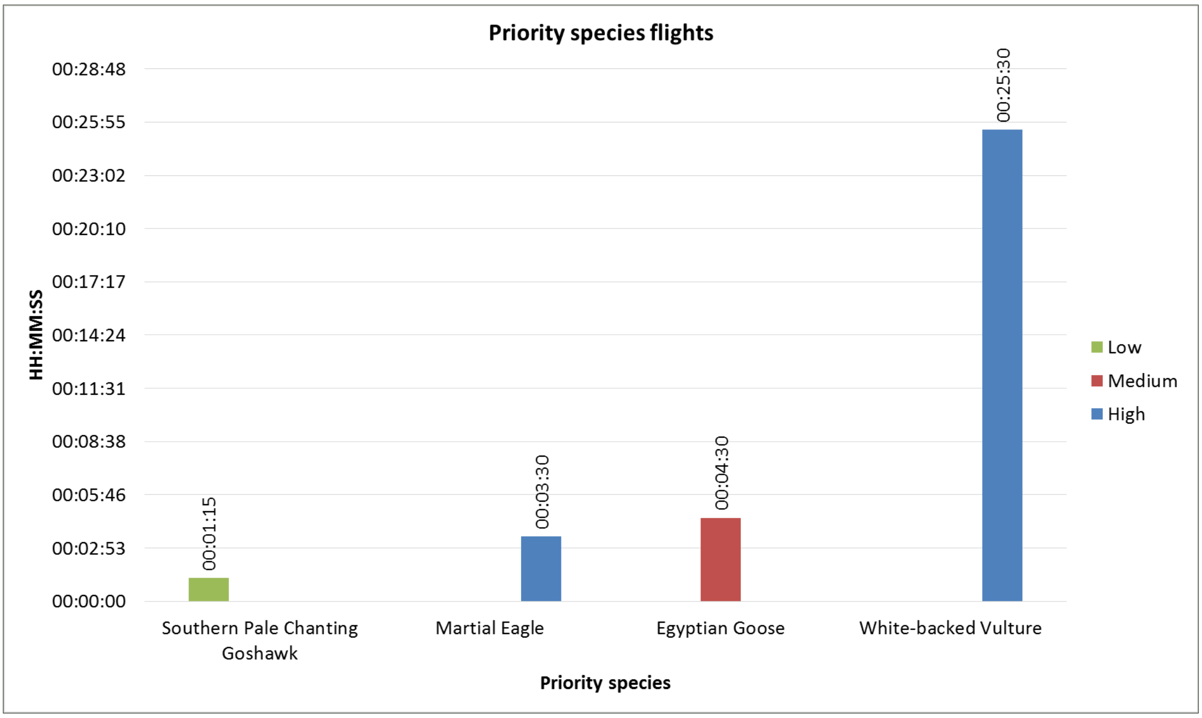

Figure 12: Flight duration and heights recorded for priority species. Duration (hours: minutes: seconds) of flights indicated on the bars

9.2.1 Sample size and representativeness of flight data

Due to the importance of knowing if the sample size (i.e. the number of watch periods at the site) was sufficiently large so that the counts recorded represent the average number of birds belonging to priority species sufficiently well, we present some discussion regarding sample size at this survey. Sample size is determined by the precision at which statements about the average counts are required. The more precise an estimate is to be, the larger the required sample size. The quantity that has the final say in sample size determination is the variability of the data from which the estimate of the parameter in question (in this case the true average count) is to be computed. Variability of data is measured by its standard deviation and for the counts these are computed from the available data and listed in Tables 2 and 3 of Annexure D.

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

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

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

where $t_{\alpha/2}(n-1)$ is the upper □/*2* = 2.5% point (for a 95% confidence interval) of Student's *t* distribution with *n – 1* degrees of freedom (*n* the sample size) and *s* an estimate of the true standard deviation of the counts (see Zar, *2010*, page *115*). Formula 1 shows that the sample size will increase with decreasing (i.e. better) precision. It also shows that the sample size will decrease as the variability, *s,* becomes smaller. Before *n* can be computed, *d* has to be specified and *s* has to be known. The latter is usually estimated from known data (such as the current survey, here summarised in Tables 2 and 3).

The largest standard deviation for the counts is recorded as s = *1.67* (see Table 2 of Annexure D). If this is used in formula (*1*) with confidence coefficient 95% and *d* = *1* (i.e. we wish to estimate the true mean to within a count of ± *1*, which is more than adequate) the result is *n* ≥ *11.9*. Thus it can be concluded that the *n* = *24* watch periods that were used during the survey are more than sufficient for the selected precision.

The computation of the confidence interval and equivalently the use of formula (*1*), is dependent on certain assumptions (e.g. normality of the counts distribution). These assumptions are perhaps not always met. However, it should provide a reasonable indication of the validity of the estimates based on the achieved sample sizes.

The computations and the outcome of the data exhibited in the tables and graphs in Annexure C in this report show that the survey may be taken to be statistically representative of the flight behaviour of priority species of birds that occur in the area and that more data will not necessarily succeed in improving the estimates in a substantial way.

See Appendix D for a detailed explanation of the statistical methods.

9.2.2 Spatial distribution of flight activity

Flight maps were prepared, indicating the spatial distribution of passages containing flights of priority species flights observed from the three vantage points (see Figures 13-16 below). This was done by overlaying a 100m x 100m grid over the survey area. Each grid cell was then given a weighting score taking into account the duration and distance of individual flight lines through a grid cell and the number of individual birds associated with each flight crossing the grid cell. High altitude flights are indicated in shades of blue, medium height flights are indicated in shades of yellow, orange and red, and low altitude flights are indicated in shades of green.

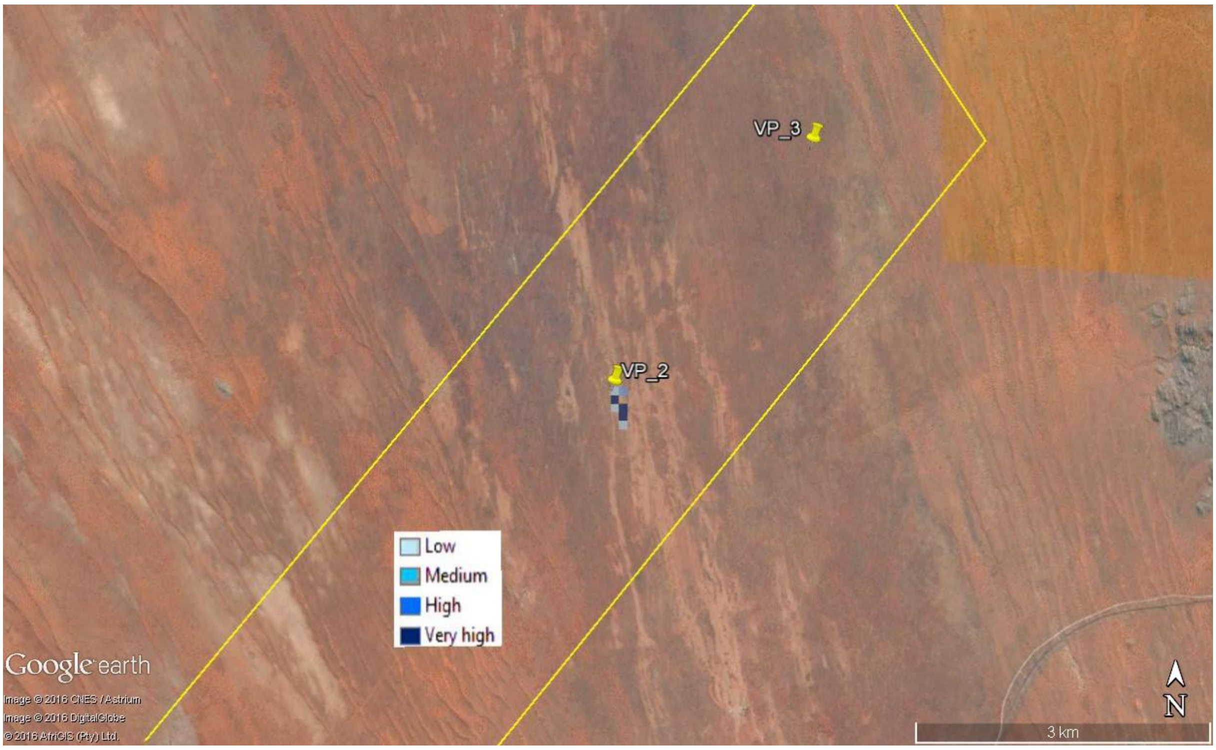

Figure 13: Spatial distribution and weighting scores of flights for Martial Eagle. All flights were at high altitude.

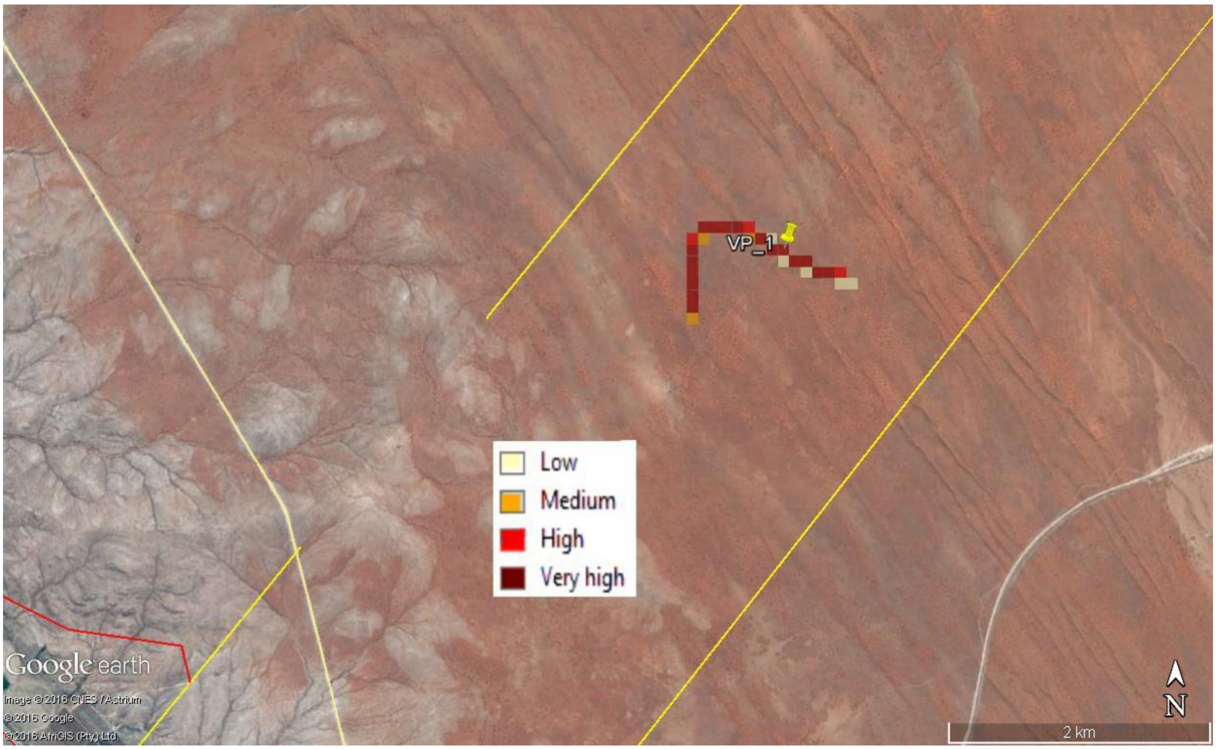

Figure 14: Spatial distribution of flights and weighting scores for Egyptian Goose.All flights were at medium height.

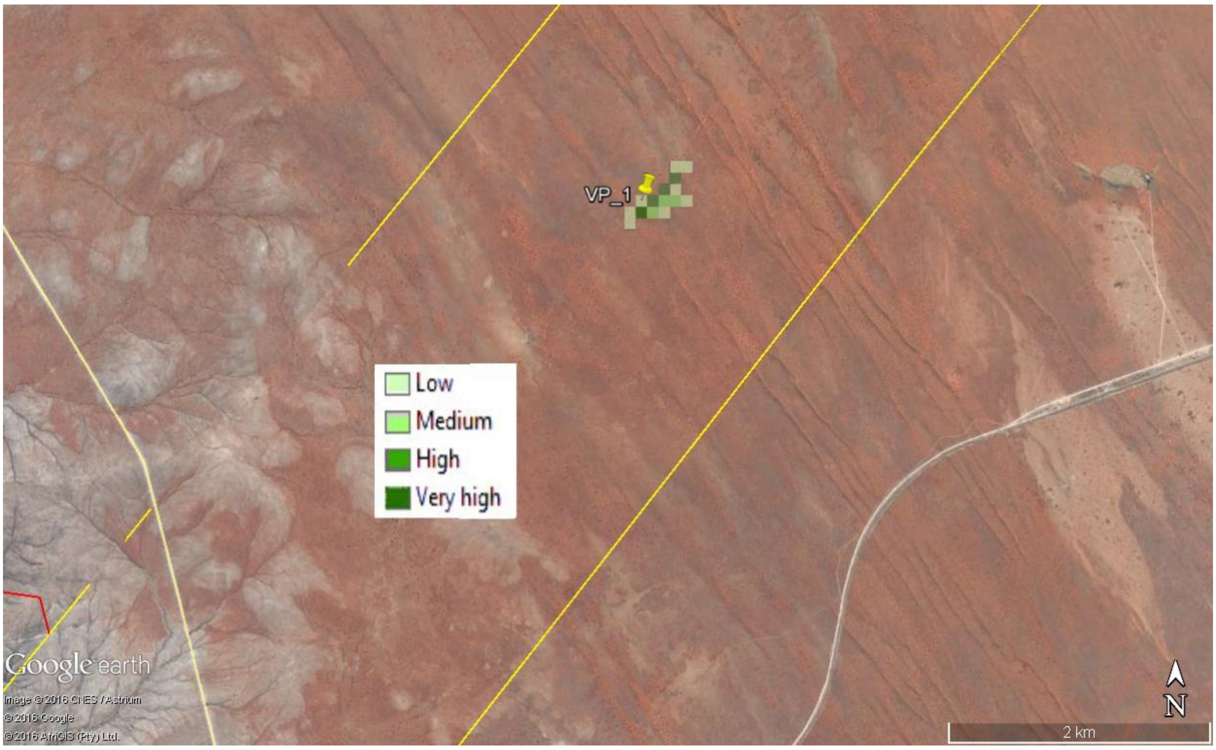

Figure15: Spatial distribution of flights and weighting scores for Southern Pale Chanting Goshawk. All flights were at low height.

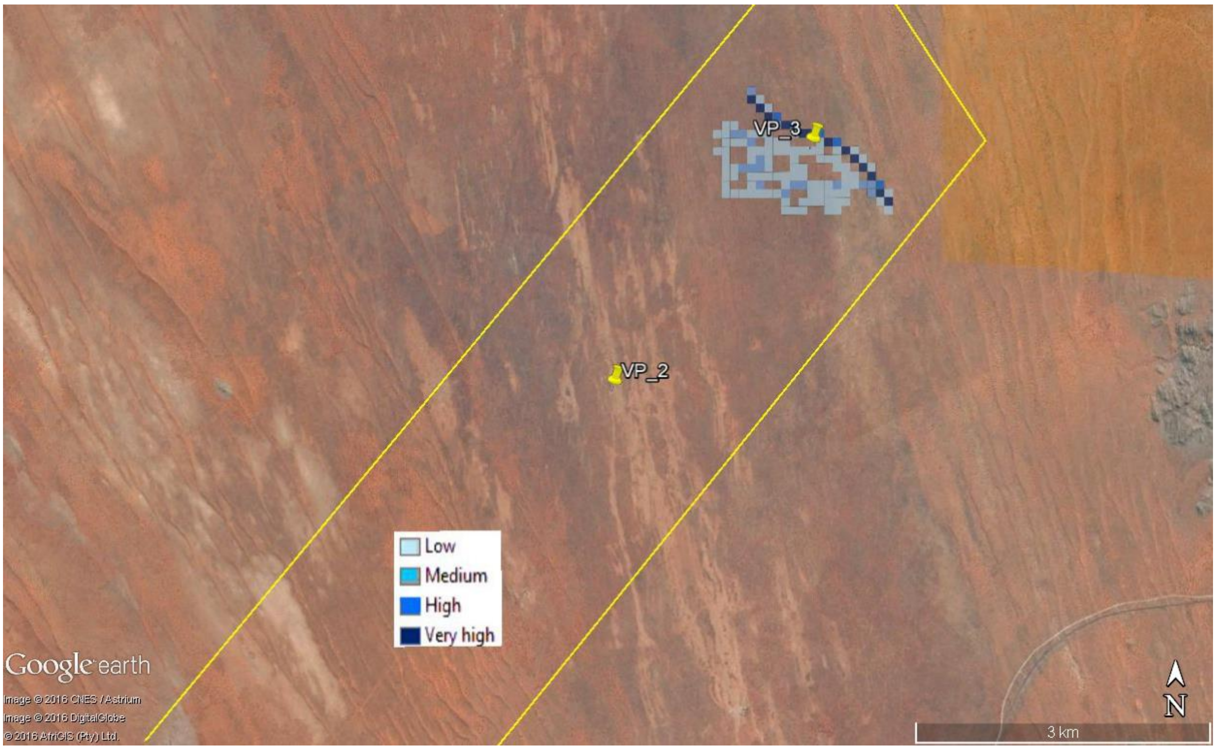

Figure16: Spatial distribution of medium height flights and weighting scores for White-backed Vulture. All flights were at high height.

10 IMPACT ASSESSMENT

10.1 Impacts of solar facilities and associated infrastructure on avifauna

The full spectrum of impacts of solar facilities on birds is only now starting to emerge from compliance reports at solar facilities. These can be summarised as follows:

- Temporary displacement due to disturbance associated with the construction of the solar plant and associated infrastructure;
- Collisions with the heliostats or solar panels;
- Burning due to solar flux (only relevant to CSP plants, not relevant for PV plants);
- Permanent displacement due to habitat transformation; and
- Collisions with the associated power lines resulting in mortality.

10.1.1 Impacts of the solar infrastructure on birds

There are currently two known types of direct solar-related bird fatalities (McCrary *et al*. 1986; Hernandez *et al*. 2014; Kagan *et al*. 2014):

- Collision-related fatality — fatality resulting from the direct contact of the bird with a project structure(s). This type of fatality has been documented at solar projects of all technology types.
- Solar-flux-related fatality — fatality resulting from the burning/singeing effects of exposure to concentrated sunlight. Passing through the area of solar flux may result

in: (a) direct fatality; (b) singeing of flight feathers that cause loss of flight ability, leading to impact with other objects; or (c) impairment of flight capability to reduce the ability to forage or avoid predators, resulting in starvation or predation of the individual (Kagan *et al.* 2014). Solar-flux-related fatality has been observed only at facilities employing power tower technologies.

A literature review reveals a scarcity of published, scientifically vetted information regarding large-scale solar plants and birds. To date, only one published scientific study has been conducted on the direct impacts of solar facilities on avifauna, namely "*Avian mortality at a solar energy power plant*" by McCrary, McKernan, Schreiber, Wagner & Sciarrotta 1986. This describes the results of monitoring at the experimental Solar One solar power plant in southern California (now de-commissioned), which was a 10 megawatt, central receiver solar power plant consisting of a 32-ha field of 1 818, 6.9 x 6.9m mirrors (heliostats) which concentrates sunlight on a centrally located, tower-mounted boiler, 86m in height. Since then, several much larger plants have been constructed in the Desert Southwest of the USA namely the 250MW, 1 300ha California Valley Solar Ranch (CVSR) PV plant (completed in 2013), the 377 MW, 1 600ha Ivanpah central receiver CSP plant (completed in 2014), the 550MW, 1 600ha Desert Sunlight PV plant (completed in 2015) and the 250MW, 1 880ha Genesis Solar Energy parabolic trough Concentrated Solar Power plant (completed in 2014).

McCrary *et al*. (1986) searched for dead birds amongst the heliostat mirrors and around the central receiver tower at Solar One, and they estimated a bird fatality rate caused by bird collisions with heliostat mirrors and the tower, and by heat encountered when birds flew through the concentrated sunlight reflected toward the tower. Their forty visits (one week apart) to the facility over a two year period revealed 70 bird carcasses involving 26 species. It was estimated that between 10% and 30% of carcasses were removed by scavengers in between visits, so the actual mortality figure may have been slightly higher. They estimated that 57 (81%) of these birds died through collision with infrastructure, mostly the heliostats. Species killed in this manner included waterbirds, small raptors, gulls, doves, sparrows and warblers. Thirteen (19%) of the birds died through burning in the standby points. Species killed in this manner were mostly swallows and swifts. However, they appeared to have under-appreciated the magnitude of the impacts caused by Solar One, likely because they did not know as much as scientists know today about scavenger removal rates and searcher detection error (Smallwood 2014). Their search pattern was not fixed, so it was not as rigorous as modern searches at wind energy projects and other energy generation and transmission facilities. They placed 19 bird carcasses to estimate the proportion remaining over the average time span between their visits to the project site, though they provided few details about their scavenger removal trial. It is known today that the results of removal trials can vary substantially for many reasons, including the species used, time since death, and the number of carcasses placed in one place at one time, etc. (Smallwood 2007). They also performed no searcher detection trials, because they concluded that the ground was sufficiently exposed that all available bird carcasses would have been found. This conclusion would not be accepted today, based on modern fatality search protocols.

Smallwood (2014) recalculated the estimated fatality rate at Solar One, but this time using US national averages to represent scavenger removal rates and searcher detection rates (see Smallwood 2007, 2013). He re-calculated it as 87.4 mortalities per year with an 80% confidence interval (CI) of 69.6 to 105.5.

Systematic avian monitoring surveys were conducted at the 1 600ha Ivanpah Solar Electric Generating System CSP (Ivanpah) central receiver facility in accordance with the Project’s Avian & Bat Monitoring and Management Plan over four seasons from 29 October 2013 to 20 October 2014 (Harvey & Associates 2015). These surveys included avian point counts, raptor/large bird surveys and facility monitoring for avian fatalities. Overall, approximately 29.2% of the facility was searched (not including offsite transects, which are outside the facility). A total of 695 avian mortalities (including 25 injured birds that died), and eight injured birds were found over the first four seasons. These avian fatality search results, along with searcher efficiency carcass removal rates from trials conducted onsite, were input into a fatality estimator model (Huso 2010) to provide an estimate of the fatalities for the facility. Overall, the estimated avian mortality was 1492 or 42.6% of birds (90% confidence interval 1,046-2,371) from known causes and 2012 or 57.4% of birds (90% confidence interval 1,450-3,334) from unknown causes. The sources of mortality for known causes were 47.4% singed, 51.9% with evidence of collision effects, and 0.7% from other project causes. For the fatalities from unknown causes, the estimate was driven by a high number of feather spots (47.2% of all detections) which may have led to over-estimation of the number of unknowns.

The estimate of 3 504 mortalities at Ivanpah contrasts markedly with an earlier estimate by Smallwood (2014). Smallwood calculated the estimated annual mortality at Ivanpah to be potentially as high as 28 380 birds per year. In his testimony to the California Energy Commission he explains as follows: *“The April searches turned up 101 fatalities and the May searches discovered another 82 fatalities. If the searches were performed according to document TB201315, which summarised a monitoring plan for Ivanpah, then weekly searches were performed at 20% of the heliostat mirrors at Ivanpah during April and May 2014. Given the size range of the birds found, including many hummingbirds, swallows and warblers, I would predict that the overall adjustment rate for searcher detection and carcass persistence would be no greater than 20%. That means the number of fatalities found would be divided by 0.2 to arrive at an adjusted estimate of 473 fatalities per month within the search areas. This number then would be divided by 0.2 (corresponding with 20% of the project being searched) to extrapolate the fatality estimate to the rest of Ivanpah, yielding 2,365 birds per month during April and May 2014. If this rate persisted yearlong, then Ivanpah might be killing 28,380 birds, which would be 3.6 times greater than the fatality rate I predicted.”* With such widely differing estimates, it is clear that systematic study and efforts to standardize data through the development of systematic monitoring protocols are needed to make any conclusions about the avian risks of utility-scale solar development.

Weekly mortality searches at 20% coverage are also being conducted at the 1 300ha 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 the 1 600ha Ivanpah CSP central receiver plant, 1 600ha Desert Sunlight PV plant and 1 880ha Genesis parabolic trough solar plants. The results of the investigation are tabled below in Table 2:

Table 8-1: Comparison of avian mortality causes at three solar plants in California, USA (Kagan et al. 2014).

Cause of death	Ivanpah central receiver CSP	Genesis parabolic trough CSP	Desert Sunlight PV	Total
Solar flux	47	0	0	47
Impact trauma	24	6	19	49
Predation trauma	5	2	15	22
Trauma of undetermined causes	14	0	0	14
Electrocution	1	0	0	1
Emaciation	1	0	0	1
Undetermined (remains in poor condition)	46	17	22	85
No evident cause of death	3	6	5	14
Total	141	31	61	233

When the results of the three solar plants are pooled, collisions with reflective surfaces (impact trauma) emerge 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 in the USA. They found that the causes of death documented at solar facilities include solar flux, impact trauma, predation trauma, electrocution, and emaciation; however, the cause of death is often unknown. **With the exception of California Solar One, the cause of death could not be determined for the majority of bird deaths at all solar facilities.** Solar flux was the second-ranked cause of death at the two power tower solar facilities (Ivanpah and Solar One). Collision ranked second at Desert Sunlight, CVSR, and Genesis. It is important to note that fatality observations made within these large solar facilities may not be caused by the project facilities. 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. Passerines were the taxonomic group most frequently found killed or injured at six California solar energy facilities, ranging from 39.6% to 62.5% of the avian mortalities. 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 projects.

Sheet glass used in commercial and residential buildings has been well established as a hazard for birds. A recent comprehensive review estimated between 365 – 988 million birds are killed annually in the USA due to collisions with glass panels (Loss *et al.* 2014). It is therefore to be expected that the reflective surfaces of solar panels and heliostats will constitute a similar risk to avifauna. A related problem is the so-called "lake effect" i.e. it seems very likely that reflections from solar facilities' infrastructure, particularly large sheets of dark blue photovoltaic panels, may well be attracting birds in flight across the open desert, who mistake the broad reflective surfaces for water (Kagan *et al.* 2014). 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. The unusually high number of waterbird mortalities at the Desert Sunlight PV facility (44%) seems to support this hypothesis. In the case of Desert Sunlight, the 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).

Variables that may affect the illusory characteristics of solar panels are structural elements or markings that may break up the reflection. Visual markers spaced at distances of 28cm apart or less have been shown to reduce the number of window strike events on large commercial buildings (Kagan *et al.* 2014). A paper by Horvath *et al.* (2010) provides experimental evidence that placing a white outline and/or white grid lines on solar panels significantly reduce the attractiveness of those panels to aquatic insects, with a loss of only 1.8% in energy producing surface area. While similar detailed studies have yet to be carried out with birds, this work, combined with the window strike results, suggest that significant reductions in avian mortality at solar facilities could be achieved by relatively minor modifications of panel and mirror design (Kagan *et al.* 2014). This could be an experimental mitigation measure should results of the operational phase monitoring indicate significant mortality of priority avifauna due to collisions at the proposed Sand Draai solar facilities.

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 such time as statistically tested results emerge from existing compliance programmes, conclusions will inevitably be largely speculative and based on professional opinion.

10.1.2 Displacement due to habitat transformation and disturbance associated with the construction and operation of the plant

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. All of 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.

At the 1 600ha Ivanpah Solar Electric Generating System CSP (Ivanpah) facility, seventeen avian use surveys were conducted at each of 80 survey points (40 in desert bajada habitat and 40 in heliostat arrays), representing more than 350 hours of survey effort. Species composition was compared between these avian use survey results and detections during standardized monitoring surveys. A total of 54 bird species were recorded on avian use surveys during the first four seasons. Total species richness was highest in the desert (47 species), and much lower in the heliostat grids (24 species).

Evidently, the same is true for PV plants. 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. It is highly likely that the same pattern of reduced avifaunal densities will manifest itself at the proposed Sand Draai solar plants.

10.1.3 Mortality on associated transmission line infrastructure

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

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (Van Rooyen 2004). The electrocution risk is largely determined by the pole/tower design. In the case of the proposed Helena Solar 1 PV plant, no electrocution risk is envisaged because the design of the steel mono-pole 132kV lines will not pose an electrocution threat to any of the priority species which are likely to occur at the site.

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

> *"The collision risk posed by power lines is complex and problems are often localised. While any bird flying near a power line is at risk of collision, this risk varies greatly between different groups of birds, and depends on the interplay of a wide range of factors (APLIC 1994). Bevanger (1994) described these factors in four main groups – biological, topographical, meteorological and technical. Birds at highest risk are those that are both susceptible to collisions and frequently exposed to power lines, with waterbirds, gamebirds, rails, cranes and bustards usually the most numerous reported victims (Bevanger 1998, Rubolini et al. 2005, Jenkins et al. 2010).*
>
> *The proliferation of man-made structures in the landscape is relatively recent, and birds are not evolved to avoid them. Body size and morphology are key predictive factors of collision risk, with large-bodied birds with high wing loadings (the ratio of body weight to wing area) most at risk (Bevanger 1998, Janss 2000). These birds must fly fast to remain airborne, and do not have sufficient manoeuvrability to avoid unexpected obstacles. Vision is another key biological factor, with many collision-prone birds principally using lateral vision to navigate in flight, when it is the lower-resolution, and often restricted, forward vision that is useful to detect obstacles (Martin & Shaw 2010, Martin 2011, Martin et al. 2012). Behaviour is important, with birds flying in flocks, at low levels and in crepuscular or nocturnal conditions at higher risk of collision (Bevanger 1994). Experience affects risk, with migratory and nomadic species that spend much of their time in unfamiliar locations also expected to collide more often (Anderson 1978, Anderson 2002). Juvenile birds have often been reported as being more collision-prone than adults (e.g. Brown et al. 1987, Henderson et al. 1996).*
>
> *Topography and weather conditions affect how birds use the landscape. Power lines in sensitive bird areas (e.g. those that separate feeding and roosting areas, or cross flyways) can be very dangerous (APLIC 1994, Bevanger 1994). Lines crossing the prevailing wind conditions can pose a problem for large birds that use the wind to aid take-off and landing (Bevanger 1994). Inclement weather can disorient birds and reduce their flight altitude, and strong winds can result in birds colliding with power lines that they can see but do not have enough flight control to avoid (Brown et al. 1987, APLIC 2012).*
>
> *The technical aspects of power line design and siting also play a big part in collision risk. Grouping similar power lines on a common servitude, or locating them along other features such as tree lines, are both approaches thought to reduce risk (Bevanger 1994). In general, low lines with short span lengths (i.e.*

the distance between two adjacent pylons) and flat conductor configurations are thought to be the least dangerous (Bevanger 1994, Jenkins et al. 2010). On many higher voltage lines, there is a thin earth (or ground) wire above the conductors, protecting the system from lightning strikes. Earth wires are widely accepted to cause the majority of collisions on power lines with this configuration because they are difficult to see, and birds flaring to avoid hitting the conductors often put themselves directly in the path of these wires (Brown et al. 1987, Faanes 1987, Alonso et al. 1994a, Bevanger 1994)."

From incidental record keeping by the Endangered Wildlife Trust, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (see Figure 17 below - Jenkins *et al.* 2010).

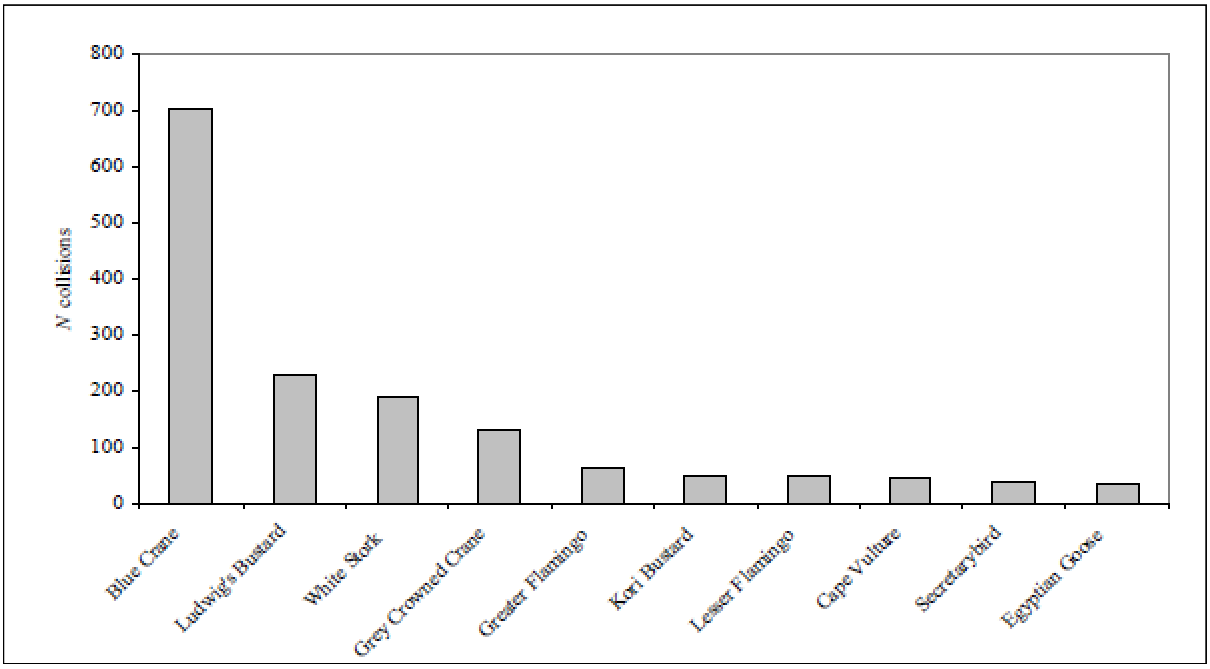

Figure 17: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/EWT Strategic Partnership central incident register 1996 - 2008 (Jenkins *et al.* 2010)

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

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

Despite doubts about the efficacy of line marking to reduce the collision risk for bustards (Jenkins *et al.* 2010; Martin *et al.* 2010), there are numerous studies which prove that marking a line with PVC spiral type Bird Flight Diverters (BFDs) generally reduce mortality rates (e.g. Barrientos *et al.* 2011; Jenkins *et al.* 2010; Alonso & Alonso 1999; Koops & De Jong 1982), including to some extent for bustards (Barrientos *et al.* 2012; Hoogstad 2015 pers.comm). Beaulaurier (1981) summarised the results of 17 studies that involved the marking of earth wires and found an average reduction in mortality of 45%. Barrientos *et al.* (2011) reviewed the results of 15 wire marking experiments in which transmission or distribution wires were marked to examine the effectiveness of flight diverters in reducing bird mortality. The presence of flight diverters was associated with a decrease of 55–94% in bird mortalities. Koops and De Jong (1982) found that the spacing of the BFDs were 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).

10.2 Assessment of the Sand Draai parabolic trough 150MW CSP plant

10.2.1 Displacement due to disturbance associated with the construction and de-commissioning of the solar plant and associated road, powerline and pipeline (construction and de-commissioning)

The construction (and de-commissioning) of the CSP plant and associated infrastructure (pipeline, road and powerline) will result in a significant amount of movement and noise, which will lead to displacement of avifauna from the site. It is highly likely that most priority species listed in Table 7-3 will vacate the area for the duration of these activities.

The Red listed Martial Eagles breeding on tower 22 of the existing Garona-Gordonia 132kV line is the most important factor to consider from a potential displacement perspective. Martial Eagles are very sensitive birds and may abandon the nest temporarily or even permanently if they are frequently disturbed. In order to prevent this from happening, it is strongly recommended that Alternative 1 is utilised for the location of the plant, in association with Alternative 2 of the road and pipeline options, and Alternative 1 of the power line options. This should effectively remove the potential of disturbance by placing the closest infrastructure at least 3.4km away from the nest (see Figure 18 below). Ideally a no development zone of at least 2.5km should be maintained around the nest.

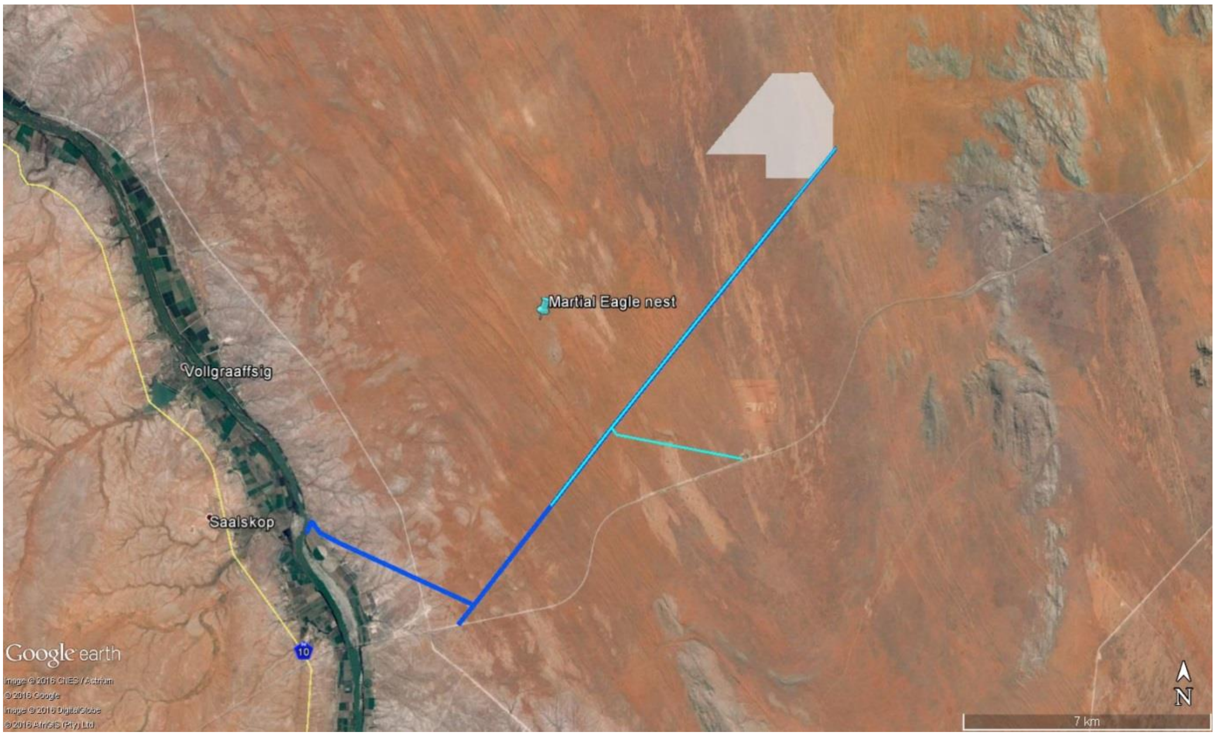

Figure 18: Recommended lay-out to minimise disturbance impact on pair of Martial Eagles breeding on tower 22 of the Garona-Gordonia 132kV power line. Dark blue = Alternative 2 of pipeline and road, light blue = Alternative 1 of power line, grey = Alternative 1 of CSP parabolic trough plant.

See Annexure E for a sensitivity map, indicating the recommended buffer zone around the Martial Eagle nest.

10.2.2 Displacement due to habitat transformation associated with the CSP plant and associated road, powerline and pipeline (operation)

The construction of the CSP 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, the construction of the parabolic troughs will prevent sunlight from reaching the vegetation below, 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 concentrators, but it will be a fraction of what was available before the construction of the plant, and it will contain few shrubs as this will most likely have been cleared prior to construction. Table 7.3 lists the priority species that could potentially be affected by this impact. Small 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, likely that many of the smaller passerine species will continue to use the habitat available within the solar facility albeit at lower densities. This will however differ from species to species and it may not be true for all of the smaller species. Larger species which require contiguous, un-fragmented tracts of suitable habitat (e.g. large raptors, korhaans and bustards) are more likely to be displaced entirely from the area of the proposed plant although in the case of some 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 troughs may actually attract them to the area. The significance of the potential displacement impact is difficult to assess at this stage and will only become clear through operational phase surveys. There will be no material difference in the level of displacement due to habitat transformation associated with the two alternative plant lay-outs.

10.2.3 Collisions with the parabolic troughs (operation)

The priority species that were recorded in the study area which could potentially be exposed to collision risk are listed in Table 7.3. The so-called "lake effect" could act as a potential attraction to some species and it is expected that flocking species which were recorded in large numbers i.e. Grey-backed Sparrow-lark, Namaqua Sandgrouse, Sociable Weaver, Yellow Canary and several species of doves and other seed eaters would be most susceptible to this impact as they habitually arrive in flocks at water holes to drink. Multiple mortalities could potentially result from this, which in turn could attract raptors e.g. Tawny Eagle, Southern Pale Chanting Goshawk, Lanner Falcon and Pygmy Falcon which will feed on dead and injured birds which could in turn expose them to collision risk, especially when pursuing injured birds. In addition, the "lake effect" produced by the troughs may potentially draw various water birds to the area. The unusually high number of waterbird mortalities at facilities which are all situated in extremely arid environments i.e. Desert Sunlight facility (44%), Genesis (19%) and Ivanpah (10%) is noted in this respect. The presence of evaporation ponds and the proximity of the Orange River with its large populations of waterbirds to the Sand Draai site may be an aggravating factor, e.g. Egyptian Goose was recorded during monitoring. The evaporation ponds, in combination with the "lake effect" might attract Greater and Lesser Flamingo. However, it is not possible to tell whether this will actually happen until post-construction monitoring reveals actual mortality at the site.

10.2.4 Collisions with the earthwire of the 132kV power line (operation)

The most likely priority species candidates for collision mortality on the proposed 132kV power line are medium to large terrestrial species i.e. Karoo Korhaan, Kori Bustard, and Secretarybird which have all been recorded at the site. Other non-priority species that could potentially be impacted through collisions are Northern Black Korhaan, Red-crested Korhaan and Namaqua Sandgrouse. Greater and Lesser Flamingo could also be impacted, should they be attracted to the evaporation ponds and by the "lake effect".

10.2.5 Other impacts

Cape Sparrows and other small birds will very likely attempt to nest underneath the troughs to take advantage of the shade, but this should not adversely affect the operation of the equipment. The troughs are probably too low for Sociable Weavers to nest on them, but they might attempt to build their giant nests on other infrastructure. Another impact that could potentially materialise is the pollution of the troughs by large birds defecating on them, particularly Pied Crows and raptors, if they get to perch regularly on the troughs. It is expected that the regular cleaning and maintenance activities will prevent this from becoming a problem, but close monitoring will still be required.

10.3 Impact Rating System

The potential environmental impact associated with the project was evaluated according to its nature, extent, duration, intensity, probability and significance of the impacts, whereby:

- ***Nature***: A brief written statement of the environmental aspect being impacted upon by a particular action or activity.
- ***Extent***: The area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment phase of a project in terms of further defining the determined significance or intensity of an impact. For example, high at a local scale, but low at a regional scale;
- ***Duration***: Indicates what the lifetime of the impact will be;
- ***Intensity***: Describes whether an impact is destructive or benign;

- ***Probability***: Describes the likelihood of an impact actually occurring; and
- ***Cumulative***: In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

Table 8-2: Criteria and description of impact

CRITERIA		DESCRIPTION			
EXTENT	**International (5)** International scale	**National (4)** The whole of South Africa	**Regional (3)** Provincial and parts of neighbouring provinces	**Local (2)** Within a radius of 2 km of the construction site	**Site (1)** Within the construction site
DURATION	**Permanent (5)** Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient	**Long-term (4)** The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter. The only class of impact which will be non-transitory	**Medium-term (3)** The impact will last for the period of the construction phase, where after it will be entirely negated	**Short-term (2)** The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (few months)	**Very Short-term (1)** The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (few days)
FREQUENCY	**Continuous (5)** Daily to a significant percentage every day	**Very Frequent (4)** Few times a week to daily	**Frequent (3)** Few times a month	**Unusual (2)** Once or twice every 5 years	**Very Rare (1)** Once or twice a decade
INTENSITY	**High (5)** Natural, cultural and social functions and processes are altered to extent that	**Medium High (4)** Natural, cultural and social functions and processes are altered to	**Medium (3)** Affected environment is altered, but natural, cultural and social functions and processes	**Low (2)** Impact affects the environment in such a way that natural, cultural and social	**Very Low (1)** Impact does not affects the environment in such a way that natural, cultural and social functions

	they permanently cease	extent that they temporarily cease	continue albeit in a modified way	functions and processes are not affected	and processes are not affected
PROBABILTY OF OCCURANCE	**Definite (5)** Impact will certainly occur	**Very Likely (4)** Most likely that the impact will occur	**Likely (3)** The impact may occur	**Probable (2)** Likelihood of the impact materialising is low	**Improbable (1)** Likelihood of the impact materialising is very low

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

Table 8-3: Significance table

Low impact (0 -5 points)	A low impact has no permanent impact of significance. Mitigation measures are feasible and are readily instituted as part of a standing design, construction or operating procedure.
Medium impact (6 -10 points)	Mitigation is possible with additional design and construction inputs.
Medium to High impact (11 -15 points)	The design of the site may be affected. Mitigation and possible remediation are needed during the construction and/or operational phases. The effects of the impact may affect the broader environment.
High impact (16 - 20 points)	High consequences and mitigation is essential.
Extremely High	Permanent and important impacts. The design of the site may be affected. Intensive remediation is needed during construction and/or operational phases. Any activity which results in a “very high impact” is likely to be a fatal flaw.
Status	Denotes the perceived effect of the impact on the affected area.
Positive (+)	Beneficial impact.
Negative (-)	Deleterious or adverse impact.
Neutral (/)	Impact is neither beneficial nor adverse.
It is important to note that the status of an impact is assigned based on the status quo – i.e. should the project not proceed. Therefore not all negative impacts are equally significant.	

The suitability and feasibility of all proposed mitigation measures will be included in the assessment of significant impacts. This will be achieved through the comparison of the significance of the impact before and after the proposed mitigation measure is implemented. Mitigation measures identified as necessary will be included in an EMPr.

Table 8-4: Parabolic Trough plant proposed mitigation and significance rating

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
CONSTRUCTION AND DECOMMISIONING **Avifauna: Displacement of priority species due to disturbance associated with the construction of the solar plant – Alternative 1** **The following activities have been identified as sources of disturbance:** • 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	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium (-3) Probability: Most likely (-4) Significance: High (-17)	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • 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.	Extent: Site (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium (-3) Probability: Probable (-2) Significance: Medium to High (-15)

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; • Maintenance of fire breaks and roads; and Weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.			

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
CONSTRUCTION AND DECOMMISIONING **Avifauna: Displacement of priority species due to disturbance associated with the construction of the solar plant – Alternative 2** **The following activities have been identified as sources of disturbance:** • 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,	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium High (-4) Probability: Definite (-5) Significance: High (-19)	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • 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.	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium High (-4) Probability: Definite (-4) Significance: High (-18)

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; • Maintenance of fire breaks and roads; and weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.			

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
CONSTRUCTION AND DECOMMISIONING **Avifauna: Displacement of priority species due to disturbance associated with the construction of the pipeline and access road – Alternative 1** **The following activities have been identified as sources of disturbance:** • Excavation/trenching for water pipeline; • Construction of new dirt or gravel road; • 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;	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium High (-4) Probability: Definite (-5) Significance: High (-19)	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • 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.	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium High (-4) Probability: Definite (-4) Significance: High (-18)

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
CONSTRUCTION AND DECOMMISIONING **Avifauna: Displacement of priority species due to disturbance associated with the construction of the pipeline and access road – Alternative 2** **The following activities have been identified as sources of disturbance:** • Excavation/trenching for water pipeline; • Construction of new dirt or gravel road; • 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.	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium (-3) Probability: Most likely (-3) Significance: High (-16)	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • 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.	Extent: Site (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium (-3) Probability: Probable (-2) Significance: Medium to High (-15)

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
CONSTRUCTION AND DECOMMISIONING **Avifauna: Displacement of priority species due to disturbance associated with the construction of the powerline – Alternative 1** The following typical activities have been identified as sources of disturbance: • The power line servitude is cleared of vegetation to allow operation of a line according to the established standards. • Temporary access roads are used to build the line. • The various pole parts are manufactured and delivered by type. • The steel parts needed for the placement of the foundations are	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium (-3) Probability: Most likely (-4) Significance: High (-17)	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • 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.	Extent: Site (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium (-3) Probability: Probable (-2) Significance: Medium to High (-15)

delivered. • A work crew excavates the foundations using bulldozers and hydraulic shovels. Depending on the nature of the soil, the foundation may be made of fill delivered by truck or crawler carrier, or of concrete, which may be delivered or prepared on-site. Once the foundation is in place, the excavation is backfilled. • A crew assembles the poles using cranes and bulldozers. The pole is then erected by means of a telescopic crane. • The conductor stringing is done segment by segment. The conductor is paid out from a cable drum at one end of the segment and run through stringing blocks at the tops of the poles. At the other end of the segment are a puller and a take-up reel. Line crews are on hand to ensure that the operation runs			

smoothly.			
ACTIVITY	**IMPACT PRE-MITIGATION**	**MITIGATION**	**IMPACT POST-MITIGATION**
CONSTRUCTION AND DECOMMISIONING **Avifauna: Displacement of priority species due to disturbance associated with the construction of the powerline – Alternative 2** **The following typical activities have been identified as sources of disturbance:** • The power line servitude is cleared of vegetation to allow operation of a line according to the established standards. • Temporary access roads are used to build the line. • The various pole parts are manufactured and delivered by type. • The steel parts needed for the placement of the foundations are delivered. • A work crew excavates	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium High (-4) Probability: Definite (-5) Significance: High (-19)	• Construction activity should be restricted to the immediate footprint of the infrastructure. • Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species. • Measures to control noise and dust should be applied according to current best practice in the industry. • Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • 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.	Extent: Local (-2) Duration: Medium-term (-3) Frequency: Continuous (-5) Intensity: Medium High (-4) Probability: Definite (-4) Significance: High (-18)

the foundations using bulldozers and hydraulic shovels. Depending on the nature of the soil, the foundation may be made of fill delivered by truck or crawler carrier, or of concrete, which may be delivered or prepared on-site. Once the foundation is in place, the excavation is backfilled. • A crew assembles the poles using cranes and bulldozers. The pole is then erected by means of a telescopic crane. • The conductor stringing is done segment by segment. The conductor is paid out from a cable drum at one end of the segment and run through stringing blocks at the tops of the poles. At the other end of the segment are a puller and a take-up reel. Line crews are on hand to ensure that the operation runs smoothly.			

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
OPERATION **Avifauna: Displacement of priority species due to habitat destruction associated with the operation of the solar plant – Alternative 1** **The following activities have been identified as sources of displacement:** • Vegetation clearing, grading, cut and fill; • Maintenance of fire breaks and roads; and weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Continuous (-5) Intensity: High (-5) Probability: Definite (-5) Significance: High (-20)	• Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • 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.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Continuous (-5) Intensity: High (-5) Probability: Most likely (-4) Significance: High (-19)

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
OPERATION **Avifauna: Displacement of priority species due to habitat destruction associated with the operation of the solar plant – Alternative 2** **The following activities have been identified as sources of displacement:** • Vegetation clearing, grading, cut and fill; • Maintenance of fire breaks and roads; and weed removal, brush clearing, and similar land management activities related to the ongoing operation of the project.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Continuous (-5) Intensity: High (-5) Probability: Definite (-5) Significance: High (-20)	• Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum. • 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.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Continuous (-5) Intensity: High (-5) Probability: Most likely (-4) Significance: High (-19)

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
OPERATION **Avifauna: Mortality of priority species due to collisions with the parabolic troughs – Alternative 1** **The following activities have been identified as sources of collision mortality:** • The priority species that were recorded in the study area which could potentially be exposed to collision risk are listed in Table 7.3. • Multiple mortalities could potentially result from this, which in turn could attract raptors e.g. Tawny Eagle, Southern Pale Chanting Goshawk, Lanner Falcon and Pygmy Falcon which will feed on dead and injured birds which could in turn expose them to collision risk, especially when pursuing injured birds.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Unusual (-2) Intensity: Medium (-3) Probability: Likely (-3) Significance: Medium - High (-13)	• An avifaunal specialist must be appointed to oversee all aspects of operational phase monitoring (including carcass searches) and assist with the on-going management of bird impacts that may emerge as the monitoring programme progresses. Formal operational phase monitoring should be implemented once the solar arrays have been constructed. The purpose of this would be to establish to what extent displacement of priority species have taken place. The exact time when operational phase monitoring should commence, will depend on the construction schedule, and will be agreed upon with the site operator once these timelines have been finalised. • As an absolute minimum, operational phase monitoring should be undertaken for the first two years of operation, and then repeated again in year 5, and again every five years thereafter. This is necessary to account for inter-annual variations in avifaunal activity as the result of varying rainfall patterns which can be highly erratic in this arid habitat. The exact scope and nature of the operational phase monitoring will be informed by the results of the monitoring on an ongoing basis and the EMPr will be updated accordingly.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Unusual (-2) Intensity: Low (-2) Probability: Probable (-2) Significance: Medium to High (-11)

		• Carcass searches should be implemented to search the ground between arrays of troughs on a weekly basis (every two weeks at the longest) for at least one year to determine the magnitude of collision fatalities. Searches should be done on foot. Searches should be conducted randomly or at systematically selected arrays of troughs to the extent that equals 33% or more of the project area. Detection trials should be integrated into the searches. • Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including minor modifications of panel and mirror design to reduce the illusory characteristics of troughs. What is considered to be significant will have to be established on a species specific basis by the avifaunal specialist, in consultation with Birdlife South Africa. • The exact protocol to be followed for the carcass searches and operational phase monitoring must be compiled by the avifaunal specialist in consultation with the plant operator and Environmental Control Officer before the commencement of operations.	

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
OPERATION **Avifauna: Mortality of priority species due to collisions with the parabolic troughs – Alternative 2** **The following activities have been identified as sources of collision mortality:** • The priority species that were recorded in the study area which could potentially be exposed to collision risk are listed in Table 7.3. • Multiple mortalities could potentially result from this, which in turn could attract raptors e.g. Tawny Eagle, Southern Pale Chanting Goshawk, Lanner Falcon and Pygmy Falcon which will feed on dead and injured birds which could in turn expose them to collision risk,	Extent: Site (-1) Duration: Long-term (-4) Frequency: Unusual (-2) Intensity: Medium (-3) Probability: Likely (-3) Significance: Medium - High (-13)	• An avifaunal specialist must be appointed to oversee all aspects of operational phase monitoring (including carcass searches) and assist with the on-going management of bird impacts that may emerge as the monitoring programme progresses. Formal operational phase monitoring should be implemented once the solar arrays have been constructed. The purpose of this would be to establish to what extent displacement of priority species have taken place. The exact time when operational phase monitoring should commence, will depend on the construction schedule, and will be agreed upon with the site operator once these timelines have been finalised. • As an absolute minimum, operational phase monitoring should be undertaken for the first two years of operation, and then repeated again in year 5, and again every five years thereafter. This is necessary to account for inter-annual variations in avifaunal activity as the result of varying rainfall patterns which can be highly erratic in this arid habitat. The exact scope and nature of the operational phase monitoring will be informed by the results of the monitoring	Extent: Site (-1) Duration: Long-term (-4) Frequency: Unusual (-2) Intensity: Low (-2) Probability: Probable (-2) Significance: Medium to High (-11)

especially when pursuing injured birds.		on an ongoing basis and the EMPr will be updated accordingly. • Carcass searches should be implemented to search the ground between arrays of troughs on a weekly basis (every two weeks at the longest) for at least one year to determine the magnitude of collision fatalities. Searches should be done on foot. Searches should be conducted randomly or at systematically selected arrays of troughs to the extent that equals 33% or more of the project area. Detection trials should be integrated into the searches. • Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including minor modifications of panel and mirror design to reduce the illusory characteristics of troughs. What is considered to be significant will have to be established on a species specific basis by the avifaunal specialist, in consultation with Birdlife South Africa. • The exact protocol to be followed for the carcass searches and operational phase monitoring must be compiled by the avifaunal specialist in consultation with the plant operator and Environmental Control Officer before the commencement of operations.	

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
OPERATION **Avifauna: Mortality of priority species due to collisions with the earthwire of the 132kV power line – Alternative 1** **The following activities have been identified as sources of collision mortality:** • The priority species that were recorded in the study area which could potentially be exposed to collision risk are listed in Table 7.3. • The most likely priority species candidates for collision mortality on the proposed 132kV power line are medium to large terrestrial species i.e. Karoo Korhaan, Kori Bustard, and Secretarybird which have all been recorded at the site.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Continuous (-5) Intensity: Medium (-3) Probability: Likely (-3) Significance: High (-16)	• The 132kV grid connection should be inspected at least once a quarter for a minimum of three years by the avifaunal specialist to establish if there is any significant collision mortality. Thereafter the frequency of inspections will be informed by the results of the first three years. • The detailed protocol to be followed for the inspections will be compiled by the avifaunal specialist prior to the first inspection. • The proposed transmission line for evacuation of the electricity generated by the PVs should be marked with Bird Flight Diverters (BFDs) for their entire length on the earth wire of the line, 5m apart, alternating black and white.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Continuous (-5) Intensity: Low (-2) Probability: Likely (-3) Significance: Medium to High (-15)

ACTIVITY	IMPACT PRE-MITIGATION	MITIGATION	IMPACT POST-MITIGATION
OPERATION **Avifauna: Mortality of priority species due to collisions with the earthwire of the 132kV power line – Alternative 2** **The following activities have been identified as sources of collision mortality:** • The priority species that were recorded in the study area which could potentially be exposed to collision risk are listed in Table 7.3. • The most likely priority species candidates for collision mortality on the proposed 132kV power line are medium to large terrestrial species i.e. Karoo Korhaan, Kori Bustard, and Secretarybird which have all been recorded at the site.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Continuous (-5) Intensity: Medium (-3) Probability: Likely (-3) Significance: High (-16)	• The 132kV grid connection should be inspected at least once a quarter for a minimum of three years by the avifaunal specialist to establish if there is any significant collision mortality. Thereafter the frequency of inspections will be informed by the results of the first three years. • The detailed protocol to be followed for the inspections will be compiled by the avifaunal specialist prior to the first inspection. • The proposed transmission line for evacuation of the electricity generated by the PVs should be marked with Bird Flight Diverters (BFDs) for their entire length on the earth wire of the line, 5m apart, alternating black and white.	Extent: Site (-1) Duration: Long-term (-4) Frequency: Continuous (-5) Intensity: Low (-2) Probability: Likely (-3) Significance: Medium to High (-15)

10.4 Cumulative impacts

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

Currently there is no agreed method for determining significant adverse cumulative impacts on ornithological receptors, although clearly a more strategic approach should be followed than is currently the case (Jenkins *et al.* 2011). The Scottish Natural Heritage (2005) recommends a five-stage process to aid in the ornithological assessment:

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

10.4.1 Potential mortality due to collisions with the proposed parabolic troughs

In the current instance, not all the criteria proposed above by the Scottish Natural Heritage can be met in assessing the cumulative impact of potential mortality due to collisions with the proposed parabolic troughs. The main reason is that no scientifically verified information exists with regard to actual avifaunal mortality levels with the status quo as it currently exists for the nine pentads (676km²) which overlap substantially with the proposed development. In other words there are no existing studies to review as far as existing impacts on the avifauna is concerned. In the absence of any scientifically verified data on actual mortality levels, general knowledge and experience will have to suffice. Given the extensive farming practices which are currently used in the region (excluding the irrigation activity along the Orange River), it can be surmised that the existing anthropogenic impacts on avifauna in this region is relatively low. Overall, the very low human population is definitely advantageous to avifauna in general. This assertion would ideally need to be tested empirically in order to make comparisons possible, but a study of that proportion falls outside the scope of this project.

The one existing impact that can be taken as confirmed is the mortality of Ludwig's Bustard, Kori Bustard and possibly Secretarybird due to collisions with the existing high voltage network. Due to the presence of the Garona MTS, there is an extensive network of HV lines feeding into the substation. The extent of this mortality factor is unknown, but it can be assumed that it is a regular occurrence (Shaw 2013). The key question therefore is to what extent potential collisions with the parabolic troughs will contribute to this existing and potentially significant mortality factor, taking into account not only the status quo as it currently stands, but also the future situation as far as other solar developments are concerned such as the neighbouring Bokpoort CSP facility which is currently under construction and the proposed central receiver and PV facilities on the farm Sand Draai. It is not envisaged that collisions of bustards with the parabolic troughs will be a major impact, as the species are not likely to be attracted by the "lake effect". The cumulative impact of mortality of bustard collisions at the proposed Sand Draai site, due to collisions with the parabolic troughs, is therefore likely to be negligible.

Overall, the cumulative impact of collisions with parabolic troughs at Sand Draai should be **Medium** for priority species occurring within the nine pentads around the proposed plant. With mitigation, this could probably be reduced to **Low,** but it must be borne in mind that mitigation for this type of impact still in an experimental phase.

10.4.2 Displacement of priority species due to habitat transformation and disturbance

The difficulties associated with the quantification of cumulative impacts of the renewable energy facilities have already been explained above. The current land use, namely extensive stock farming, is not displacing any priority species although it may be that periodic overgrazing might have an impact on the habitat and therefore the densities of some species. However, that cannot be categorically confirmed without more research. As far as potential future impacts are concerned, the cumulative impact of habitat transformation due to the combined Bokpoort and Sand Draai solar facilities (approximately 20km² or 2% of the 676km² pentad area), is likely to be relatively insignificant for most priority species, except possibly for the pair of Martial Eagles breeding near the site. The average Martial Eagle breeding territory in the Nama Karoo is approximately 280km² (Hockey *et al.* 2005), which means that the breeding pair of Martial Eagles at Sand Draai stands to lose about 7% of their territory due to direct habitat loss. Apart from the direct habitat loss, the activity around the solar farm might also act as a deterrent, resulting in the birds losing more than 7% of their territory in real terms. Overall, the significance of this impact is rated at **Medium**, and will remain so irrespective of mitigation.

10.4.3 Bird collisions, particularly priority species, with the proposed 132kV grid connection

The difficulties associated with the quantification of cumulative impacts at a local level have already been explained above. The risks that power lines pose to avifauna, especially to bustards, is well researched (Shaw 2013). These transmission lines will increase the already high collision risk to these species that power lines pose throughout its range. No quantification of bustard collision mortality has been undertaken for the 9 pentad area, but it can be assumed that it is a regular occurrence (Shaw 2013). The key question therefore is to what extent transmission line collisions will contribute to this existing and potentially significant mortality factor. All in all, it is envisaged that collisions of priority species, particularly bustards but also Secretarybird, with the new Sand Draai 132kV grid connection will have a **Medium** cumulative impact. If the recommendations in this report are implemented, it is envisaged that the cumulative impact of this mortality factor could be reduced to a **Low** level.

10.5 No-Go Alternative

The no-go alternative will result in the current status quo being maintained as far as the avifauna is concerned. Given the extensive farming practices which are currently used in the region, it can be surmised that the existing anthropogenic impacts on avifauna is relatively low. Overall, the very low human population in the study area is definitely advantageous to avifauna in general. The no-go option would maintain the ecological integrity of the study area as a whole as far as avifauna is concerned.

11 CONCLUSIONS

The negative impact of the proposed Sand Draai parabolic trough facility on local priority avifauna will be medium to high, depending on the nature of the impact and the level of mitigation which is applied.

In the case of the plant, the displacement impact due to disturbance during construction is rated as high - negative to start with, and could be reduced to medium to high after application of mitigation measures, provided Alternative 1 is used. If Alternative 2 is used, the impact will remain high, primarily due to the potential impact on the breeding pair of Martial Eagles on tower 22 of the Garona – Gordonia 132kV line. In the case of habitat transformation during operation, the displacement impact on priority species is high – negative and will remain as such after the application of mitigation measures. The impact of direct mortality of priority species due to collisions with the parabolic troughs is likely to be medium to high, and will remain so despite mitigation.

In the case of the proposed pipeline and access road, the impact of disturbance during construction will be high if Alternative 1 is used, primarily due to the potential impact on the breeding pair of Martial Eagles on tower 22 of the Garona – Gordonia 132kV line, despite mitigation. If Alternative 2 is used, the impact will be medium to high.

The proposed 132kV circuit grid connection will have a high negative collision impact on avifauna during operation which could be reduced to medium to high through the application of anti-collision mitigation measures. The impact of displacement caused by the construction of the power line will be high negative if Alternative 2 is used, but it could be reduced to medium to high if Alternative 1 is used, with appropriate mitigation.

In summary therefore the best combination would be Alternative 1 for the plant, Alternative 2 for the road and pipeline and Alternative 1 for the power line.

The cumulative impact of the facility on regional priority avifauna will range from medium to low, depending on the level mitigation which is applied. While the impact on local priority avifauna is likely to be medium to high, the regional impact of the facility is likely to be considerably less, and it could therefore be authorised provided that all mitigation measures are implemented as detailed in the report.

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ANNEXURE A: CURRICULUM VITAE

CHRIS VAN ROOYEN

DATE OF BIRTH: 30 April 1964

SPECIALIST FIELD: Avifauna

RELEVANT WORK EXPERIENCE (PLSE SEE APPENDIX A FOR A MORE COMPREHENSIVE CAREER HISTORY)

- 1991-1995: Volunteer for the Endangered Wildlife Trust's Raptor Conservation Group and Vulture Study Group.
- 1996-2007: Specialist Consultant with the Endangered Wildlife Trust. Duties entailed the overall co-ordination and management of the Endangered Wildlife Trust's national programme to eliminate negative wildlife interactions with electrical utility structures in southern Africa
- Since November 2007 to present: Environmental Consultant specialising in Bird Impact Assessment Studies.

CLIENTS

Industry

- Eskom Distribution Division
- Eskom Transmission Division
- Eskom Research (Resources and Strategy)
- Eskom Generation Division
- Botswana Power Company
- NamPower (Namibia)
- Debswana (Botswana)
- SAPPI
- Texas Utility Company (USA)
- TransPower (New Zealand)
- South African Roads Agency
- Mainstream Renewable Power
- Windcurrent SA
- Biotherm Energy
- Vleesbaai Independent Power Producer
- Renewable Energy Systems SA
- SAGIT
- JUWI
- Globeleq South Africa
- Mulilo Renewable Project Developments
- Electrawinds
- Cennergi
- Innowind
- Windlab

Lead Consultants

- Bohlweki Environmental
- Strategic Environmental Focus
- Tswelopele Environmental
- Digby Wells Associates
- Iliso Consulting

- Savannah Environmental
- PBA International
- Gibb
- Landscape Dynamics
- BKS
- Naledzi Environmental
- Eyethu Engineers
- Ninham Shand
- WSP Environmental
- Enviro Dynamics (Namibia)
- Eco Assessments
- Loci Environmental (Botswana)
- SRK
- Zitholele Consulting
- EcoPlan (Namibia)
- Groundwater Consultant Services – SA
- CSIR
- CIC International
- EnviroXcellence Services
- Naledzi Environmental Consultants
- Cymbian Enviro-social Consultants
- Envirolution Consulting
- Nzumbululo Heritage Consultants
- Synergistics Environmental Services
- Seedcracker Environmental Consulting
- Namibia Nature Foundation
- Texture Environmental
- Environmental Evaluation Unit, University of Cape Town
- Aurecon
- Royal Haskoning
- Margen Industrial Services
- Senkosi Environmental Consultants

PROJECTS

Bird Impact Assessment Specialist Studies:

For power lines:

1. Chobe 33kV Distribution line
2. Athene - Umfolozi 400kV
3. Beta-Delphi 400kV
4. Cape Strengthening Scheme 765kV
5. Flurian-Louis-Trichardt 132kV
6. Ghanzi 132kV (Botswana)
7. Ikaros 400kV
8. Matimba-Witkop 400kV
9. Naboomspruit 132kV
10. Tabor-Flurian 132kV
11. Windhoek - Walvisbaai 220 kV (Namibia)
12. Witkop-Overyssel 132kV
13. Breyten 88kV
14. Adis-Phoebus 400kV
15. Dhuva-Janus 400kV
16. Perseus-Mercury 400kV
17. Gravelotte 132kV
18. Ikaros 400 kV
19. Khanye 132kV (Botswana)

20. Moropule – Thamaga 220 kV (Botswana)
21. Parys 132kV
22. Simplon –Everest 132kV
23. Tutuka-Alpha 400kV
24. Simplon-Der Brochen 132kV
25. Big Tree 132kV
26. Mercury-Ferrum-Garona 400kV
27. Zeus-Perseus 765kV
28. Matimba B Integration Project
29. Caprivi 350kV DC (Namibia)
30. Gerus-Mururani Gate 350kV DC (Namibia)
31. Mmamabula 220kV (Botswana)
32. Steenberg-Der Brochen 132kV
33. Venetia-Paradise T 132kV
34. Burgersfort 132kV
35. Majuba-Umfolozi 765kV
36. Delta 765kV Substation
37. Braamhoek 22kV
38. Steelpoort Merensky 400kV
39. Mmamabula Delta 400kV
40. Delta Epsilon 765kV
41. Gerus-Zambezi 350kV DC Interconnector: Review of proposed avian mitigation measures for the Okavango and Kwando River crossings
42. Giyani 22kV Distribution line
43. Liqhobong-Kao 132/11kV distribution power line, Lesotho
44. 132kV Leslie – Wildebeest distribution line
45. A proposed new 50 kV Spoornet feeder line between Sishen and Saldanha
46. Cairns 132kv substation extension and associated power lines
47. Pimlico 132kv substation extension and associated power lines
48. Gyani 22kV
49. Matafin 132kV
50. Nkomazi_Fig Tree 132kV
51. Pebble Rock 132kV
52. Reddersburg 132kV
53. Thaba Combine 132kV
54. Nkomati 132kV
55. Louis Trichardt – Musina 132kV
56. Endicot 44kV
57. Apollo Lepini 400kV
58. Tarlton-Spring Farms 132kV
59. Kuschke 132kV substation
60. Bendstore 66kV Substation and associated lines
61. Kuiseb 400kV (Namibia)
62. Gyani-Malamulele 132kV
63. Watershed 132kV
64. Bakone 132kV substation
65. Eerstegoud 132kV LILO lines
66. Kumba Iron Ore: SWEP - Relocation of Infrastructure
67. Kudu Gas Power Station: Associated power lines
68. Steenberg Booysendal 132kV
69. Toulon Pumps 33kV
70. Thabatshipi 132kV
71. Witkop-Silica 132kV
72. Bakubung 132kV
73. Nelsriver 132kV
74. Rethabiseng 132kV
75. Tilburg 132kV
76. GaKgapane 66kV

77. Knobel Gilead 132kV
78. Bochum Knobel 132kV
79. Madibeng 132kV
80. Witbank Railway Line and associated infrastructure
81. Spencer NDP phase 2 (5 lines)
82. Akanani 132kV
83. Hermes-Dominion Reefs 132kV
84. Cape Pensinsula Strengthening Project 400kV
85. Magalakwena 132kV
86. Benficosa 132kV
87. Dithabaneng 132kV
88. Taunus Diepkloof 132kV
89. Taunus Doornkop 132kV
90. Tweedracht 132kV
91. Jane Furse 132kV
92. Majeje Sub 132kV
93. Tabor Louis Trichardt 132kV
94. Riversong 88kV
95. Mamatsekele 132kV
96. Kabokweni 132kV
97. MDPP 400kV Botswana
98. Marble Hall NDP 132kV
99. Bokmakiere 132kV Substation and LILO lines
100. Styldrift 132kV
101. Taunus – Diepkloof 132kV
102. Bighorn NDP 132kV
103. Waterkloof 88kV
104. Camden – Theta 765kV
105. Dhuva – Minerva 400kV Diversion
106. Lesedi –Grootpan 132kV
107. Waterberg NDP
108. Bulgerivier – Dorset 132kV
109. Bulgerivier – Toulon 132kV
110. Nokeng-Fluorspar 132kV
111. Mantsole 132kV
112. Tshilamba 132kV
113. Thabamoopo - Tshebela – Nhlovuko 132kV
114. Arthurseat 132kV
115. Borutho 132kV MTS
116. Volspruit - Potgietersrus 132kV
117. Matla-Glockner 400kV
118. Delmas North 44kV
119. Houwhoek 11kV Refurbishment
120. Clau-Clau 132kV
121. Ngwedi-Silwerkrans 134kV
122. Nieuwehoop 400kV walk-through
123. Booysendal 132kV Switching Station
124. Tarlton 132kV

Bird Impact Assessment Studies for power stations:

1. Open Cycle Gas Turbine Plants & The Associated Transmission Lines & Substation At Atlantis, Western Cape
2. Kangra Power Station: Siting Report

Ongoing involvement in Bird Impact Assessment Studies for wind-powered generation facilities:

1. Eskom Klipheuwel Experimental Wind Power Facility, Western Cape
2. Mainstream Wind Facility Jeffreys Bay, Eastern Cape (EIA and monitoring)
3. Biotherm, Swellendam, (Excelsior), Western Cape (EIA and monitoring)
4. Biotherm, Napier, (Matjieskloof), Western Cape (pre-feasibility)
5. Windcurrent SA, Jeffreys Bay, Eastern Cape (2 sites) (EIA and monitoring)
6. Caledon Wind, Caledon, Western Cape (EIA)
7. Innowind (4 sites), Western Cape (EIA)
8. Renewable Energy Systems (RES) Oyster Bay, Eastern Cape (EIA and monitoring)
9. Oelsner Group (Kerriefontein), Western Cape (EIA)
10. Oelsner Group (Langefontein), Western Cape (EIA)
11. InCa Energy, Vredendal Wind Energy Facility Western Cape (EIA)
12. Mainstream Loeriesfontein Wind Energy Facility (EIA and monitoring)
13. Mainstream Noupoort Wind Energy Facility (EIA and monitoring)
14. Biotherm Port Nolloth Wind Energy Facility (Monitoring)
15. Biotherm Laingsburg Wind Energy Facility (EIA and monitoring)
16. Langhoogte Wind Energy Facility (EIA)
17. Vleesbaai Wind Energy Facility (EIA and monitoring)
18. St. Helena Bay Wind Energy Facility (EIA and monitoring)
19. Electrawind, St Helena Bay Wind Energy Facility (EIA and monitoring)
20. Electrawind, Vredendal Wind Energy Facility (EIA)
21. SAGIT, Langhoogte and Wolseley Wind Energy facilities
22. Renosterberg Wind Energy Project – 12 month preconstruction avifaunal monitoring project
23. De Aar – North (Mulilo) Wind Energy Project – 12 month preconstruction avifaunal monitoring project
24. De Aar – South (Mulilo) Wind Energy Project – 12 month bird monitoring
25. Namies – Aggenys Wind Energy Project – 12 month bird monitoring
26. Pofadder - Wind Energy Project – 12 month bird monitoring
27. Dwarsrug Loeriesfontein - Wind Energy Project – 12 month bird monitoring
28. Waaihoek – Utrecht Wind Energy Project – 12 month bird monitoring & EIA study
29. Amathole – Butterworth Wind Energy Project – 12 month bird monitoring
30. Noupoort East and West Wind Energy Projects 12 month bird monitoring & EIA specialist study (Innowind)
31. Beaufort West Wind Energy Facility 12 month bird monitoring & EIA specialist study (Mainstream)
32. Leeuwdraai Wind Energy Facility 12 month bird monitoring & EIA specialist study (Mainstream)
33. Sutherland Wind Energy Facility 12 month bird monitoring (Mainstream)
34. Maralla Wind Energy Facility 12 month bird monitoring & EIA specialist study (Biotherm)
35. Esizayo Wind Energy Facility 12 month bird monitoring & EIA specialist study (Biotherm)
36. Humansdorp Wind Energy Facility 12 month bird monitoring & EIA specialist study (Cennergi)
37. Aletta Wind Energy Facility 12 month bird monitoring & EIA specialist study (Biotherm)
38. Eureka Wind Energy Facility 12 month bird monitoring & EIA specialist study (Biotherm)

39. Makambako Wind Energy Faclity (Tanzania) 12 month bird monitoring & EIA specialist study (Windlab)

Bird Impact Assessment Studies for Solar Energy Plants:

1. Concentrated Solar Power Plant, Upington, Northern Cape.
2. De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
3. JUWI Kronos PV project, Copperton, Northern Cape
4. Sand Draai Solar project, Groblershoop, Northern Cape
5. Helena PV Project, Copperton, Northern Cape
6. Letsitsing Solar Project, Lichtenburg, North-West
7. Sendawo Solar Project, Vryburg, North-West
8. Letsoai Solar Project, Aggeneys Northern Cape
9. Enamandla Solar Project, Aggeneys, Northern Cape

Bird Impact Assessment Studies for Desalination Plants:

1. Proposed Desalination Project at Mile 6 near Swakopmund, Namibia

Risk Assessments on existing electricity infrastructure:

1. Amandel 132kV
2. Atlanta 22kV
3. Butterworth-Ncora 66kV
4. Debswana Jwaneng 66kV (Botswana)
5. Edwardsdam – Mareetsane 88kV
6. Gaberone 132kV (Bostwana)
7. Lydenburg-Merensky 132kV
8. Tabor-Dendron 132kV
9. Vryheid-Bredasdorp 66kV
10. Vygeboom 132kV
11. Watershed-Mmabatho 88kV
12. Welgevonden 22kV network
13. Ferrum-Garona 275kV
14. Investigation into genet related faulting at the Perseus Substation,
15. North-West Transmission Region
16. Investigation into genet related faulting at the Helios Substation, Western Transmission Region
17. Investigation into vulture electrocutions on staggered vertical reticulation structures in the Northern Cape

Strategic Environmental Assessments:

- National Electricity Grid Infrastructure SEA Specialist Report: Avifauna

Bird Impact Assessment Studies for other non-power line developments:

1. Lizard Point Golf Estate
2. Lever Creek Estates
3. Leloko Lifestyle Estates
4. Vaaloewers Residential Development
5. Clearwater Estates Grass Owl Impact Study
6. Sommerset Ext. Grass Owl Study
7. Proposed Three Diamonds Trading Mining Project (Portion 9 and 15 of the Farm Blesbokfontein)

8. N17 Section: Springs To Leandra –"Borrow Pit 12 And Access Road On (Section 9, 6 And 28 Of The Farm Winterhoek 314 Ir)
9. South African Police Services Gauteng Radio Communication System: Portion 136 Of The Farm 528 Jq, Lindley.
10. Report for the proposed upgrade and extension of the Zeekoegat Wastewater Treatment Works, Gauteng.
11. Bird Impact Assessment for Portion 265 (a portion of Portion 163) of the farm Rietfontein 189-JR, Gauteng.
12. Bird Impact Assessment Study for Portions 54 and 55 of the Farm Zwartkop 525 JQ, Gauteng.
13. Bird Impact Assessment Study Portions 8 and 36 of the Farm Nooitgedacht 534 JQ, Gauteng.
14. Shumba's Rest Bird Impact Assessment Study
15. Randfontein Golf Estate Bird Impact Assessment Study
16. Zilkaatsnek Wildlife Estate
17. Regenstein Communications Tower (Namibia)
18. Input into Richards Bay Comparative Risk Assessment Study
19. Maquasa West Open Cast Coal Mine
20. Glen Erasmia Residential Development, Kempton Park, Gauteng
21. Bird Impact Assessment Study, Weltevreden Mine, Mpumalanga
22. Bird Impact Assessment Study, Olifantsvlei Cemetery, Johannesburg
23. Camden Ash Disposal Facility, Mpumalanga
24. Lindley Estate, Lanseria, Gauteng

Environmental Impact Assessment Reports:

- Draft Environmental Impact Report for a proposed dam in the Mosetse River in Botswana

Basic Assessments:

- Proposed temporary and permanent diversion of Lovato Road, Gauteng
- Flood Management: Rosslyn East at Frans du Toit Road, City of Tshwane

Section 24G of NEMA applications:

- Rectification application for the de-silting of the Kaalplaasspruit, Rosslyn

Papers and Conference Presentations

1. Van Rooyen, C. S. 1996. Towards an Integrated Management System for the Management of Wildlife Interactions with Electricity Structures. Abstracts of the 2nd International Conference on Raptors p.9. Raptor Research Foundation/University of Urbino.

2. Van Rooyen, C.S. & Piper, S.E. 1997. The effects of Powerlines on Vultures. *In*: BOSHOFF, A.F., ANDERSON, M.D.& BORELLO, W.D. (Eds). *Vultures in the 21st Century: Proceedings of a workshop on vulture research and conservation in southern Africa.* Johannesburg: Vulture Study Group: 102-104.

3. Kruger, R. & Van Rooyen, C.S. 1998. Evaluating the risk existing powerlines pose to large raptors by using risk assessment methodology: The Molopo case study. Proceedings of the 5th World Conference on Birds of Prey and Owls (in press). Raptor Conservation Group/World Working Group on Birds of Prey and Owls. Midrand. South Africa.

4. Van Rooyen, C.S., Kruger, R., Nelson, P.A & Fedorsky, C.A. 1998. The Eskom/EWT Strategic Partnership: The South African Approach towards the Management of Wildlife/Utility Interactions. EEI Natural Resources/Biologist National Workshop.1998. Edison Electrical Institute, Washington, D.C.

5. Van Rooyen, C.S. 1998. Raptor mortality on powerlines in South Africa. Proceedings of the 5th World Conference on Birds of Prey and Owls (in press.). Raptor Conservation Group/World Working Group on Birds of Prey and Owls. Midrand. South Africa

6. Van Rooyen, C.S. 1998. Experiences of Partnerships in South Africa. Conference Proceedings, Second NGO Conference on the Environment, November 3-5 1998. Gaberone, Botswana.

7. Van Rooyen, C.S. 1999**.** An overview of the Eskom-EWT Strategic Partnership in South Africa. EPRI Workshop On Avian Interactions with Utility Structures 2-3 December 1999, Charleston, South Carolina.

8. Van Rooyen, C.S. & Taylor, P.V. 1999. Bird Streamers as probable cause of electrocutions in South Africa. EPRI Workshop on Avian Interactions with Utility Structures 2-3 December 1999. Charleston, South Carolina.

9. Van Rooyen, C.S. 2000. An overview of vulture electrocutions in South Africa. Vulture News No.43. Endangered Wildlife Trust. Johannesburg, South Africa.

10. Van Rooyen, C.S. Vosloo, H.F. & R.E. Harness. 2002. Eliminating bird streamers as a cause of faulting on transmission lines in South Africa. IEEE 46th Rural Electric Power Conference. May 2002. Colorado Springs. Colorado.

11. Van Rooyen, C. 2003. Mitigation Programme for Avian Collisions with Eskom Transmission Lines. Unpublished Progress Report. Endangered Wildlife Trust. September 2003.

12. Smallie, J. & Van Rooyen, C. 2003. Risk assessment of bird interaction on the Hydra-Droërivier 1 and 2 400kV. Unpublished report to Eskom Transmission Group. Endangered Wildlife Trust. Johannesburg. South Africa

13. Kruger, R. Van Rooyen, C.S. & Maritz, A. 2003. The electrocution risk posed to vultures by vertically configured medium voltage designs. Proceedings of the 6th World Conference on Birds of Prey and Owls, Budapest, Hungary, May 2003.

14. Van Rooyen, C. 2004. Report on vulture interactions with powerlines in southern Africa: 1996 to 2003. In: Monadjem, A., Anderson, M.D., Piper, S.E. & Boshoff, A.F. (Eds). *The vultures of Southern Africa-Quo Vadis?* Proceedings of a workshop on vulture research and conservation in southern Africa. Birds of Prey Working Group, Johannesburg.

15. Smallie, J. J & Van Rooyen, C.S. 2005. Impact of Bird Streamers on Quality of Supply on Transmission Lines: A Case Study. Proceedings of the 5th International Conference on Power and Energy Systems, Benalmadena, Spain.

16. Jenkins, A. Van Rooyen, C.S., De Goede J.A, Matshikiza M.T. 2005. Managing raptor interactions with powerlines in South Africa. Proceedings of the 5th International Conference on Power and Energy Systems, Benalmadena, Spain.

17. Van Rooyen, C.S., Froneman A, Piper S, Michael M. 2006. Assessing the power line network in the KwaZulu-Natal Province of South Africa from a vulture

interaction perspective. Proceedings of International Conference on Utility Line Structures, Fort Collins, Colorado, March 2006.

Research Reports

1. Van Rooyen, C. Jenkins, A. De Goede, J. & Smallie J. 2003. Environmentally acceptable ways to minimise the incidence of power outages associated with large raptor nests on Eskom pylons in the Karoo: Lessons learnt to date. Project number 9RE-00005 / R1127 Technology Services International. Johannesburg. South Africa.

2. Jenkins, A. De Goede, J. & Van Rooyen, C. 2004. Environmentally acceptable ways to minimise the incidence of power outages associated with large raptor nests on Eskom pylons in the Karoo. Project number R99-00754. Technology Services International. Johannesburg. South Africa.

3. Jenkins, A. De Goede, J. & Van Rooyen, C. 2005. Implementation of management recommendations stemming from the Eskom Electric Eagle Project (or EEEP Phase 5). Project number R99-00754. Technology Services International. Johannesburg. South Africa.

4. Van Rooyen, C., Froneman A. & Piper S.E. 2004. The evaluation of vulture interactions with power lines in KwaZulu-Natal: Research Report RES/RR/04/24331. Eskom Resources and Strategy.

5. Van Rooyen, C. 2006. The evaluation of vulture interactions with power lines in KwaZulu-Natal: Phase Two. Research Report RES/RR/06/28111. Eskom Resources and Strategy.

6. Van Rooyen, C.S., Froneman A, Piper S. 2006. The quantification of risks that power lines pose to vultures in the greater Kimberley area. Research Report RES/RR/06/28106. Eskom Resources and Strategy.

Book Chapters

1. Van Rooyen, C.S & Ledger J. A. 1999. Birds and Utility Structures: Developments in Southern Africa. In: Birds and Power lines: Collisions, Electrocution and Breeding. Ferrer M and Janss G F E Eds.
2. Van Rooyen, C.S. 2004. The Management of Wildlife Interactions with overhead lines. In The fundamentals and practice of Overhead Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.

Guidelines

1. Jenkins A R; Van Rooyen C S; Smallie J J; Anderson M D & Smit H A. 2011. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Endangered Wildlife Trust and Birdlife South Africa.

Awards

- The Eskom-EWT Strategic Partnership won the Edison Electric Institute Common Goals Award in the USA for outstanding electric utility customer and community relations programmes in 1997, from a field of 61 international entries from 49 countries.
- The Eskom-EWT Strategic Partnership was a finalist in the 1998 and 2000 Green Trust Awards.

- Eskom Manager's Award in 1997 for the management of animal interactions.
- Eskom Manager's Award in 1999 for environmental management.
- Highly Commended Award in 2001 for Business Efficiency from Eskom Transmission Group.
- Nominated for Eskom Chairman's Award in 2001 in Environmental Category
- Runner-up: Eskom Resources and Strategy manager's award 2003
- Listed in Marqui's Who's Who in the World 2007 edition
- Northern Cape Raptor Conservationist of the Year: 2004

ALBERT FRONEMAN

Albert Froneman **(**Pr.Sci.Nat) has more than 15 years' experience in the management of avifaunal interactions with industrial infrastructure. He holds a M.Sc. degree in Conservation Biology from the University of Cape Town. He managed the Airports Company South Africa (ACSA) – Endangered Wildlife Trust Strategic Partnership from 1999 to 2008 which has been internationally recognized for its achievements in addressing airport wildlife hazards in an environmentally sensitive manner at ACSA's airports across South Africa. Albert is recognized worldwide as an expert in the field of bird hazard management on airports and has worked in South Africa, Swaziland, Botswana, Namibia, Kenya, Israel, and the USA. He has served as the vice chairman of the International Bird Strike Committee and has presented various papers at international conferences and workshops. At present he is consulting to ACSA with wildlife hazard management on all their airports. He also an accomplished specialist ornithological consultant outside the aviation industry and has completed a wide range of bird impact assessment studies. He has co-authored numerous avifaunal specialist studies and pre-construction monitoring reports for proposed renewable energy developments across South Africa. He also has vast experience in using Geographic Information Systems to analyse and interpret avifaunal data spatially and derive meaningful conclusions. Since 2009 Albert has been a registered Professional Natural Scientist (reg. nr 400177/09) with The South African Council for Natural Scientific Professions, specialising in Zoological Science.

EXPERIENCE

Bird Impact Assessment studies and / or GIS analysis done for the following projects:

1. Aviation Bird Hazard Assessment Study for the proposed Madiba Bay Leisure Park adjacent to Port Elizabeth Airport.
2. Extension of Runway and Provision of Parallel Taxiway at Sir Seretse Khama Airport, Botswana Bird / Wildlife Hazard Management Specialist Study
3. Maun Airport Improvements Bird / Wildlife Hazard Management Specialist Study
4. Bird Impact Assesment Study - Bird Helicopter Interaction – The Bitou River, Western Cape Province South Africa
5. Proposed La Mercy Airport – Bird Aircraft interaction specialists study using bird detection radar to assess swallow flocking behaviour
6. KwaZulu Natal Power Line Vulture Mitigation Project – GIS analysis
7. Perseus-Zeus Powerline EIA – GIS Analysis
8. Southern Region Pro-active GIS Blue Crane Collision Project.
9. Specialist advisor ~ Implementation of a bird detection radar system and development of an airport wildlife hazard management and operational environmental management plan for the King Shaka International Airport
10. Matsapha International Airport – bird hazard assessment study with management recommendations
11. Evaluation of aviation bird strike risk at candidate solid waste disposal sites in the Ekurhuleni Metropolitan Municipality
12. Gateway Airport Authority Limited – Gateway International Airport, Polokwane: Bird hazard assessment; Compile a bird hazard management plan for the airport
13. Bird Specialist Study - Evaluation of aviation bird strike risk at the Mwakirunge Landfill site near Mombasa Kenya
14. Bird Impact Assessment Study - Proposed Weltevreden Open Cast Coal Mine Belfast, Mpumalanga

15. Avian biodiversity assessment for the Mafube Colliery Coal mine near Middelburg Mpumalanga
16. Avifaunal Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
17. Avifaunal Impact Assessment Study (with specific reference to African Grass Owls and other Red List species) Stone Rivers Arch
18. Airport bird and wildlife hazard management plan and training to Swaziland Civil Aviation Authority (SWACAA) for Matsapha and Sikhupe International Airports
19. Avifaunal Impact Scoping & EIA Study - Renosterberg Wind Farm and Solar PV site
20. Bird Impact Assessment Study - Proposed 60 year Ash Disposal Facility near to the Kusile Power Station
21. Avifaunal pre-feasibility assessment for the proposed Montrose dam, Mpumalanga
22. Bird Impact Assessment Study – Proposed ESKOM Phantom Substation near Knysna, Western Cape
23. Habitat sensitivity map for Denham's Bustard, Blue Crane and White-bellied Korhaan in the Kouga Municipal area of the Eastern Cape Province
24. Swaziland Civil Aviation Authority – Sikhuphe International Airport – Bird hazard management assessment
25. Avifaunal monitoring – extension of Specialist Study - SRVM Volspruit Mining project – Mokopane Limpopo Province
26. Avifaunal Specialist Study – Rooikat Hydro Electric Dam – Hope Town, Northern Cape
27. The Stewards Pan Reclamation Project – Bird Impact Assessment study
28. Airports Company South Africa – Avifaunal Specialist Consultant – Airport Bird and Wildlife Hazard Mitigation

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

a. Jeffrey's Bay Wind Farm – 12 month preconstruction avifaunal monitoring project
b. Oysterbay Wind Energy Project – 12 month preconstruction avifaunal monitoring project
c. Ubuntu Wind Energy Project near Jeffrey's Bay – 12 month preconstruction avifaunal monitoring project
d. Bana-ba-Pifu Wind Energy Project near Humansdorp – 12 month preconstruction avifaunal monitoring project
e. Excelsior Wind Energy Project near Caledon – 12 month preconstruction avifaunal monitoring project
f. Laingsburg Spitskopvlakte Wind Energy Project – 12 month preconstruction avifaunal monitoring project
g. Loeriesfontein Wind Energy Project Phase 1, 2 & 3 – 12 month preconstruction avifaunal monitoring project
h. Noupoort Wind Energy Project – 12 month preconstruction avifaunal monitoring project
i. Vleesbaai Wind Energy Project – 12 month preconstruction avifaunal monitoring project
j. Port Nolloth Wind Energy Project – 12 month preconstruction avifaunal monitoring project
k. Langhoogte Caledon Wind Energy Project – 12 month preconstruction avifaunal monitoring project
l. Lunsklip – Stilbaai Wind Energy Project – 12 month preconstruction avifaunal monitoring project
m. Indwe Wind Energy Project – 12 month preconstruction avifaunal monitoring project
n. Zeeland St Helena bay Wind Energy Project – 12 month preconstruction avifaunal monitoring project
o. Wolseley Wind Energy Project – 12 month preconstruction avifaunal monitoring project
p. Renosterberg Wind Energy Project – 12 month preconstruction avifaunal monitoring project

q. De Aar – North (Mulilo) Wind Energy Project – 12 month preconstruction avifaunal monitoring project (2014)
r. De Aar – South (Mulilo) Wind Energy Project – 12 month bird monitoring
s. Namies – Aggenys Wind Energy Project – 12 month bird monitoring
t. Pofadder - Wind Energy Project – 12 month bird monitoring
u. Dwarsrug Loeriesfontein - Wind Energy Project – 12 month bird monitoring
v. Waaihoek – Utrecht Wind Energy Project – 12 month bird monitoring
w. Amathole – Butterworth Utrecht Wind Energy Project – 12 month bird monitoring & EIA specialist study
x. De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring

Geographic Information System analysis & maps

1. ESKOM Power line Makgalakwena EIA – GIS specialist & map production
2. ESKOM Power line Benficosa EIA – GIS specialist & map production
3. ESKOM Power line Riversong EIA – GIS specialist & map production
4. ESKOM Power line Waterberg NDP EIA – GIS specialist & map production
5. ESKOM Power line Bulge Toulon EIA – GIS specialist & map production
6. ESKOM Power line Bulge DORSET EIA – GIS specialist & map production
7. ESKOM Power lines Marblehall EIA – GIS specialist & map production
8. ESKOM Power line Grootpan Lesedi EIA – GIS specialist & map production
9. ESKOM Power line Tanga EIA – GIS specialist & map production
10. ESKOM Power line Bokmakierie EIA – GIS specialist & map production
11. ESKOM Power line Rietfontein EIA – GIS specialist & map production
12. Power line Anglo Coal EIA – GIS specialist & map production
13. ESKOM Power line Camcoll Jericho EIA – GIS specialist & map production
14. Hartbeespoort Residential Development – GIS specialist & map production
15. ESKOM Power line Mantsole EIA – GIS specialist & map production
16. ESKOM Power line Nokeng Flourspar EIA – GIS specialist & map production
17. ESKOM Power line Greenview EIA – GIS specialist & map production
18. Derdepoort Residential Development – GIS specialist & map production
19. ESKOM Power line Boynton EIA – GIS specialist & map production
20. ESKOM Power line United EIA – GIS specialist & map production
21. ESKOM Power line Gutshwa & Malelane EIA – GIS specialist & map production
22. ESKOM Power line Origstad EIA – GIS specialist & map production
23. Zilkaatsnek Development Public Participation –map production
24. Belfast – Paarde Power line - GIS specialist & map production
25. Solar Park Solar Park Integration Project Bird Impact Assessment Study – avifaunal GIS analysis.
26. Kappa-Omega-Aurora 765kV Bird Impact Assessment Report – Avifaunal GIS analysis.
27. Gamma – Kappa 2nd 765kV – Bird Impact Assessment Report – Avifaunal GIS analysis.
28. ESKOM Power line Kudu-Dorstfontein Amendment EIA – GIS specialist & map production.
29. Proposed Heilbron filling station EIA – GIS specialist & map production
30. ESKOM Lebatlhane EIA – GIS specialist & map production
31. ESKOM Pienaars River CNC EIA – GIS specialist & map production
32. ESKOM Lemara Phiring Ohrigstad EIA – GIS specialist & map production
33. ESKOM Pelly-Warmbad EIA – GIS specialist & map production
34. ESKOM Rosco-Bracken EIA – GIS specialist & map production
35. ESKOM Ermelo-Uitkoms EIA – GIS specialist & map production
36. ESKOM Wisani bridge EIA – GIS specialist & map production

37. City of Tswane – New bulkfeeder pipeline projects x3 Map production
38. ESKOM Lebohang Substation and 132kV Distribution Power Line Project Amendment GIS specialist & map production
39. ESKOM Geluk Rural Powerline GIS & Mapping
40. Eskom Kimberley Strengthening Phase 4 Project GIS & Mapping
41. ESKOM Kwaggafontein - Amandla Amendment Project GIS & Mapping
42. ESKOM Lephalale CNC – GIS Specialist & Mapping
43. ESKOM Marken CNC – GIS Specialist & Mapping
44. ESKOM Lethabong substation and powerlines – GIS Specialist & Mapping
45. ESKOM Magopela- Pitsong 132kV line and new substation – GIS Specialist & Mapping

Professional affiliations

South African Council for Natural Scientific Professions (SACNASP) registered Professional Natural Scientist (reg. nr 400177/09) – specialist field: Zoological Science. Registered since 2009

NICO LAUBSCHER

I was born as the first child of Andries Johannes Laubscher and Johanna Margaretha (neé Lubbe), on Saturday, 28 July 1934, in Paarl, South Africa. My childhood was spent on a farm near the small town of Tadcaster at Vaalhartz in the Northern Cape, where I also matriculated in 1951 at the Vaalhartz High School. From here, I moved to Potchefstroom University for further studies. My wife and I currently reside in the beautiful town of Stellenbosch in the Western Cape.

STUDIES:

Academic qualifications achieved at Potchefstroom University (now North-West University):

1952 - 1956	B.Sc. (Mathematics & Applied mathematics)
	Honns. B.Sc. (Mathematics & statistics)
	M.Sc. (Mathematics & statistics)
1957 - 1959	D.Sc. (Statistics)
	Dissertation: "On transformations for the stabilization of variance and the normalization of distribution functions".
	Promoters: Proff. H S Steyn, Sr. & J M de Wet.

PROFESSIONAL CAREER:

1957 - 1974	Head of Statistics Division, National Research Institute for Mathematical Sciences (of the CSIR, Pretoria).
1975 - 1986	Professor of Statistics, University of Port Elizabeth (now Nelson Mandela Metropolitan University).
1987 - 1989	Professor of Statistics, Stellenbosch University.
1990 - 1996	Company Statistician, S A Nylon Spinners (Pty) Ltd., Bellville.
1996 - present	Founder and director of InduStat Pro cc.

INTERNATIONAL EXPERIENCE:

1959 - 1960	One year visit at Cornell University, Ithaca, New York. Guest of Professor Jack Wolfowitz.
1967	Visiting Rothamsted Experimental Station in England, the Mathematisch Centrum in Amsterdam, various Statistical Institutes in the USA and

	Research Laboratories of the CSIRO in Sydney, Canberra, Melbourne and Adelaide in Australia.
1974	One year visit to Stanford University, Stanford, CA. Invited by Professor Ingram Olkin.
1983	One year visit to Eidgenossische Technische Hochschule, Zürich. Invited by Professor Frank Hampel.

PROFESSIONAL SOCIETIES:

South African Statistical Association
Member: 1957 - present
President: 1973
Fellow: 1974
Editor of the SA Statistical Journal: 1975 - 1977.
American Statistical Association
Member: 1974 - present
South African Mathematical Society
One of the founding members: 1957.

SPECIALISED KNOWLEDGE:

- Design of experiments (DOE) and the analysis of data obtained through DOE.
- Statistical process control
- Data mining

WORK FOCUS:

1957 - 1965	Mainly worked in the application of statistics to the physical sciences: physics, chemistry, engineering, wood research, road research and nutritional science.
1966 - 1986	In this period the most important applications were in the field of medical and biological sciences. From this work about 20 publications were written in support of the statistical aspects of research in medicine, mostly in The South African Medical Journal. This work mostly dealt with basic health care but also includes applications in zoology and botany.
1987 - 1989	During this time, as chief consulting statistician at the University of Stellenbosch, there was a diverse field of application, but mainly in psychology, sociology and education.
1989 - 1996	As company statistician at S.A. Nylon Spinners my work dealt with the application of statistical science to the manufacturing of polymer, synthetic yarn and in engineering. I also undertook a study for SANS in 1993 on statistical models in forecasting the incidence of HIV and AIDS.
1996 -	Industrial statistics.

ANNEXURE B: SPECIALIST DECLARATION

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

PROPOSED CONCENTRATED SOLAR POWER (CSP) AND PHOTOVOLTAIC (PV) PLANTS AND ASSOCIATED INFRASTRUCTURE ON THE FARM SAND DRAAI 391 IN THE SIYANDA DISTRICT MUNICIPALITY

Specialist:	Chris van Rooyen Consulting		
Contact person:	Chris van Rooyen		
Postal address:	30 Roosevelt Street, Robindale, Randburg		
Postal code:	2194	Cell:	0824549570
Telephone:		Fax:	
E-mail:	Vanrooyen.chris@gmail.com		
Professional affiliation(s) (if any)	-		

Project Consultant:	Royal Haskoning DHV		
Contact person:	Johan Blignaut		
Postal address:	P.O Box 867, Gallo Manor		
Postal code:	2052	Cell:	
Telephone:	011) 798 6000	Fax:	
E-mail:	Johan.blignaut@rhdhv.com		

4.2 The specialist appointed in terms of the Regulations_

I, Chris van Rooyen

, declare that -- General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Chris van Rooyen Consulting

Name of company (if applicable):

Date: 31 January 2016

ANNEXURE C: FIELD SURVEYS

The objective of the pre-construction monitoring at the proposed Sanddraai Solar Facilities was to gather baseline data over a period of six months on the following aspects pertaining to avifauna:

- The abundance and diversity of birds at the solar farm sites to measure the potential displacement effect of the wind farm.
- Flight patterns of priority species at the solar farm sites to measure the potential impact on flight activity of the solar farm.

The monitoring protocol for the site is designed according to the draft version (November 2015) of *Best Practice Guidelines for assessing and monitoring the impact of solar energy facilities on birds in southern Africa (Jenkins et al.).*

The monitoring surveys were conducted at the proposed turbine sites by one field monitor from 6-15 October and 2-6 December 2015.

Monitoring was conducted in the following manner:

- Seven walk transects of 1km each were identified at the turbine site and counted 16 times each. All birds were recorded during walk transects.
- The following variables were recorded:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Distance from transect (0-50 m, 50-100 m, >100 m);
    - Wind direction;
    - Wind strength (calm; moderate; strong);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);
    - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground); and
    - Co-ordinates (priority species only).

- Three vantage points (VP's) were identified for the recording of flight altitude and patterns of priority species over the development site. The following variables were recorded for each flight:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;

- o Wind direction;
- o Wind strength (estimated Beaufort scale 1-7);
- o Weather (sunny; cloudy; partly cloudy; rain; mist);
- o Temperature (cold; mild; warm; hot);
- o Flight altitude (high i.e. >250m; medium i.e. 20m – 250m; low i.e. <20m);
- o Flight mode (soar; flap; glide ; kite; hover); and
- o Flight time (in 15 second-intervals).

The objective of the transect monitoring was to gather baseline data on the use of the site by birds in order to measure potential displacement by the wind farm activities. The objective of vantage point counts was to measure the potential collision risk with the solar infrastructure, and to see how flight behaviour is influenced by the solar infrastructure. Priority species which were defined as follows:

- o South African Red Data species;
- o South African endemics and near-endemics;
- o Waterbirds; and
- o Raptors.

Figure 1 below indicates the area where monitoring was performed.

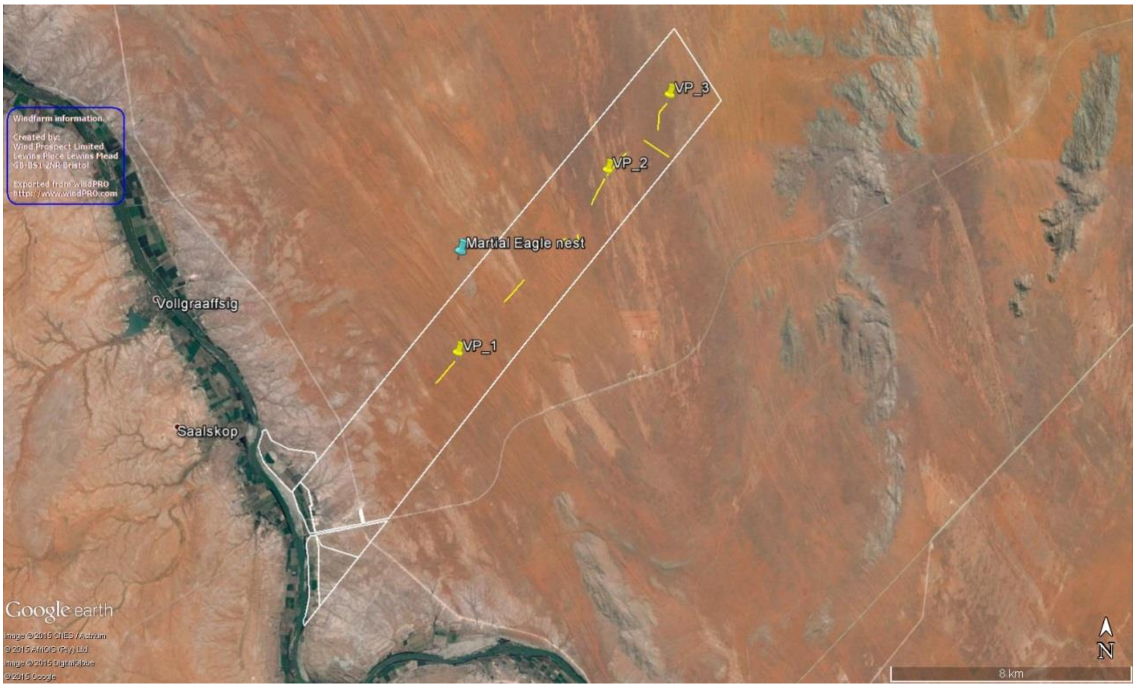


Figure 1: Area where monitoring was performed, with position of VPs (yellow placemarks walk transects (yellow lines) and study area boundaries (white polygon).

ANNEXURE D: STATISTICAL ANALYSIS FOR PRIORITY BIRD SPECIES AT VANTAGE POINTS: GROBLERSHOOP/SANDDRAAI

Introduction

The data on which this report is based are contained in the MS Excel file "*VP Data - Sanddraai Sp Su 2015 AF 4Nico 20160115.xlsx*". This file contains records for each individual flight of priority species birds that were recorded at each of three vantage points for watch periods that lasted for three hours at a time. The survey covers two seasons of the year and took place during the dates indicated in Table *1*. Environmental and other relevant information were recorded (e.g. Temperature, Wind Direction, Wind Speed and the categories of height at which the birds flew). Watch periods where no birds were recorded with their concomitant variables were also documented.

Table *1*. The survey dates.

Start Date	End Date	Season	Number of Days	Watch periods
2015-10-06	2014-10-15	Spring 2015	10	12
2015-12-02	2015-12-06	Summer 2015	5	12

There were 12 watch periods of 3h each allocated to Spring and Summer surveys, spread over the three vantage points.

Some basic statistics concerning the data set are presented here, including a discussion of whether the data obtained are representative of the true occurrence of those birds identified as priority species in the area.

Descriptive statistics

Tables of descriptive statistics are computed and captured in this section. It should be noted that birds belonging to only two flight classes were observed during the survey, viz. *Soaring Birds* and *Water Birds*. It is notable that no *Terrestrial Birds* were recorded. Only four priority species birds were recorded, viz., Martial Eagle (*Polymaetus bellicosus*), White-backed Vulture (*Gyps africanus*), Southern Pale Chanting Goshawk (*Melierax canorus*) and Egyptian Goose (*Alopochen aegyptiaca*). Due to the small number of birds that occurred almost all analyses are done for all individuals rather than for the number of flights observed (*"flight"* is a description for a group of two or more birds flying or associating together).

The following basic statistics were computed:

- A count of the total number of individual birds (by species and flight class) observed during the survey against the *Height* at which they were observed to fly. These data are displayed in Table A in the *Appendix*. As already noted this is not a bird-rich area since only a total of 13 individual birds belonging to four priority species were observed during the survey periods.
- Appendix Table B shows the times that the soaring and water birds flew at medium height and at all heights. The times spent at medium height are expressed as a percentage of the total observed flying times. These percentages have to be interpreted with care and should always be seen together with the total time in flight.
- Appendix Tables C – F provide summary statistics intended to provide insight into the behaviour of the species observed w.r.t. their presence according to season and their occurrence profiles during various weather conditions such as temperature, wind direction and wind strength.
- The counts observed during consecutive watch periods, also identified by season and vantage point, are listed separately in Tables H and I in the *Appendix* for soaring and water birds separately and with calculations of updated average counts for consecutive watch periods.
- Whenever watch periods are involved in any of the statistics reported, the counts per watch period are counts per 3h time duration.

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

Averages & variability of counts

The descriptive statistics of average counts, standard deviations (Std.Dev.) and *95%* lower and upper confidence intervals (LCL and UCL) for the mean count per watch period for the data in each of the two seasons are computed from the data in Tables H and I. The results are listed in Tables *2* and *3*.

Note: A confidence interval for the mean at a selected confidence level implies that if it were possible to take the infinite number of all possible samples of size $n = 12$ (in the present case of sampling per season) and a *95%* confidence interval for the mean is computed in each case, then *95%* of those intervals are expected to contain the true mean value.

The number of individual birds are recorded for each flight. Due to the small difference between the number of flights and the number of individual birds observed, the following analyses are presented for individual bird counts only. Thus Tables *2* and *3* report the statistics for the total number of individual birds per watch period for the two flight classes.

Using Table 2, the data in Tables 2 and 3 are to be interpreted as follows. Each season had 12 watch periods allocated to it. The last row of column 3, shows that *11* soaring bird individuals were counted during the *24* watch periods, leading to an estimated overall average of *0.46* individuals per *3*h watch period, a standard deviation of *1.67* and a *95%* confidence interval for the true mean of *0 – 1.16*. The data for the seasons and for Table 3 are similarly interpreted.

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

Season	Watch periods	Soaring birds: Individuals				
		Count	Avge	Std.Dev.	95% LCL	95% UCL
Spring	12	0	0.00	0.00	0.00	0.00
Summer	12	11	0.92	2.31	0.00	2.39
All Grps	24	11	0.46	1.67	0.00	1.16

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

Season	Watch periods	Water birds: Individuals				
		Count	Avge	Std.Dev.	95% LCL	95% UCL
Spring	12	0	0.00	0.00	0.00	0.00
Summer	12	2	0.17	0.58	0.00	0.53
All Grps	24	2	0.08	0.41	0.00	0.26

Stability and Representativeness

The standard deviations reported in Tables *2 – 3* are measures of the variability that exists in the counts observed. Figures *1* (Soaring bird *individuals*) and *2* (Water bird *individuals*) expose the variability of the counts only for counts of individuals as already stated.

Figure 1: Soaring birds: sequential time plot of individual soaring bird counts.

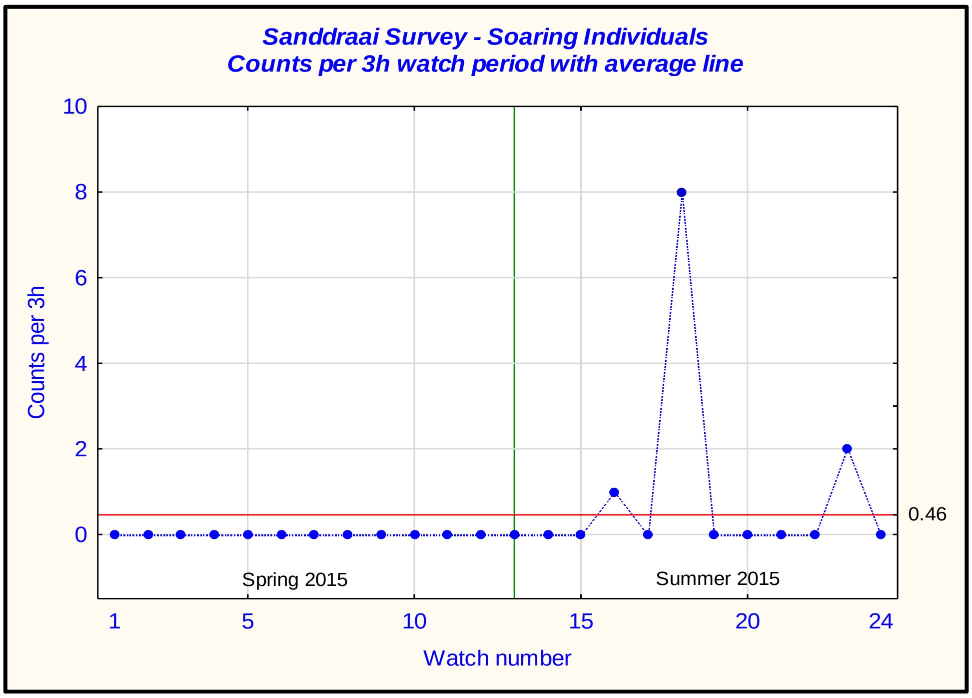
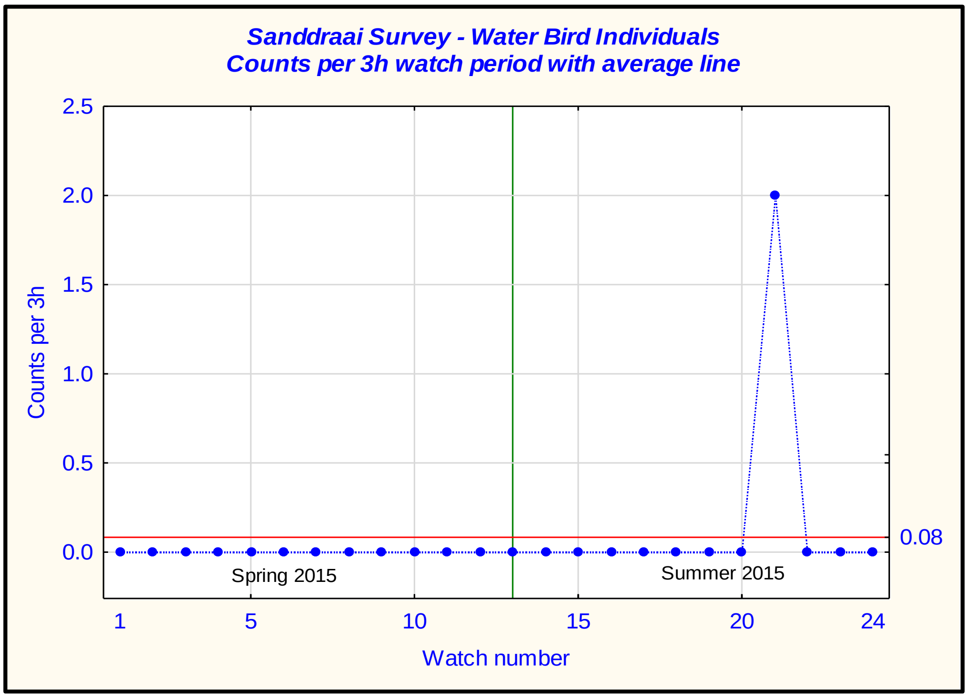


Figure 2: Water birds: sequential time plot of individual Water bird counts.



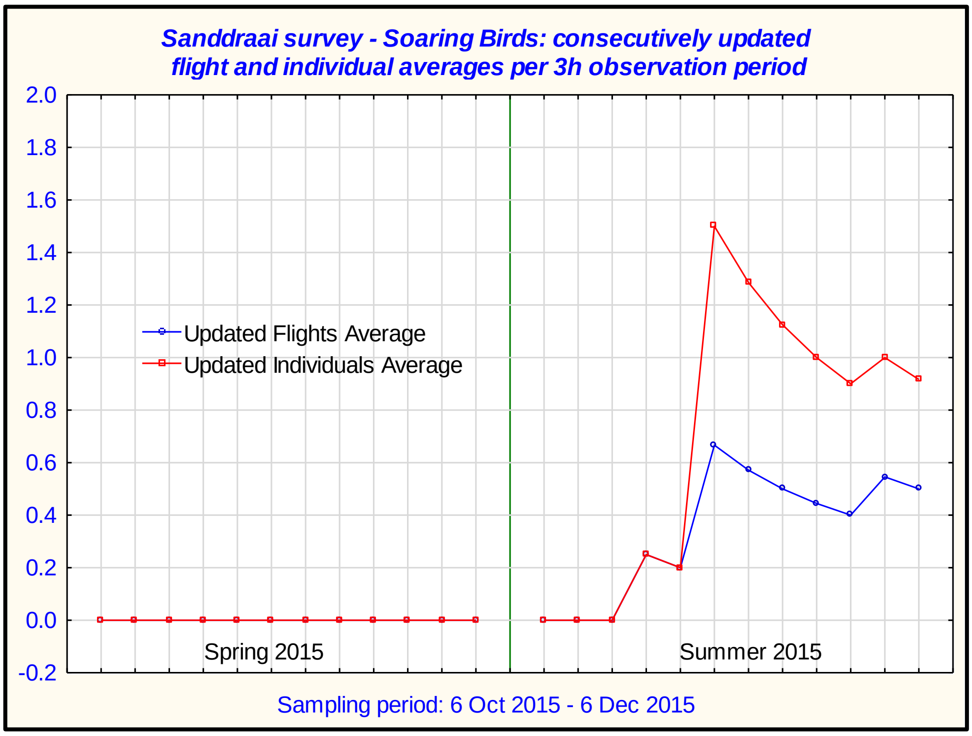
Note that for both soaring and water birds none were observed during the entire Spring survey and it was only late in the Summer survey that a once-off occurrence of water birds was recorded.

In surveys of this nature insight into the representativeness and stability of the counting process may be obtained by plotting updated average counts watch period by watch period. This will yield an continually improving estimate of the average number of birds occurring in the area as counts are added. As more data are gathered the more accurate the estimate will become. The issue is to determine if the updated average count begins to stabilise towards the end of the survey. If so, it follows that a stable and representative sample has been achieved.

To investigate the behaviour of this process the average number of individual birds are computed from all preceding data as the data become available in consecutive watch periods (day after day and sequentially integrating dta from the different vantage points). These updated averages are expected to vary to a large extent in the initial stages of sampling and to stabilise as more data come in. Since the counts may vary (in principle) substantially over the seasons (especially for individual counts) the updated averages are determined separately for each season and are listed in Tables H and I in the Appendix.

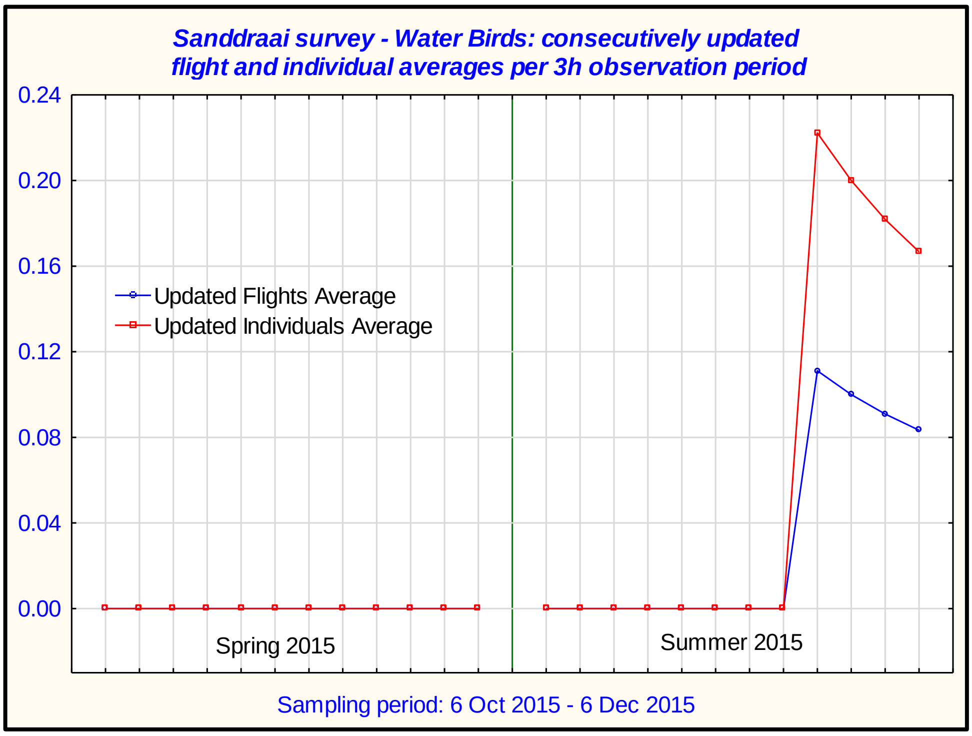
Figure 3 shows these updated averages for flights and for individual counts of soaring birds. Figure 4 does the same for water birds.

Figure *3*. **Soaring birds: updated average for *Flight* and *Individual* counts, separately by season. Where only a red line is visible, red and blue lines are identical.**



The bumps in the graphs of Figure 3 show that it was only during the 16th watch period that the first soaring bird was observed and thereafter only during watch periods 18 and 23. This confirms the almost extreme sparsity of birds in the area.

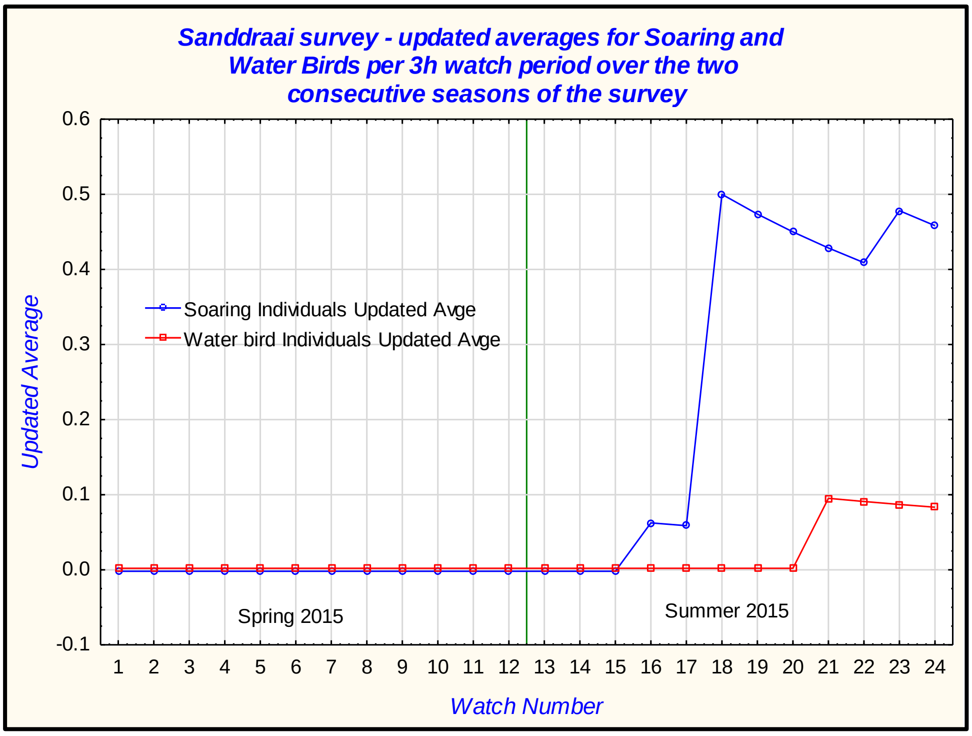
Figure *4*. Water birds: updated average for *Flight* and *Individual* counts, separately by season. Where only a red line is visible, red and blue lines are identical.



In the case of water birds, Figure *4*, only a single sighting occurred and that during the 21st watch period of the survey.

Figure *5* is prepared by not recalculating the updated averages at the change from Spring to Summer but continuing it over both seasons for consecutive watch periods.

Figure 5. Soaring and water birds: updated average for *Individual* counts.



As is to be expected, not only due to the small number of observed birds but in particular because no birds were recorded during the Spring survey, Figure 5 is practically identical to Figure 3.

Sample size

Due to the importance of knowing if the sample size (i.e. the number of watch periods at the site) was sufficiently large so that the counts recorded represent the average number of birds (for example per flight class) sufficiently well, we present some discussion regarding sample size at this survey.

Sample size is determined by the precision at which statements about the average counts are required. The more precise an estimate is to be, the larger the required sample size. The quantity that has the final say in sample size determination is the variability of the data from which the estimate of the parameter in question (in this case the true average count) is to be computed. Variability of data is measured by its standard deviation and for the counts these are computed from the available data and listed in Tables 2 and 3.

The technical question is: how many watch periods (*n*) must be sampled in order to obtain an interval estimate with *precision* of "*d*" units (counts) that will contain the true mean value with prescribed probability, e.g. 95%. This is to say that the true mean count per watch period lies in an interval of $\bar{x} \pm d$ with certainty of $1 - \alpha$ (= *95%*, for example). Here $\bar{x}$ is the sample estimate of the true mean value and *d* its precision. The interval $(\bar{x} - d, \bar{x} + d)$

is known as (for example) the *95%* confidence interval for the true mean value (see Zar, *2010*, p. *105*). A practical approximation to an appropriate sample size may be derived by specifying a desirable precision, *d*, and a standard deviation, *s*, to determine the confidence interval. Thus the sample size may be shown to be obtained from the formula:

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

where $t_{\alpha/2}(n-1)$ is the upper $\alpha/2$ = 2.5% point (for a 95% confidence interval) of Student's *t* distribution with *n – 1* degrees of freedom (*n* the sample size) and *s* an estimate of the true standard deviation of the counts (see Zar, *2010*, page *115*). Formula 1 shows that the sample size will increase with decreasing (i.e. better) precision. It also shows that the sample size will decrease as the variability, *s,* becomes smaller. Before *n* can be computed, *d* has to be specified and *s* has to be known. The latter is usually estimated from known data (such as the current survey, here summarised in Tables 2 and 3).

The largest standard deviation for the counts (for soaring as well as water birds) is recorded as s = *1.67* (see Table 2). If this is used in formula (*1*) with confidence coefficient 95% and *d = 1* (i.e. we wish to estimate the true mean to within a count of ± *1*, which is more than adequate) the result is $n \geq 11.9$.
Thus it can be concluded that the $n = 24$ watch periods that were used during the survey are more than sufficient for the selected precision.

The computation of the confidence interval and equivalently the use of formula (*1*), is dependent on certain assumptions (e.g. normality of the counts distribution). These assumptions are perhaps not always met. However, it should provide a reasonable indication of the validity of the estimates based on the achieved sample sizes.

Conclusion

The computations and the outcome of the data exhibited in the tables and graphs in this report show that the survey may be taken to be statistically representative of both the soaring and water bird priority species of birds that occur in the area and that more data will not necessarily succeed in improving the estimates in a substantial way.

References

Dell, Inc., (*2015*), Dell STATISTICA (data analysis software system), Version 13. www.Software.dell.com.

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

APPENDIX

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

Species	Flight Class	Flying Height			Row Totals
		Low	Medium	High	
White-backed Vulture	Soaring	0	0	8	8
Martial Eagle	Soaring	0	0	1	1
Southern Pale Chanting Goshawk	Soaring	2	0	0	2
Count (Soaring)		2	0	9	11
Egyptian Goose	Waterbird	0	2	0	2
Count (Waterbird)		0	2	0	2
Total count (Overall)		0	2	9	13

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

Species	Flight Class	Valid N and Flight Duration (minutes)				
		At Medium Height		At All Heights		% Time at Medium Ht
		N	Time (min)	N	Time (min)	
White-backed Vulture	Soaring	0	0	8	25.5	0%
Martial Eagle	Soaring	0	0	1	3.5	0%
Southern Pale Chanting Goshawk	Soaring	0	0	2	1.25	0%
Count (Soaring)		0	0	11	30.25	0%
Egyptian Goose	Waterbird	2	4.5	2	4.5	100%
Count (Waterbird)		2	4.5	2	4.5	100%
Total count (Overall)		2	4.5	13	34.75	12.9%

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

Species	Flight Class	Season		Row Totals
		Spring	Summer	
White-backed Vulture	Soaring	0	8	8
Egyptian Goose	Soaring	0	2	2
Martial Eagle	Soaring	0	1	1

Count (Soaring)		0	11	11
Egyptian Goose	Waterbird	0	2	2
Count (Waterbird)		0	2	2
Total count (Overall)		0	13	13

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

Species	Flight Class	Temperature		Row Totals
		Warm	Hot	
White-backed Vulture	Soaring	0	8	8
Southern Pale Chanting Goshawk	Soaring	0	2	2
Martial Eagle	Soaring	0	1	1
Count (Soaring)		0	11	11
Egyptian Goose	Waterbird	2	0	2
Count (Waterbird)		2	0	2
Total count (Overall)		2	11	13

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

Species	Flight Class	Weather condition		
		Partly Cloudy	Sunny	Row Totals
White-backed Vulture	Soaring	0	8	8
Southern Pale Chanting Goshawk	Soaring	0	2	2
Martial Eagle	Soaring	1	0	1
Count (Soaring)		1	10	11
Egyptian Goose	Waterbird	0	2	2
Count (Terrestrial)		0	2	2
Total count (Overall)		1	12	13

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

Species	Flight Class	Wind Direction		Row Totals
		W	NW	
White-backed Vulture	Soaring	8	0	8
Southern Pale Chanting Goshawk	Soaring	2	0	2
Martial Eagle	Soaring	0	1	1
Count (Soaring)		10	1	11
Black-winged Lapwing	Waterbird	2	0	2
Count (Waterbird)		2	0	2
Total count (Overall)		12	1	13

Table G: Number of individual priority species birds recorded by Species and Wind Strength (Beaufort Scale).

Species	Flight Class	Light Air	Gentle Breeze	Moderate Breeze	Total
White-backed Vulture	Soaring	0	8	0	8
Southern Pale Chanting Goshawk	Soaring	0	2	0	2
Martial Eagle	Soaring	0	0	1	1
Count (Soaring)		0	10	1	11
Egyptian Goose	Waterbird	2	0	0	2
Count (Waterbird)		2	0	0	2
Total count (Overall)		2	10	1	13

Table H: ***Soaring birds*****: flights and individuals for priority species per watch period (of 3h) and by vantage point over time with updated averages per consecutive watch period.**

Watch Number	Date	Season	VP	Flights count	Flights Updated Avge	Individuals count	Individuals Updated Avge
1	2015-10-06	Spring	VP1	0.0	0.00	0.0	0.00
2	2015-10-06	Spring	VP1	0.0	0.00	0.0	0.00
3	2015-10-07	Spring	VP1	0.0	0.00	0.0	0.00
4	2015-10-07	Spring	VP1	0.0	0.00	0.0	0.00
5	2015-10-08	Spring	VP2	0.0	0.00	0.0	0.00
6	2015-10-08	Spring	VP2	0.0	0.00	0.0	0.00
7	2015-10-08	Spring	VP3	0.0	0.00	0.0	0.00
8	2015-10-09	Spring	VP2	0.0	0.00	0.0	0.00
9	2015-10-09	Spring	VP2	0.0	0.00	0.0	0.00
10	2015-10-14	Spring	VP3	0.0	0.00	0.0	0.00

11	2015-10-14	Spring	VP3	0.0	0.00	0.0	0.00
12	2015-10-15	Spring	VP3	0.0	0.00	0.0	0.00
13	2015-12-02	Summer	VP2	0.0	0.00	0.0	0.00
14	2015-12-02	Summer	VP2	0.0	0.00	0.0	0.00
15	2015-12-02	Summer	VP2	0.0	0.00	0.0	0.00
16	2015-12-02	Summer	VP2	1.0	0.25	1.0	0.25
17	2015-12-04	Summer	VP3	0.0	0.20	0.0	0.20
18	2015-12-04	Summer	VP3	3.0	0.67	8.0	1.50
19	2015-12-04	Summer	VP3	0.0	0.57	0.0	1.29
20	2015-12-04	Summer	VP3	0.0	0.50	0.0	1.13
21	2015-12-06	Summer	VP1	0.0	0.44	0.0	1.00
22	2015-12-06	Summer	VP1	0.0	0.40	0.0	0.90
23	2015-12-06	Summer	VP1	2.0	0.55	2.0	1.00
24	2015-12-06	Summer	VP1	0.0	0.50	0.0	0.92

Table I: ***Water birds*: flights and individuals for priority species per watch period (of 3h) and by vantage point over time with updated averages per consecutive watch period.**

Watch Number	Date	Season	VP	Flights count	Flights Updated Avge	Individuals count	Individuals Updated Avge
1	2015-10-06	Spring	VP1	0.0	0.00	0.0	0.00
2	2015-10-06	Spring	VP1	0.0	0.00	0.0	0.00
3	2015-10-07	Spring	VP1	0.0	0.00	0.0	0.00
4	2015-10-07	Spring	VP1	0.0	0.00	0.0	0.00
5	2015-10-08	Spring	VP2	0.0	0.00	0.0	0.00
6	2015-10-08	Spring	VP2	0.0	0.00	0.0	0.00
7	2015-10-08	Spring	VP3	0.0	0.00	0.0	0.00
8	2015-10-09	Spring	VP2	0.0	0.00	0.0	0.00
9	2015-10-09	Spring	VP2	0.0	0.00	0.0	0.00
10	2015-10-14	Spring	VP3	0.0	0.00	0.0	0.00
11	2015-10-14	Spring	VP3	0.0	0.00	0.0	0.00
12	2015-10-15	Spring	VP3	0.0	0.00	0.0	0.00
13	2015-12-02	Summer	VP2	0.0	0.00	0.0	0.00
14	2015-12-02	Summer	VP2	0.0	0.00	0.0	0.00
15	2015-12-02	Summer	VP2	0.0	0.00	0.0	0.00
16	2015-12-02	Summer	VP2	0.0	0.00	0.0	0.00
17	2015-12-04	Summer	VP3	0.0	0.00	0.0	0.00
18	2015-12-04	Summer	VP3	0.0	0.00	0.0	0.00
19	2015-12-04	Summer	VP3	0.0	0.00	0.0	0.00

20	2015-12-04	Summer	VP3	0.0	0.00	0.0	0.00
21	2015-12-06	Summer	VP1	1.0	0.11	2.0	0.22
22	2015-12-06	Summer	VP1	0.0	0.10	0.0	0.20
23	2015-12-06	Summer	VP1	0.0	0.09	0.0	0.18
24	2015-12-06	Summer	VP1	0.0	0.08	0.0	0.17

ANNEXURE E SENSITIVITY MAP