Avian Assessment: Kotulo Tsatsi Solar PV3 Facility Development, near Kenhardt, Northern Cape

Prepared for:

savannah environmental

Prepared by:

BIRDS & BATS UNLIMITED

1 SPECIALIST EXPERTISE

Dr Rob Simmons, Director of Birds & Bats Unlimited is an ecologist, ornithologist, and environmental consultant, with over 30 years' research experience in North America, Africa, Europe and Asia. Permanent Resident in South Africa. Currently a Research Associate of the FitzPatrick Institute's Centre of Excellence, University of Cape Town. Formerly employed in Namibia's Ministry of Environment & Tourism as the state ornithologist, specialising in wetland, avian and montane biodiversity. Schooled in London (Honours: Astrophysics), Canada (MSc: Biology) and South Africa (PhD: Zoology).

SURVEY EXPERIENCE:

- **Sandwich Harbour avifauna** - A 30-year project assessing fluctuations in wetland avifauna relative to Walvis Bay via random plot counts - published in *Conservation Biology* (Simmons et al. 2015)
- **Arid species diversity across a rainfall gradient -** a 3-year project at 5 sites across a 270 km gradient, assessing avian diversity in 3 Namibian habitats. Dry rivers critical refugia as biodiversity declined *Ecosystems,* Seymour et al (2015)
- **Population monitoring of Namibian endemics**–Determined densities and overall population numbers of all 16 Namibian endemic birds with Edinburgh University published *Biological Conservation* Robertson et al (1996);
- **Damara Tern status** –I devised a stratified random survey of the 1470-km Namibian coast, to determine the global population of this tern. Published *Ibis* 1998. Angolan breeding colonies published *Af J Mar Sci,*
- **Black Harrier conservation**– From 2000 - present study of *Endangered* Black Harriers in South Africa, followed by satellite tags to determine ecology and migration with FitzPatrick students. *PlosOne* Garcia-Heras et al. (2019).

Research on new avian mitigation measures for the wind and power industry:

- **testing use of vulture restaurants** to draw vultures away from wind farms in Lesotho.
- proposing and **testing coloured-blade mitigation** to reduce raptor fatalities in SA.
- **Implementing staggered pylons on parallel lines** as the first effective mitigation for high bustard deaths.

Environmental Impact Assessments (renewable energy, power lines, mining, airports)

- birds impacted by a proposed Haib **copper mine** near the Orange River (1994);
- siting of proposed Lüderitz **wind farm** prior to formal assessments for NamPower (1997);
- impact of **water abstraction** from Karst System wetland birds Tsumeb (2003) (J Hughes);
- impact of **uranium mine** at Valencia, Khan River, Namibia (Aug 2007, Feb 2008)
- **Biodiversity surveys** in Namib Desert, Angola, (SANBI–Angola joint surveys- Dr B. Huntley)
- **Wind farm** assessments on the west coast at Kleinsee and Koingnaas (Savannah – 2011)
- EIA report on avian impacts at Namaqualand + Springbok **wind farms** (Mulilo –2015, 2017)
- Pre-construction avian impacts at the Witteberg (Karoo) **wind farm** site – (Anchor Environmental 2011-2012) and Verreaux's Eagles (G7/Building Energy 2014-2015,2019)+Amendments (Building Energy 2019)
- Pre-construction avian monitoring Karoshoek CSP-trough **CSP-tower** Solar Park (Upington) (Savannah Environmental for Emvelo Eco Projects, 2015-2016)
- Pre-construction avian impacts at a Tankwa Karoo **wind farm** (Genesis Eco-Energy 2016-17)
- Pre-construction avian impacts at **Juno SOLAR PV,** Strandfontein (AMDA Pty Ltd, 2016-2017)
- Specialist studies of Red Data raptors at Jeffreys Bay **wind farm** (Globeleq, 2016-2019)
- Pre-construction avian impacts at Namas and Zonnequa **wind farms**, Kleinsee N. Cape (Atlantic Energy Partners and Genesis Eco-Energy 2016-17);
- Pre-construction vulture impacts and mitigations tests Letseng **wind farm** Lesotho (eGEN+AGR 2017/8);
- Walvis Bay **waterfront development** impacts on Walvis Bay lagoon avifauna (ECC) 2017
- Avian-**power line** EIA study of 450 km-long, 400 kV line (Lithon-Nampower 2017-2018);
- Pre-construction avian impacts of Kappa 1 and 2 **wind farms** in Tankwa (Eco-Genesis 2018-2019);
- Pre-construction avian impacts of Nama Karoo **wind farms** Komas + Gromis (Enertrag) 2019;
- Avian impacts Kruisvallei **Hydro-project power line** Free State and IFC compliance(Building Energy 2019)
- Amendments to avian impact assessment - hub height considerations - at the Springbok (Nama-Karoo) **wind farm** site (Mulilo 2019) and the Namas and Zonnequa **wind farms** (Enertrag) 2019
- Specialist studies of Black Harriers at **Elands Bay** wind farm and aquaculture site (Planet Capital 2020)**.**

Consultancy work at: http://www.birds-and-bats-unlimited.com
Papers and academic background at: www.fitzpatrick.uct.ac.za/fitz/staff/research/simmons

SPECIALIST DECLARATION

I, Robert E. Simmons, as the appointed independent specialist, in terms of the 2014 EIA Regulations, declare that:

- I act as the independent specialist in this application;
- I perform the work in an objective manner, even if this results in findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have, and will not have, any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- 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 have no vested interest in the proposed activity proceeding;
- 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;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study 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.

Dr R E Simmons
Revised: 30 March 2023

NB: this report was co-authored with Marlei Martins (Director of Birds & Bats Unlimited). She too adheres to the principles listed above and her profile can be found at www.birds-and-bats-unlimited.com/birds

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2 SUMMARY

This study is a re-assessment of the avian species that occur and may be at risk in the revised Photo-voltaic (PV) Kotulo Tsatsi Solar PV3 development site located midway between Kenhardt in the north and Brandvei in the south of the Northern Cape. The area was previously assessed in 2016 for Concentrated Solar Power (CSP) with Solar Reserve and is now being re-assessed for photo-voltaic facilities for Black Gold Renewable Energies (BGRE). Three PV sites are considered (PV1, PV3 and PV4), and this report focusses on the PV3 site.

The objective of the study was to

(i) determine areas of high avian sensitivity throughout the expanded area where they may occur; and
(ii) record avian use of the areas specifically proposed for development of the PV facility in the summer of 2020. This is compared with more comprehensive studies undertaken in 2016.

The total size of the Kotulo Tsatsi site is ~56 000-ha, of which 15 500-ha has been surveyed on three previous site visits over dry and wet seasons (November 2014, March 2015 and 2016). The remaining ~28 500-ha include portions of the farms Steyns Vley 280, Melkbosch Vley 278, Kopjes Vley 281, and Gemsbok Rivier 301 and comprise the expanded area, but excludes the Groot Vloere pan.

While on site, the following project development areas were surveyed:

1. The expanded site (100-km^2), located north of the original CSP sites (a proposed Wind farm site)
2. Sites for PV1, PV3, and PV4 projects.

This report summarises the findings from all trips from 2014 to December 2020 and 2021/2022 site visits, to identify the most sensitive areas and assesses the impacts of the proposed development on Priority species. Typically, impacts are:

(i) habitat alteration/destruction by the development of the solar facility itself;
(ii) disturbance by construction and maintenance activities;
(iii) direct mortality of sensitive species impacting the solar panels or surrounding infrastructure (e.g. fences, power lines).

The site visit was constrained to the hottest month of the year by the needs of the developer, as such it was not the ideal time of year.

- Five red-listed birds were recorded over the larger site, (White-backed Vulture *Gyps africanus,* Martial Eagle *Polemaetus bellicosus*, Lanner Falcon *Falco biarmicus,* Ludwig's Bustards *Neotis ludwigi,* and Sclater's Lark *Spizocorys sclateri*).
- A dead adult Martial Eagle was found below the previously active Martial nest on pylon 121 of the Aries-Helios line. The bird had probably been poisoned according to experts.
- Lanner Falcons were still present, but no Ludwig's Bustards or Sclater's Larks were recorded in 10 hours of observation or drive surveys through the area.
- Other Priority species included Booted Eagle *Aquila pennatus,* Steppe Buzzard *Buteo buteo* and Pale Chanting Goshawks *Melierax canorus* in low numbers. Karoo Korhaans *Eupodotis vigorsii* were also present.
- Very low species richness of 30 species, (compared with 54 species in 2016) across all Karoo habitats.
- Low desnsities of smaller birds averaged nine species/km, and 21 birds/km. Few aerial birds were recorded, but sandgrouse were present and breeding.

No part of the proposed PV3 site lies within the 3-km buffer around the Martial Eagle nest. The development is, thus, less likely to reduce habitat available for the perch-hunting adults. The PV facility itself is unlikely to be a

high risk to the eagles, or the vultures that appeared for the first time in 2020 and 2021, as long as open water sources are covered.

A first review of a PV site in South Africa found an average of 4.5 bird fatalities/MW/year, but no Red Data species were recorded. We conclude that:

- Few avian risks were associated with the proposed PV site.
- The development area of PV3 lies outside the 3-km Martial Eagle nest site buffer.
- This will reduce the impacts of habitat loss for future breeding Martial Eagles.
- We strongly recommend that the environmental authorisation can only be issued with a clause forbidding the illegal poisoning of Red Data birds on the farm.

If these conditions are met, we recommend that the PV3 site be given authorisation and a full post-construction monitoring programme of 12-24 months be carried out by a competent avian specialist to systematically determine avian fatalities.

3 BACKGROUND

3.1 THE SITE AND GOALS: PHOTO-VOLTAIC SOLAR FARMS

The Applicant, Kotulo Tsatsi Energy (Pty) Ltd, is proposing the construction of a photo-voltaic (PV) solar energy facility (known as the Kotulo Tsatsi Energy PV3) located on a site located approximately 70-km south-west of the town of Kenhardt and 70-km northeast of Brandvlei in the Northern Cape Province. The solar energy facility will comprise several arrays of PV panels and associated infrastructure and will have a contracted capacity of up to 480MW. The facility will be located within the farm Portion 2 of Farm Styns Vley 280 (of about 4935-ha). The PV facility is planned to be located adjacent to the authorised 480MW Kotulo Tsatsi PV2 facility, and within an area previously authorised for CSP project infrastructure. The project site falls under the Hantam Local Municipality which is part of Namakwa District Municipality. The site is accessible via an existing gravel farm road (known as Soafskolk Road) which provides access to the farm off the R27 which is located east of the project site.

The PV infrastructure assessed in this application is in response to the Applicant's need to change the authorised generation technology for the facility located on the farm Portion 2 of Farm Styns Vely 280. That is, a technology change from the previously authorised CSP project infrastructure to PV project infrastructure. In this regard, the solar PV facility will be connected to the grid via a previously authorised grid connection solution[1], which consists of a collector substation, switching station, and a power line to the Eskom Aries Substation located north-east of the project site.

Kotulo Tsatsi Energy plan to bid PV3 in the Department of Mineral Resources and Energy's (DMRE) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme with the aim of exporting the generated power into the national grid. This will aid in the diversification and stabilisation of the country's electricity supply with Kotulo Tsatsi Energy PV3 set to inject up to 480MW_{AC} into the national grid.

Two (2) additional 200MW PV facilities (Kotulo Tsatsi Energy PV1 and Kotulo Tsatsi Energy PV4) are concurrently being considered adjacent to the project site (on Portion 2 of Farm Kopjes Vley 281, and Portion 3 of Farm Styns Vley 280) and are to be assessed through separate Environmental Impact Assessment (EIA) processes.

[1] A CSP facility plus associated infrastructure, including a complete grid connection to Aries Substation was previously authorised on the site. This PV facility infrastructure replaces the CSP facility infrastructure and will retain the authorised grid connection solution (including all substations and power lines) and other associated infrastructure (including the man camp (including on-site accommodation), all water reservoirs and pipelines, the power block and thermal storage.

A development area [2] of ~1 888-ha was defined through the Scoping evaluation of the site and has now been assessed for the facility footprint. The development footprint has an extent of ~1 350-ha.

» Solar PV array footprint comprising:
  - PV modules and mounting structures
  - Inverters and transformers
  - Integrated Energy Storage System (IESS)
  - Cabling between the project components
  - Internal access roads.
» Access roads, internal distribution roads and fencing around the development footprint.
» Admin block comprising:
  - Site offices and maintenance buildings, including workshop areas for maintenance and storage.
  - Assembly plant
  - Laydown areas.

The assessment of the PV facility on the site is to support the technology change from the previously authorised CSP project infrastructure to PV project infrastructure. In this regard, the following previously authorised infrastructure will be retained for use for the planned PV facility, and the associated footprint areas of the following previously authorised infrastructure have not been reassessed in this EIA:

» Complete grid connection to Aries Substation:
  - Other associated infrastructure: Grid connection via a previously authorised grid connection solution, which consists of internal grid reticulation, a collector substation, switching substation, and a power line to the Eskom Aries Substation located north-east of the project site.
  - facility man camp (including on-site accommodation),
  - all water reservoirs and pipelines,
  - power block and thermal storage solution.

3.2 Potential Avian Impacts

The development areas itself is 1 888-ha in extent and the development footprint where habitat may be permanently disturbed may be slightly larger for the 480MW solar array. This will reduce habitat availability for birds within the development footprint. It is a simple exercise to calculate the numbers of birds potentially lost due to habitat loss from our estimates of birds per unit area. These are likely to be minimal given that smaller birds generally occur at higher densities than larger birds, breed faster, and are less likely to suffer high population reduction. However, avoidance of some habitats will reduce the impact.

The main avian impacts according to a position paper on the subject by Birdlife SA (http://www.birdlife.org.za/images/stories/conservation/birds_and_wind_energy/solar_power.pdf) are the

(i) displacement of nationally important species from their habitats,
(ii) loss of habitats for such species,
(iii) disturbance during the construction, and operation, of the solar plant.

3.3 Aims, Methods and Terms of Reference

The following project development areas were surveyed for sensitive avian species during multi-season monitoring (note that these were often outside the PV3 area considered but allow us to characterise the area for its avifauna, especially the rarer birds:

[2] The development area is ~1834ha in extent.

1. Larger area for the expanded site (100-km^2), located north of PV 1, 3, and 4 (see Figures 1 and 2); and
2. The specific sites for PV3.

The primary aims of the avian monitoring for the Kotulo Tsatsi PV sites are to:

1. Determine the *densities* of birds regularly present, or resident, within the impact area of the proposed developments before the construction phase.
2. Document the *patterns and movements* of birds in the vicinity of the proposed PV areas before construction.
3. Identify areas which are *not appropriate for development* (i.e., fall within any buffered areas surrounding nests or wetland areas).
4. Monitor the patterns and movements of birds in the proposed development areas.
5. Employ previous surveys of Red Data and endemic bird species, to determine which species may occur when conditions improve.

The following published sources of bird data were consulted:

- The DFFE Screening Toll provided at https://screening.environment.gov.za/screeningtool/#/app/screen_tool/Solar%20PV
- Coordinated Avifaunal Road Count (CAR) of the Animal Demography Unit, University of Cape Town.
- Important Bird Areas Programme (IBA) of Birdlife South Africa.
- The Southern African Bird Atlas Programme (SABAP)) to determine if previous data was available for this remote area. Only limited SABAP2 data (http://sabap2.adu.org.za/index.php) was available and no IBAs are present in the region.
- A comprehensive report for the proposed Eskom power line route (Aries-Helios) that passes through the proposed solar park (Smallie and Shaw 2013).

We augmented these data with our pre-construction site visits undertaken in September 2014, March 2015, and June 2016, that coincided with the maximum periods of avian activity in arid areas such as this (Simmons and Martins 2016). Those surveys assessed avifauna in the central portion (16 000-ha) of the planned solar expansion area and the wind farm to the northeast.

We spent a total of 50 days on site combining visits in 2014-2015-2016 with our site visit in 2020 and 2021.

This report provides the overall results of all the bird monitoring undertaken, maps those areas which are not negotiable in terms of sensitivity, and provides an update to the recommendations made in earlier reports (Simmons & Martins 2016).

3.4 Study Area

Several sections of the farms Steyns Vley 280, Melkbosch Vley 278, Kopjes Vley 281, and Gemsbok Rivier 301 located 50-km north of Brandvlei, Northern Cape (S 29° 48', E 20° 32') have been ear-marked for development of the Kotulo Tsatsi solar park. Within the study area possible locations for two new CSP towers (CSP 4 and CSP 5), and a PV development, were assessed. This is a hot, arid area of the Nama Karoo biome, in which low-intensity sheep farming occurs, supporting a sparsely populated farming community. The PV sites were re-visited in 2020 and 2021 and coincided with seven years of drought that ended in 2022.

3.4.1 Vegetation of the Study Area

The vegetation of this section of the Nama Karoo lies on the intersection of the Lower Gariep Broken veld, the Bushmanland Basin Shrubland and Inland Azonal Wetland type (i.e., the small ephemeral washes and pans: Mucina and Rutherford 2006). In layman's terms this is a very arid area of Karooid vegetation, interspersed with dry pans, and with a mean annual rainfall varying from 150–200mm and midday temperatures averaging 19.3°C

(winter) to 35.5°C (summer). The area is dry most of the year with rainfall concentrated in a short period from January to April, peaking in March (http://www.weathersa.co.za/climate/recent-climate). Little of the area is formerly conserved but has enjoyed some protection through the Namakwa Bioregional Plan.

A biodiversity corridor was suggested in this planning document and runs through the southern section of the study area (Figure 1). Such corridors are typically a conservation planner's tool, allowing the passage of terrestrial animals and plants between conservation "islands", to ensure genetic mixing of otherwise isolated groups. For aerial organisms such as bats and birds, such corridors are likely to play a lesser role in a conservation sense, but they may be important for wetland birds such as flamingos passing through to flooded pans. Thus, wetland species in the area were noted.

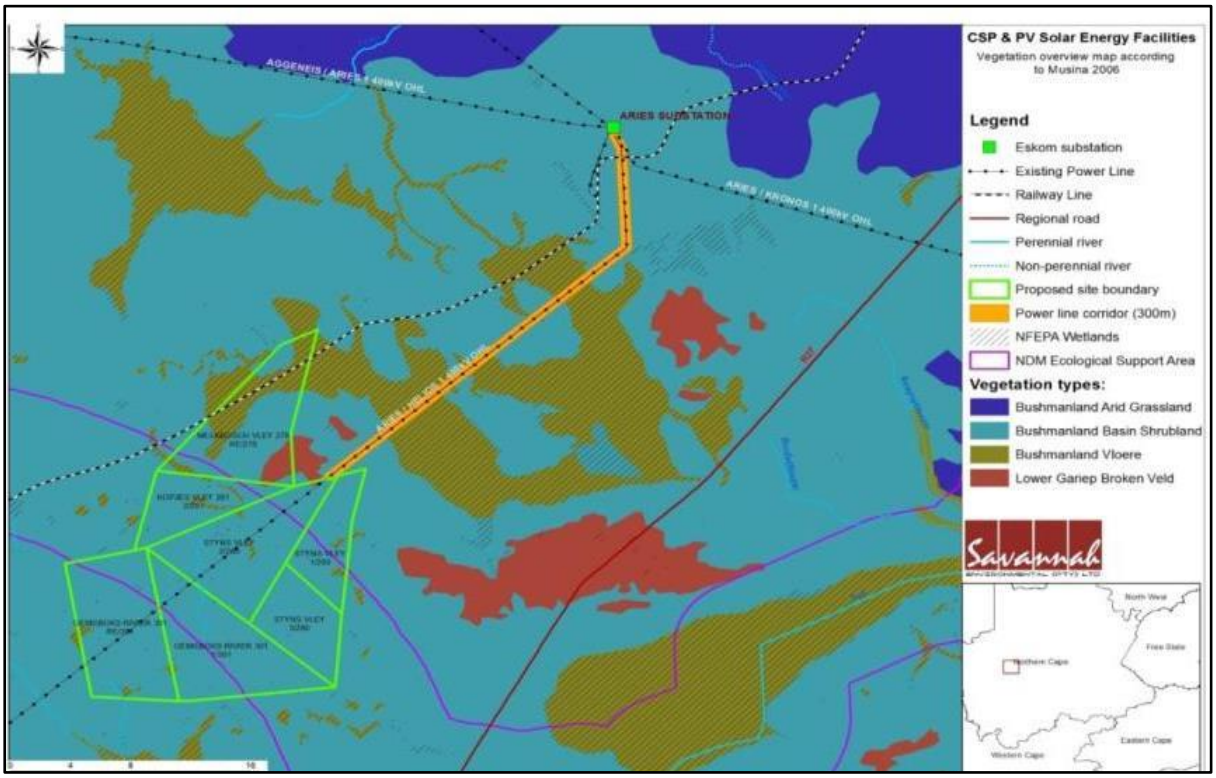


Figure 1: The proposed solar park study area (light green polygons) and power line corridor in relation to vegetation types (from Mucina and Rutherford 2006) and the proposed, and existing, power line (orange line). Only the northern and central sections were re-visted in 2020.

3.4.2 Avian Microhabitats

Bird habitats in the study area can be grouped into three broad categories:

- **open grassy/rocky areas** (Bushmanland basin shrubland) that supports grassland dominated by larks and korhaans; and larger dark rocky outcrops that support raptors and wheatears on the kopjes;
- the **low shrubland bush** (*Rhigozum spp*) that covers much of the lower lying areas, and is especially dense in the dry ephemeral river lines (photo 1);
- the **pans** (Bushmanland Vloere) which dominate the landscape in the southern sections and cover 12 500 ha. Other smaller pans occur which only accumulate ephemeral water after rains. When dry, these areas may hold flocks of seed-eating birds (Photo 2).and when they are (rarely) inundated, may hold wetland species (e.g., flamingos).

Two *artificial*, habitats are provided by:

(i) the existing power lines and accompanying pylons; and

(ii) the watering points that are scattered across the landscape for livestock.

The pylons are used by large raptorial birds from which to hunt and occasionally build nests (eagles, chanting goshawks, and kestrels and falcons), while large numbers of smaller birds are attracted to over-flowing farmer's dams (Photos 3 and 4). Each of the main habitat types was surveyed independently for bird species richness and bird abundance in the dry and wet seasons.

Photo 1: Two vegetation types used by the avian community. Open rocky ground with grasses (foreground) and the dry river washes dominated by Rhigozum bushes.

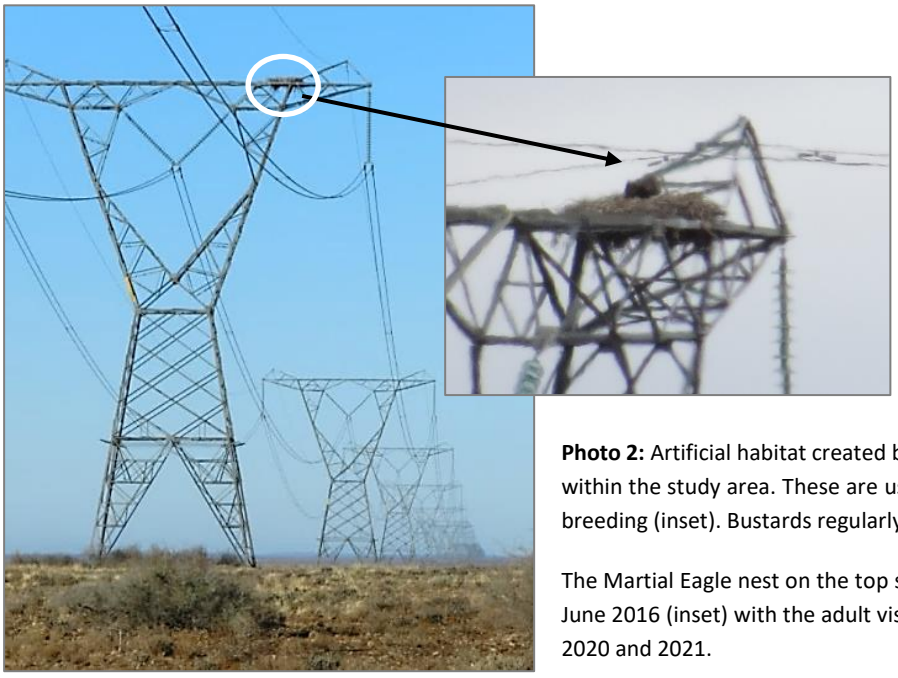


Photo 2: Artificial habitat created by pylons and transmission lines within the study area. These are used by raptors for perching and breeding (inset). Bustards regularly hit, and are killed, by the lines.

The Martial Eagle nest on the top stanchion (circled) was active in June 2016 (inset) with the adult visible on the nest, but inactive in 2020 and 2021.

Photo 3: Artificial water reservoirs for livestock are a mecca for birds in this very dry landscape and attract hundreds of birds daily, including Sparrow-larks, Lark-like buntings, and Black-headed Canaries *Crithagra alario* (inset). Up to 250 birds/day can be attracted in the dry season.

Photo 4: The greater Kotulo Tsatsi landscape was transformed with the advent of heavy rains in March 2022, with grass, locusts and mosquitoes in abundance**.**

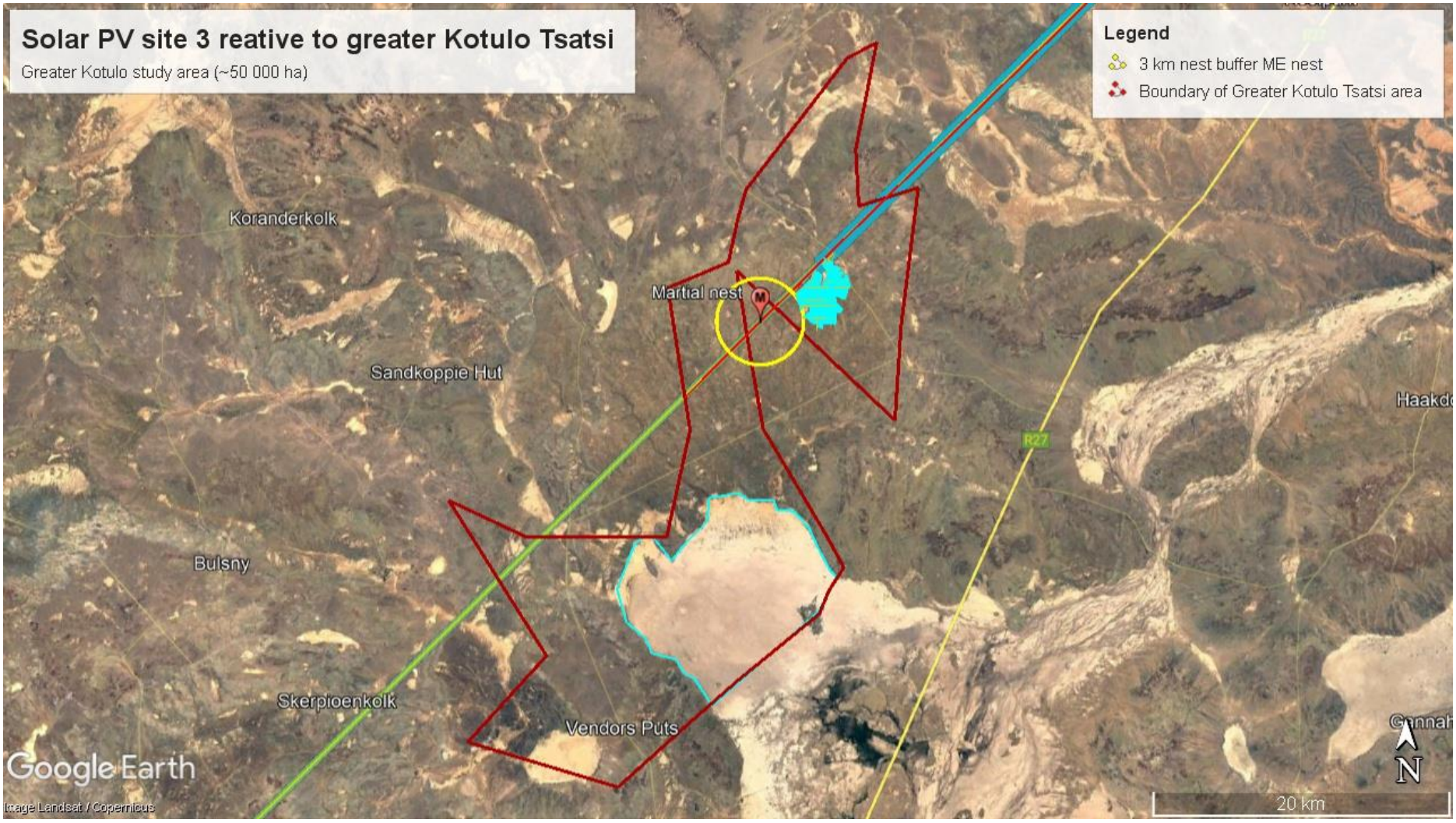


Figure 2: The Greater Kotulo Tsatsi study site where the original bird surveys in 2014-2015-2016 were based, and the relative position of the PV3 solar site (= blue filled polygon). Surveys were conducted here in summer 2020 and the power line was surveyed for avian fatalities (mainly bustards) on two occasions (2014 and 2016).

3.5 On-site Methods

In 2016 three observers surveyed all areas of the expanded study site, except for the major pans of >100-ha. Our surveys comprised:

(i) 1-km Walking transect surveys,
(ii) 12 hours of Vantage Point (VP) surveys covering a 2-km radius viewshed,
(iii) Walking VPs in areas we could not view from our stationary VPs, and
(iv) Drive surveys in which all collision-prone species were recorded.

We walked twenty-one **1-km transects** in potential areas for the PV arrays. These transects covered all main habitat types present in the areas (open grassy plains, dry river washes with *Rhigozum* shrubs, the few ephemeral rivers (southern areas), and the rocky outcrops (in the northern sections, Photos 1-4). Artificial water points were also observed for short periods. Over 200 individual birds of 29 species were recorded in the PV area in these transects alone.

The **Vantage point (VP)** observations were undertaken for 12 hours, spread evenly over two days and across the daylight period from fixed points. Using the 2-km radius we saturated the approximately 30 000-ha area to cover all regions except for the pans (Figure 3).

In the resulting twenty VPs we recorded the flight paths of all large collision-prone species, as well as aerial species such as sandgrouse, swifts, and swallows. Heights were estimated every 15 seconds for the duration of the flights against the pylons (of the 400kV Aries-Helios line) that run across the study areas.

In 2020 our coverage focussed on just three PV locations (Figure 2) in the same locations as the previous CSP towers. We additionally undertook two 1-km transects – one in the PV area and one in the proposed wind farm to the north-east.

Our overall coverage and survey of different locations around the greater Kotulo Tsatsi environment took into account the following months and years:

- September 2014 (7 days),
- March 2015 (5 days),
- June 2016 (12 days),
- December 2020 (2 days),
- February 2021 (6 days),
- May 2021 (6 days),
- August 2021 (6 days),
- March 2022 (6 days).

The total number of days of surveys (in brackets above) totalled 50 days and the duration of this project meant that all seasons; dry (2014-2016); and wet years (2021-2022) were sampled over the greater Kotulo Tsatsi study area.

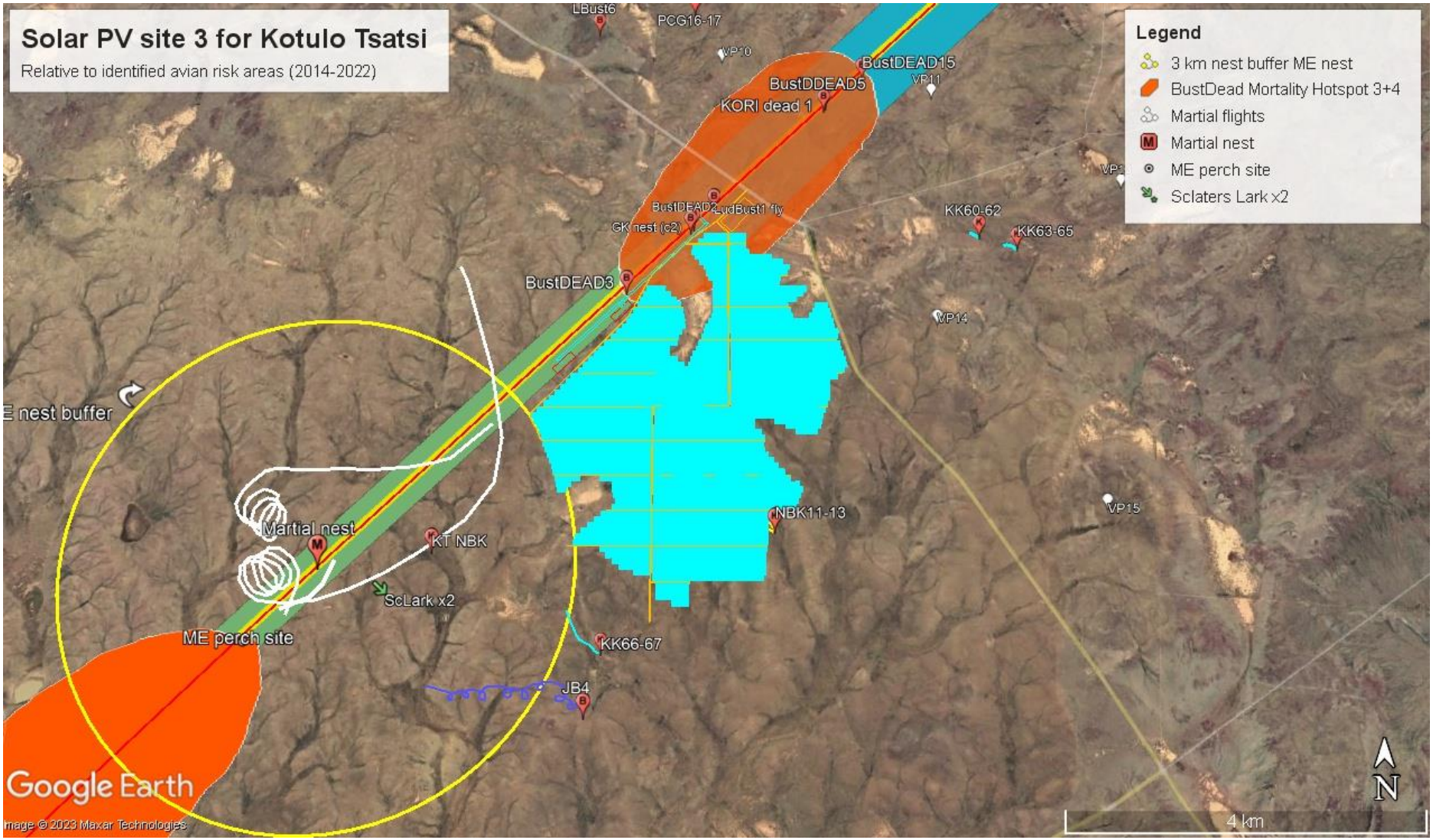


Figure 3: Location of the proposed Kotulo Tsatsi PV3 site (= blue polygon). The Martial Eagle nest (= red balloon) and 3-km buffer (= yellow circle) is illustrated, together with the Aries-Helios 400kV power line (green and yellow lines). Hotspots of bustard fatalities along the power line are shown as orange polygons.

4 RESULTS

4.1 Presence and Movements of Sensitive Species

Large sensitive species, observed from our VP observations or walking surveys, are defined as those species that are known, or expected, to be at risk from the reflective surfaces of the PV panels (Kagan et al. 2014). These species are mainly threatened Red Data species that occur in the study areas (eagles, bustards, chanting goshawks, korhaans), but also include smaller species that may fly and be attracted to water (i.e., sandgrouse or canary and lark species).

Insufficient data were available from the current bird atlas data. Thus, we relied on our own records captured over a total of 50 days of surveys in eight site visits over the period 2014-2022 (see 3.3 Methods) This period was dominated by very dry weather up until 2021/2022 when the drought broke and brought in numerous species.

4.2 Avian Species Richness and Red Data Species – Wet and Dry

In the dry period the expanded (50 000-km^2) Kotulo Tsatsi site supported five Red Data species in a low avian richness total of 72 species (Appendix 1) during 2014-2016. However, this increased rapidly to 13 Red Data species once rains broke the drought in 2021 and 2022 (Table 1).

Table 1: The 13 Red Data bird species of the 16 Priority species recorded and their likelihood of occurrence on the Kotulo Tsatsi PV3 expanded site based on the number of times recorded by BBU over 50 days of field work. Taken from all (8) site visits June 2016 (12 days), March 2015 (5 d), September 2014 (7 d), December 2020 (2 d), February 2021 (6 d), May 2021 (6 d), August 2021 (6 d), and March 2022 (6 d). Collision ranking is taken from the list of the top 100 collision-prone species (Ralston et al. 2017). Rows shaded in grey indicate Red Data species seen over or near the PV3 site.

Common Name	Scientific name	Red-list category	Collision Rank	Likelihood	Habitat
Cape Vulture	*Gyps coprotheres*	Endangered	1	1/50 = 2%	Arid montane
Verreaux's Eagle	*Aquila verreauxii*	Vulnerable	2	4/50 = 8%	Rocky montane
Ludwig's Bustard	*Neotis ludwigi*	Endangered	10	7/50 = 14%	Open grassland
Secretarybird	*Sagittarius serpentarius*	Vulnerable	12	1/50 = 2%	Open grassland
Lappet-faced Vulture	*Torgos trachelietus*	Endangered	16	6/50 = 12%	Treed arid savanna
White-backed Vulture	*Gyps africanus*	Endangered	21	5/50 = 10%	Treed Savanna
Lanner Falcon	*Falco biarmicus*	Vulnerable	22	8/50 = 16%	Arid habitats
Martial Eagle	*Polemaetus bellicosus*	Endangered	23	9/50 = 18%	Treed Savannas
Kori Bustard	*Ardeotis kori*	Near Threatened	37	2/50 = 4%	Grassland, Savanna
Red Lark	*Calendulauda burra*	Vulnerable	39	1/50 = 2%	Arid grassland
Sclater's Lark	*Spizocorys sclateri*	Near Threatened	47	8/50 = 16%	Open rocky/grassland
Karoo Korhaan	*Eupodotis vigorsii*	Near Threatened	49	36/50= 72%	Shrublands
Burchell's Courser	*Corsorius rufus*	Vulnerable	69	1/50 = 2%	Arid stoney plains

Also, *Endangered* Martial Eagles *Polemaetus bellicosus* twice bred (successfully) on the 400kV pylons traversing the study area in 2014 and 2016. No breeding was evident in 2015 or 2020, or 2021, probably due to poisoning incidents that killed an adult eagle.

Lanner Falcons *Falco biarmicus* were the least common of the Red Data species and occurred north of the PV study site (Photo 5(a).

Photos 5(a) + (b): Lanner Falcon (left) and a young Martial Eagle (above) were apparent in other sections of the study area.

Martial Eagles are residents and were observed with a nestling in September 2014 and again in June 2016 (Photo 2), within the 50 000-ha site.

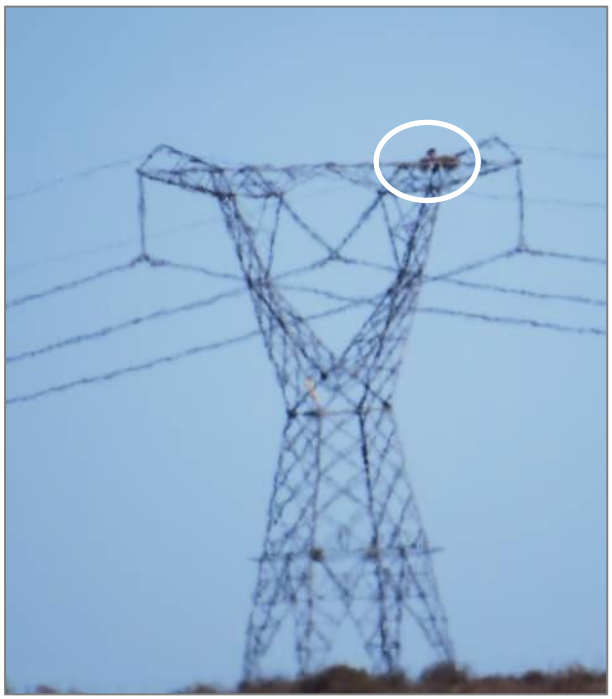


Photo 6: The active Martial Eagle nest within the development area (S 29°48'8.53" E 20°31'51.50"). This nest was active in 2014 and again in 2016, and young birds were recorded in the southern part of the study area, Photo 5(b).

We recorded only one of the two red-listed larks (Sclater's Lark: right) expected in the study area. They were recorded on five of the total 26 survey days. No Red Larks *Calendulauda burra* were recorded. The absence of this *Vulnerable* species may have arisen from the lack of red dunes (their preferred habitat) or appropriate grasses in the surveyed areas.

No other Red Data species (Secretarybird, Red Lark, Verreaux's Eagle, Lesser- and Greater Flamingo) referred to by Smallie and Shaw (2013) were recorded in our survey. These may, therefore, be uncommon visitors except at times of higher rainfall.

4.2.1 Density of Birds in the Expanded Kotulo Tsatsi Site

From the 1-km transects we recorded a mean 4.0 species/km in June 2016 (Table 2). The total number of species recorded in all walking and driving surveys was 71 (Appendix 1), with 24% more species in the wet seasons (54 and 48 species) than the dry season (42 species).

In 2020, following seven years of almost continuous drought (Kosie Zandberg pers comm) it was not surprising that the two transects yielded only 5.5 species/km and even fewer numbers of birds (10.5 birds/km). This compares with 9.9 birds/km in the June 2016 visit and 43.7 birds/km in September 2014. That represents a four-fold decline in the drought years.

The PV sites differed little with 5.7 species/km and 11.7 birds/km (Table 2). One of these species (Sclater's Lark: photo above) is a *Near Threatened* and range-restricted endemic (Lloyd 2005). Only three birds were recorded in 2016, ~1.5-km southwest of the proposed PV1 site, and none in 2020, suggesting that they are rare and nomadic in the area.

In summary, very low numbers of birds were apparent during the drought years between 2016 and 2020 on site. This means that the proposed PV sites hold a very low species richness and abundance, and no Red Data species.

From a habitat perspective, the number of birds per kilometre was consistently higher in the dry river washes that supported *Rhigozum* shrubs, than in the open grassy plains that surrounded them. This has implications for the placement of the PV sites: a site that avoids all dry river (drainage) lines will impact fewer small bird species and fewer birds. Therefore, open stony/grassy habitat is the better option for development.

Photo 6: Karoo Long-billed Larks were relatively common throughout the study area and foraged in the stoney plains amongst the grass.

4.2.2 Death of a Martial Eagle

The semi-eaten carcass of an adult Martial Eagle was found below its pylon nest on 7 December 2020. This nest (circled Photo 6 above) has been active since 2014 at the start of our studies. The pylon is numbered Aries-Helios 121.

The bird was found lying face down, with no burn marks indicating it had not been electrocuted.

Upon sending the photos to, and sharing the facts with, Mr Andre Botha, head of the EWT Birds of Prey Programme, he concluded that the bird had most probably been poisoned due to the following observations:

- The crop appeared to be full.
- Dead beetles were present (implying they, too, had been killed by the poisons).
- The carcass had hardly been scavenged by other terrestrial mammals.
- The claws were clenched, and
- The legs were outstretched.

Poisoning a Red Data species is AGAINST THE LAW. Therefore, poisoning within the solar farm is unacceptable. It must be made clear in the Environmental Authorisation that the use of poisons is strictly prohibited.

Birds & Bats Unlimited recommend that the Environmental Authorisation is only granted on the understanding that poisoning of Red Data birds is strictly prohibited for the solar farm to proceed.

Table 2: Overall bird densities from 1-km transects (n = 21) in June 2016 within the Kotulo Tsatsi expanded site**.**

OVERALL MEANS by habitat		**Species/km**	**Birds/km**
	Open plains:	3.7	7.1
	Dry river scrub:	4.6	8.3
OVERALL MEANS by area			
	CSP sites	5.0	10.5
	PV sites	5.7	11.7
	Overall expanded site	4.1	9.9
OVERALL MEANS by season			
	June (2016) [wet]	3.95	9.7
	Sept (2014) [dry]	8.75	43.7
	March (2015) [wet]	7	15.1
	Dec (2020) hot, dry	5.5	10.5

4.2.3 Passage Rates of Birds in the Expanded Kotulo Tsatsi Site

Passage Rates are a measure of the number of collision-prone Priority birds passing through a given Vantage Point area per hour.

From 213 hours of systematic observation from 18 VPs in 2014-2016 we recorded 86 Priority birds, giving a medium-low rate of 0.40 birds per hour (Appendix 2). Ten of these 86 Priority birds were threatened Red Data species, of which seven (8%) were Martial Eagles. These birds were either perched on telephone poles (Photo 5b) or pylons or soaring over the pans in the south of the study area. Their passage rate was 0.03 birds per hour – a low rate.

In 2020 these Passage rates were even lower with no birds recorded flying over the PV3 and PV4 sites. This may be biased as the recorded observation hours were only 2.0 hours.

These low rates are a combination of drought and the death of the breeding Martial Eagle (see *Death of a Martial Eagle*, p 16).

Photo 7: Collision-prone bustards remain a concern as they regularly impact the 400kV Aries-Helios power line that runs through the site. This Kori Bustard was killed shortly after a thunderstorm during our site visit in 2016.

Previous studies (Shaw and Smallie 2013, Simmons and Martins 2015) highlight the need for spiral bird diverters on all earth wires through this high-traffic area.

4.2.4 Martial Eagles and Other Priority Species in the Proposed Kotulo Tsatsi PV3 Site

Given that the primary concern arising from the first avian assessment of the Kotulo Tsatsi site was the presence of an active Martial Eagle nest on the boundary of the present PV3 site, a 3-km buffer was recommended to reduce risk to the birds from development.

It must be noted that:

- The original buffer was 3-km for the proposed CSP facility (a more dangerous design for birds than PV).
- The study was granted an Environmental Authorisation (so the 3-km buffer would be difficult to change).
- The present-day buffer recommendation based on tracking data (Dr G Tate) is 5.7-km for wind farms
- BBU is satisfied that a 3-km buffer remains an adequate prevention, because:
  - (i) PV facilities are more benign to birds than wind turbines or CSPs;
  - (ii) the 3-km buffer should be sufficient to minimis habitat loss; and
  - (iii) the 3-km buffer should be sufficient to reduce disturbance during construction.

The original nest at S29°48'8.53" E020°31'51.50" (Photo 2) was not active because a recently poisoned adult was found below the nest. Another, apparently inactive, Martial Eagle nest was recorded just outside the study area on a pylon in the south-western corner.

A juvenile bird, possibly from this nest was regularly recorded in the southern section of the expanded site (Figure 5). The presence of this nest and juvenile birds indicates that this area is well-used by Martial Eagles and the vacancy precipitated by the death of an adult at the solar site is likely to be quickly filled by another Martial Eagle. This emphasises the need to persist with the nest buffer around the nest.

It is important to understand that the poisoning of the territorial Martial Eagle will not stop this nest from being re-occupied in future years. **Therefore, the nominal 3-km nest buffer must remain in force.**

This arises because the PV site will take habitat away from the foraging birds and cause disturbance to them during construction and operation. The proposed PV3 no longer overlaps this 3-km buffer (Figure 4) and thus has served its purpose.

Photo 8: Arid-adapted Namaqua Sandgrouse were the only birds breeding (inset) on the hot gravel plains of the Kotulo Tsatsi site. Few other species were found on the over grazed areas.

4.2.5 Vultures in the Proposed Kotulo Tsatsi PV3 Site

A late addition to the avifauna that appeared in 2020 and again in 2021 was the arrival of over 100 White-backed Vultures, and a few Cape Vultures and Lappet-faced Vultures. All are Red Data species.

These species often roosted on the power line towers (Photo 9) and were sometimes close to the PV3 site. Will the siting of the solar facility have any influence on the roost site?

Given the huge foraging range of vultures in general, and White-backed Vultures in particular, it is unlikely that the presence of a PV facility will negatively influence the vultures from a loss of foraging perspective.

It is also unlikely to adversely influence the roost site given that the vultures have used several sets of pylons over several kilometres in the months that they have been recorded on the Aries–Helios line. They were first recorded in the area in 2019 by conservation farmer Francois van der Merwe.

Photo 9: White-backed Vultures (with a few Cape and Lappet-faced) were new arrivals in the summer months of 2020 and 2021**.** These conspicuous species were not recorded in 2014-2016 field work.

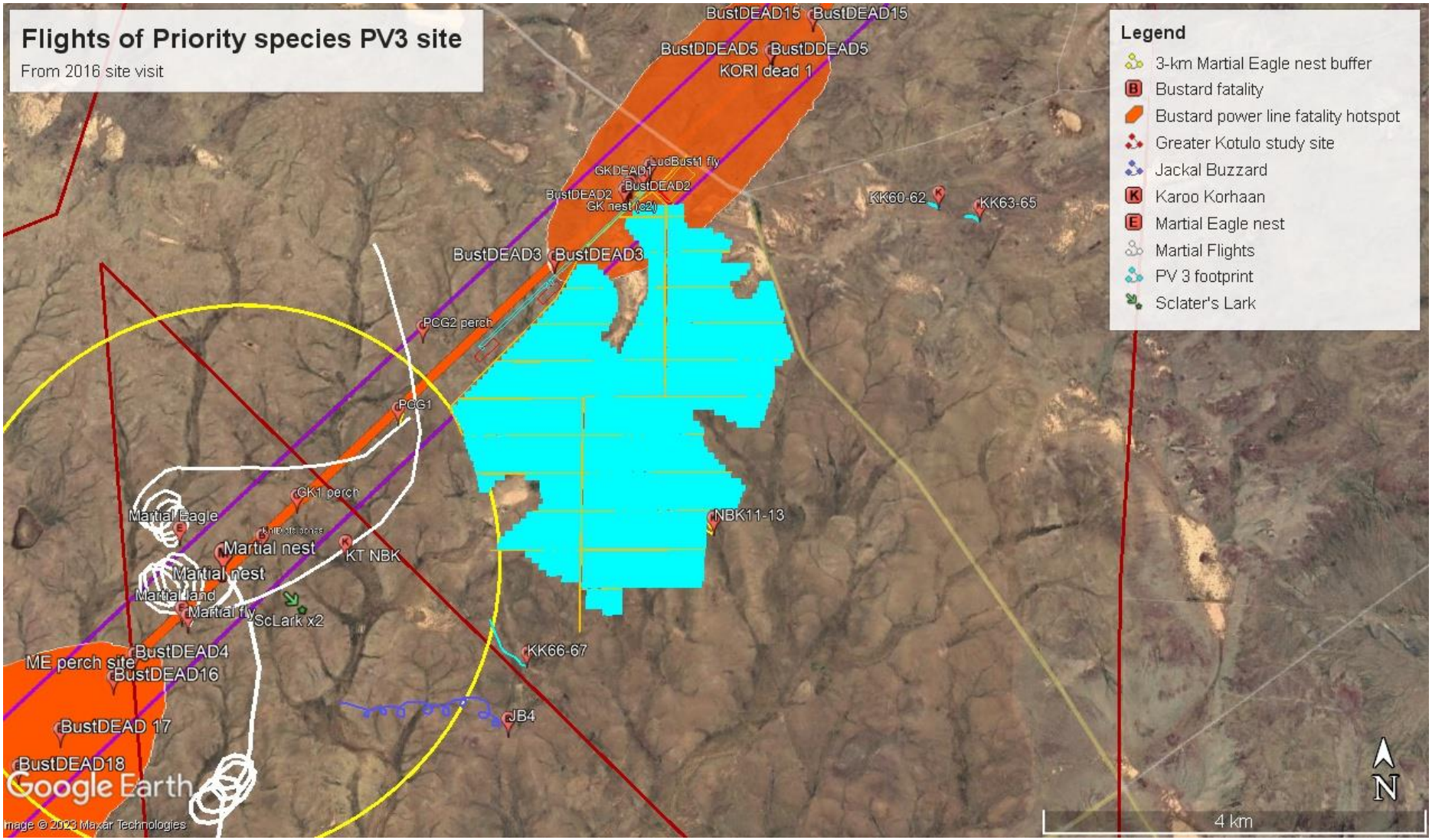


Figure 4: Flights of Priority birds recorded in 2014 and 2016 in or near the proposed photo-voltaic sites PV (= pale blue polygon)). In the PV3 area no Priority birds were recorded, with all activity either on the power line (raptors and their nests) or Karoo Korhaans and Jackal Buzzards.

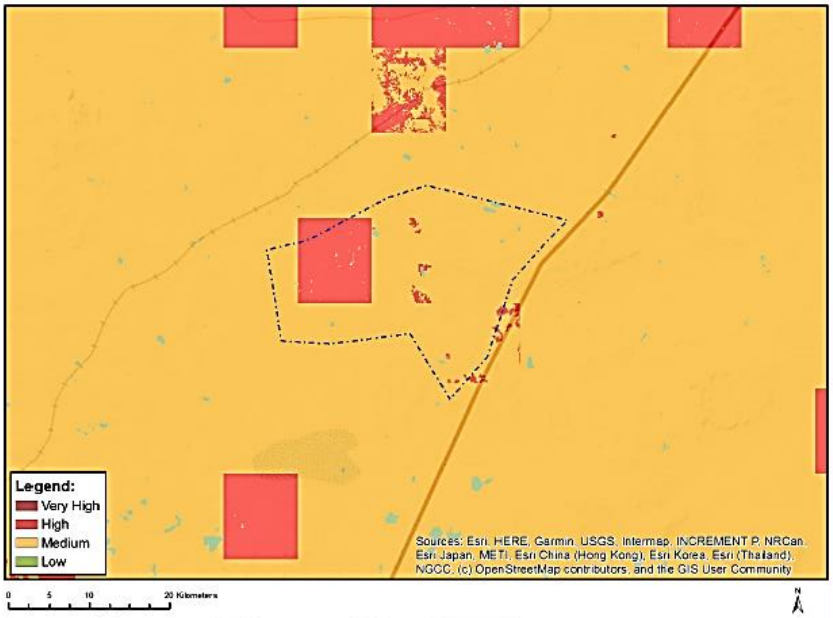
These results suggest that Martial Eagles are the only avian species that may potentially be negatively influenced by the development of the PV3 site.

Given that all structures related to the PV3site now lie outside the 3-km buffer proposed by BBU, we do not see any additional negative influence from either habitat loss, or construction, on the eagles or vultures.

4.3 DFFE Screening Tool Animal and Avian Themes

The DFFE Screening Tool (accessed 29 March 2023) indicates that the site is of High Sensitivity for the Animal Theme, based on the presence of three Red Data species (courser, eagle, and falcon). See Figure 5.

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



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

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Cursorius rufus
High	Aves-Falco biarmicus
High	Aves-Polemaetus bellicosus
Low	Subject to confirmation
Medium	Aves-Neotis ludwigii

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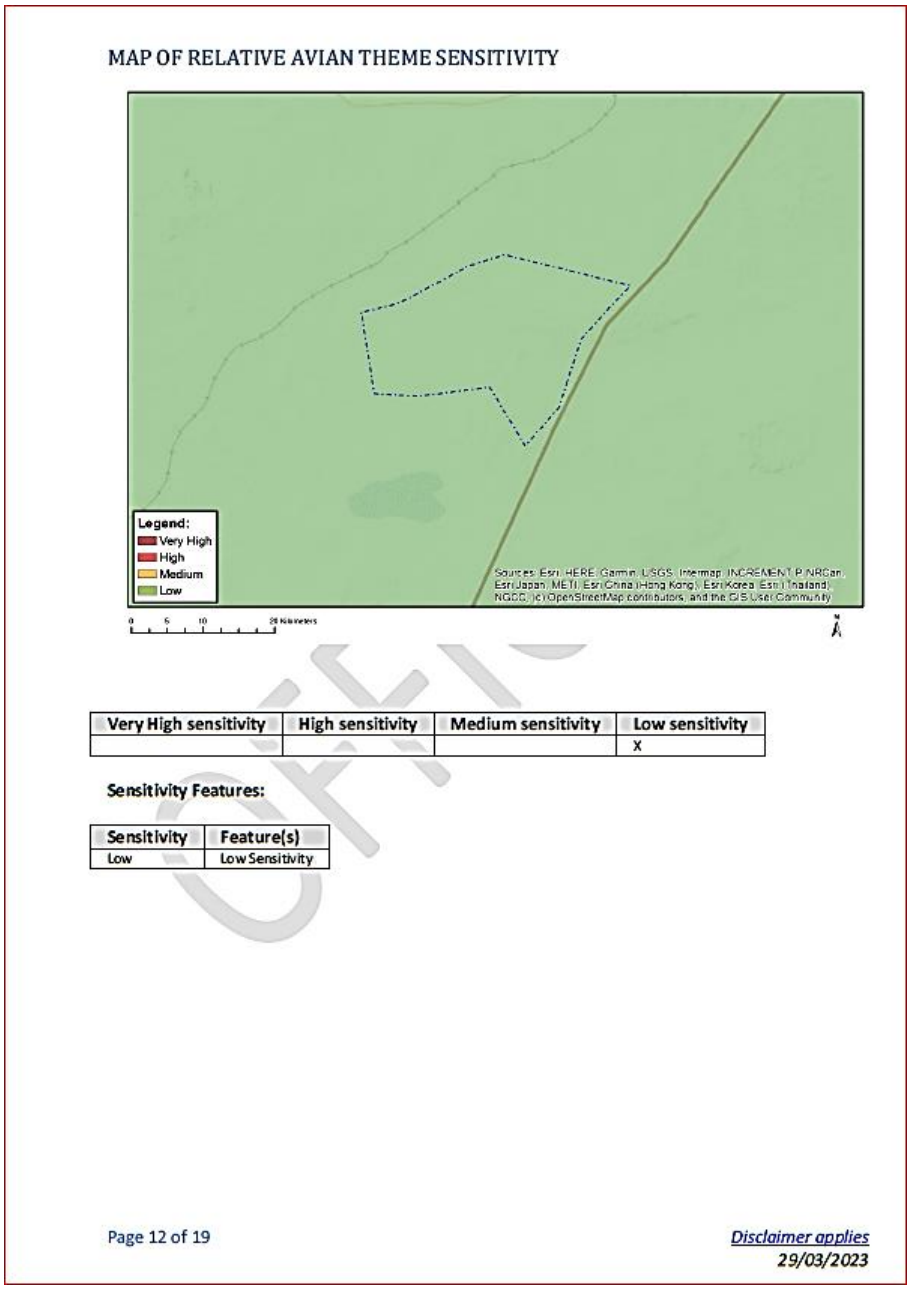
Figure 5: DFFE Screening Tool output for the Animal Theme. The red square within the site probably represents the location of the Martial Eagle nest, and this helps explain the classification.

The Screening Tool for the Avian Theme classifies the proposed solar farm area as of Low Sensitivity (Figure 6).



MAP OF RELATIVE AVIAN THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity

Disclaimer applies
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Figure 6: DFFE Screening Tool output for the Avian Theme for solar projects. The area is classified as of low avian sensitivity.

BBU, as the avian specialists, agree with both Screening Tool outputs given the presence of several Red Data bird species. The low-risk identified by the Avian Theme is in line with our assessment that solar PV facilities are of low risk to the collision-prone birds in the area.

4.4 Important Bird Areas (IBA)

No Important Bird Areas are apparent in the area (Marnewick et al. 2015).

5 QUANTIFYING THE IMPACTS

Below, we semi-quantify the significance of the impacts and evaluate the advantages of various forms of mitigation to reduce expected impacts.

To quantify the significance (S) of the expected impacts to the Priority species we need to estimate the Extent (E), Duration (D), and Magnitude (M) of the impact and estimate the probability (P) that the impact will occur. The significance can be calculated as

S = (E + M + D)P. Below we justify the scoring of these variables.

Nature: The impact of the proposed Kotulo Tsatsi PV area will generally be negative for birds given the certainty that: (i) ~1300 ha of habitat will be transformed and the associated habitat potentially fragmented by roads, power lines and other infrastructure; and (ii) birds may be killed directly if they fly into the solar panels area. Displacement may also occur.

The **Extent (E**, from 1-5) of the impact will be local within the 1300 ha area = (1).

The **Duration (D,** from 1-5) will be long-term (4) for the lifetime of the PV site. This is so for all Priority species.

The **Magnitude (M,** from 0-10) of the PV site area is expected to cause a low impact (2) for the raptors. Note that this applies mainly to the breeding Martial Eagles and the loss of habitat.

The Probability (P, from 1-5) of the Priority species having some sort of interaction with the PV site is ranked as unlikely (2) because of their low likelihood of occurring (<50% likelihood from Table 1) and low passage rates (<0.40 birds/h) on the proposed solar farm. The main risk is with the Endangered Martial Eagles that breed within 3 km of two proposed PV sites. With mitigation (i.e. avoiding the 3 km high-risk areas) this probability will decrease.

The Significance S, [calculated as S = (E+D+M)P], is as follows (Table 4) for the species identified as at risk in the (i) solar farm site.

The scale varies from:

- 0 (no significance), to
- ≤30 Low (this impact would not have a direct influence on the decision to develop in the area), to
- 30-60 (the impact could influence the decision to develop in the area unless it is effectively mitigated), to
- >60 (the impact must have an influence on the decision process to develop in the area).

Table 4. A quantification of impacts to the nine Priority species and Red Data species likely to be impacted by the proposed Kotulo Tsatsi solar PV site.

PV development site Construction Phase

Nature: Negative due to direct disturbance and loss of foraging habitat around the SOLAR PV site for the Red-listed bird groups identified as at risk above.

- The Martial Eagle, recorded on the SOLAR PV site is the raptor species most likely to be impacted because of their high likelihood of occurrence and high proportion of flights over the area. The newly arrived Vultures are not expected to be affected.

	Without mitigation	With mitigation
Extent	**1**	**1**
Duration	**4**	**4**
Magnitude	**2**	**1**
Probability	**2**	**2**
Significance (E+D+M)P	**14 low**	**12 (low)**

Status (+ve or –ve)	Negative	Negative
Reversibility	Yes, once construction disturbance finished the birds are likely to return	Yes, areas around active nests avoided during construction
Irreplaceable loss of species?	No, Martial Eagles will return to the area. But that runs the risk that these birds too will be displaced	
Can impacts be mitigated?	Yes. If the high-risk areas are avoided within the 3-km eagle nest buffer development.	Yes. If all areas identified as sensitive are avoided for development

Mitigation for SOLAR PV site: Construction

The mitigation for birds around the Kotulo Tsatsi SOLAR PV3 site is as follows:

- No development within the 3-km Martial nest buffer
- reduce disturbance near active nests – build outside the breeding season.

Some of the proposed mitigations above will require further data regarding fatalities in the solar PV site.. This will assist in determining where individual turbine-specific mitigation measures are required to be implemented.

SOLAR PV development site: Operational Phase

Nature: Negative due to direct impact fatalities, disturbance and loss of foraging habitat around the SOLAR PV site for the Red-listed bird groups identified as at risk above.

- The Martial Eagle, recorded on the SOLAR PV site are the raptors species most likely to be impacted because of their high likelihood of occurrence and high proportion of flights at BSA. White-backed Vultures are not expected to be negatively influenced in roosting or foraging strategies.

	Without mitigation	**With mitigation**
Extent	**1**	**1**
Duration	**4**	**4**
Magnitude	**2**	**1**
Probability	**3**	**2**
Significance (E+D+M)P	**21**	**18**
Status (+ve or –ve)	Negative	Negative
Reversibility	Yes, if solar development avoids areas identified as high-risk in the proposed SOLAR PV, and mitigation occurs in the remaining areas.	Yes, if solar development avoid areas identified as high-risk
Irreplaceable loss of species?	No, Martial Eagles will return to the area. But that runs the risk that these birds too will be killed by poisons or impact with lines or solar infrastructure.	
Can impacts be mitigated?	Yes. If the high-risk areas are avoided for development	Yes. If all areas identified as sensitive are avoided for development

Mitigation for SOLAR PV site:

The mitigation for birds around the Kotulo Tsatsi SOLAR PV site is as follows:

- position the solar PV site outside the 3-km high-risk shown in Figure 4;

Some of the proposed mitigations above will require further data regarding which solar panels are responsible for most deaths.. This will assist in determining where individual specific mitigation measures are required to be implemented.

SOLAR PV development site: **Decommissioning Phase**

Nature: Negative due to direct disturbance and loss of foraging habitat around the SOLAR PV site for the Red-listed bird groups identified as at risk above.

- The Martial Eagles recorded on the SOLAR PV site are the raptors species most likely to be impacted because of their high likelihood of occurrence and high proportion of flights.

	Without mitigation	**With mitigation**
Extent	**1**	**1**
Duration	**4**	**4**
Magnitude	**2**	**1**
Probability	**2**	**1**
Significance (E+D+M)P	**14**	**6**
Status (+ve or –ve)	Negative	Negative
Reversibility	Yes, if the veld is rehabilitated	Yes, if the habitat is rehabilitated

Irreplaceable loss of species?	No, Martial Eagles will return to the area. But that runs the risk that these birds too will be poisoned by irresponsible people.	
Can impacts be mitigated?	Yes. If the high-risk areas are avoided for development.	Yes. If all areas identified as sensitive are avoided for development

Mitigation for SOLAR PV site: Decommissioning phase

The mitigation for birds around the SOLAR PV site is as follows:

- Reduce degree of disturbance and length of disturbance to a minimum during sensitive breeding periods

6 CONCLUSIONS AND RECOMMENDATIONS

This multi-year avian assessment of the Kotulo Tsatsi renewables development combined site visits in 2014, 2015, 2016, and 2020 and revealed the following avian trends:

- The avifauna of the area may be affected by the infrastructure of future photo-voltaic developments, mainly through habitat loss.
- Our monitoring of the extended area at Kotulo Tsatsi revealed at least six Red Data species (White-backed Vulture, Ludwig's and Kori Bustards, Martial Eagle, Lanner Falcon and Sclater's Lark) occur within the study site.
- A further 61% (44/72) of all the species recorded were endemics.
- The avian species richness will fluctuate in tune with the degree of rainfall and, thus, more species and Red Data species are expected at times of higher rainfall.
- Most sections of the Kotulo Tsatsi site held very low species richness and abundance of Priority collision-prone birds or Red Data species due to the extended dry conditions. This suggests that they will be suitable for PV development.
- The Martial Eagle pair that bred successfully in 2014 and 2016 atop the pylon Aries-Helios 121, did not breed in 2020.
- The adult bird was found dead below its nest, and all indications were that it was poisoned. It is illegal to kill a Red Data species and the environmental authorisation must include a clause to highlight and prevent this. Without such a clause Birds & Bats Unlimited would strongly recommend that an Environmental Authorisation not be given. This is especially critical given that Red Data vultures are now in the area and highly susceptible to mass poisoning.

How might these findings and the proposed development influence the avifauna on site?

- Evaporation ponds in the Kotulo Tsatsi site may attract arid species (21 species and 159-250 birds/day were attracted to the small over-flowing dams: Simmons & Martins 2015). Thus, special mitigation siting for such ponds (i.e., moving them well away or covering them completely) must be implemented.
- We recommend that all available precautions be taken to avoid the *Endangered* Martial Eagles and other threatened birds being attracted to the PV developments. These birds frequently perch-hunt from the adjacent pylons and may negatively interact with the solar PV site.

If our recommendations and mitigations as laid out in this report are followed, we see no reason why the Kotulo Tsatsi Solar PV3 facility should not be developed. This should be undertaken in conjunction with an Environmental Management Plan (EMP) to systematically survey the facility for birds and fatalities for 12-24 months as detailed below.

This will highlight if any poisoning of Red Data species occurs and allow appropriate action by the solar farm operators.

7 ENVIRONMENTAL MANAGEMENT PROGRAMME

Given the possible impact of the proposed Kotulo Solar farm development, any impacts on avifaunal species requires systematic monitoring during both the construction- and post-construction phases. This is a recommendation of the BARESG guidelines (Jenkins et al. 2015).

The Guidelines suggest an adaptive and systematic monitoring of bird displacement (comparing avian densities before and after construction, particularly for Priority collision-prone and Red Data species) and particularly the monitoring of all panel-related fatalities, that is, birds that attempt to land on the panels believing it is open water. The latter must take account of biases introduced by scavengers removing carcasses and observers failing to detect bird remains below the panels.

The monitoring should include the following (as per BARESG guidelines):

- Post-construction monitoring should be started as the facility becomes operational, bearing in mind that the effects of the PV- facility may change over time.
- Post-construction monitoring can be divided into two categories:
  a) quantifying bird numbers and movements (replicating baseline data collection); and
  b) estimating bird mortalities.
- Carcass monitoring should be undertaken by trained observers, willing to cover a substantial portion of the solar panels per day in all weathers and over-seen by an ornithologist competent to determine species identification, and a manager to collate and analyse each year's data.
- Estimating bird fatality rates includes:
  a) estimation of searcher efficiency and scavenger removal rates.
  b) carcass searches; and
  c) data analysis incorporating systematically collected data from (a) and (b); these biases should then be allowed for in estimating fatality rates.
- A minimum of 50% of the solar farm footprint should be methodically searched for fatalities, throughout the year, with a search interval informed by scavenger removal trials and objective monitoring. Any evidence of mortalities or injuries within the remaining area should be recorded and included in reports as incidental finds.
- The search area should be defined and consistently applied throughout monitoring.
- The duration and scope of post-construction monitoring should be informed by the outcomes of the previous year's monitoring and reviewed annually.
- Post-construction monitoring of bird abundance and movements and fatality surveys should span 2-3 years to take inter-annual variation due to rain into account; and
- If significant problems are found or suspected, the post-construction monitoring should continue in conjunction with adaptive management and mitigations – accounting for the risks related to the particular site and species involved.

An assessment guided by these principles is required not only to enact and test the effectiveness of different mitigation measures where significant mortality occurs, but allow data to be collected that will benefit the welfare of avifauna at other renewable energy farms. This is also important for a study of cumulative avian impacts for the increasing number of renewable facilities planned for South Africa.

7.1 MANAGEMENT INTERVENTIONS

Where avian fatalities are found to occur to:

(i) Red Data species; or

(ii) To Priority species at unacceptably high levels (e.g. > 1 Priority species per PV year), then the additional mitigation measures detailed above, should be brought into play.

(iii) This includes the unnecessary disturbance, interference with breeding, wilful destruction of nests, or poisoning of the eagles (or other Red Data raptors on site).

We encourage all developers to release the results of the annual monitoring to Birdlife South Africa, such that South Africa-wide fatality and displacement results can be collated and assessed. Only in this way will the cumulative impacts assessments, currently crudely estimated for solar facilities, be refined, region by region.

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9 APPENDICES

9.1 Appendix 1: Bird Species recorded in the Solar Site

The 72 bird species recorded in the Kotulo Tsatsi Solar PV3 expanded site in June 2016, September 2014, March 2015, and December 2020. This list amalgamates all survey methods (i.e., 1-km transects, driving surveys, waterhole surveys, power line surveys). The five **Red Data** species, and 44 **endemic** and **near-endemic** species are colour-coded.

SPECIES	December 2020	June 2016	September 2014	March 2015
Acacia pied barbet		√	√	
Ant-eating chat		√	√	√
Barn Swallow				√
Black-chested prinia		√	√	√
Black-eared sparrowlark		Range-restricted √	Range-restricted √	√
Black-headed canary			Range-restricted √	
Bokmakierie	√	√	√	√

Booted Eagle	√	√		
Burchell's Courser				√
Cape bunting		√	√	√
Cape Glossy Starling				√
Cape penduline tit			√	√
Cape sparrow		√	√	√
Cape turtle Dove		√		√
Capped Wheatear				√
Chat Flycatcher		√		√
Chestnut-vented Titbabbler		√		
Clapper lark			√	
Common Fiscal		√		√
Common quail			√	
Dusky sunbird		√	√	√
Double-banded Courser		√		√
Egyptian Goose				√
Familiar Chat	√	√		√
Greater kestrel		√	√	√
Great Sparrow				√
Grey-backed sparrow-lark	√	√	√	√
Grey Tit		√		
Grey-backed Cisticola		√		
Jackal Buzzard		√		√
Karoo chat		√	√	
Karoo korhaan	√	√	√	√
Karoo Lark				√
Karoo long-billed lark	√	√	√	√
Karoo prinia			√	
Karoo scrub-robin		√	√	√
Kori Bustard			Near Threatened√	
Lanner Falcon		Vulnerable √	Vulnerable √	√
Large-billed lark		√	√	
Larklike bunting		√	√	√
Long-billed crombec		√	√	√
Ludwig's Bustard		**Endangered**√	Endangered√	
Martial Eagle		**Endangered**√	Endangered√	√
Mountain wheatear		√	√	√
Namaqua Sandgrouse	√	√	√	√
Northern black Korhaan		√	√	
Pale-chanting Goshawk	√	√	√	√
Pale-winged Starling				√
Pied crow	√	√	√	√
Pririt Batis		√		√
Red-faced Mousebird		√	√	
Red-eyed Bulbul		√		
Red-headed Finch		√		√
Red-backed Shrike				√

Rock Kestrel		√		
Rufous-eared warbler		√	√	√
Sabota lark (Bradfield's)	√	√	√	√
Scaly-feathered finch		√	√	√
Sclater's lark		Near Threatened range-restricted √	Near Threatened range-restricted √	√
Stark's Lark	√			
Sickle-winged Chat		√		
Southern masked weaver			√	
Speckled pigeon		√	√	√
Spike-heeled lark		√	√	√
Spotted Eagle Owl		√		
Stark's Lark		√	√	√
Tractrac chat		√	√	
Village Indigobird			Vagrant: One male seen with 25 red-billed females√	
White-backed Mousebird		√		√
White-throated canary		√	√	√
White-backed Vulture	√			
Yellow canary		√	√	√
Yellow-bellied eremomela		√	√	
TOTALS (72 species)	**13 species**	**54 species**	**44 species**	**48 species**

9.2 Appendix 2:

Passage Rates and Flight Heights of Collison-prone birds through the expanded Kotulo Tsatsi PV3 site, June 2016.

Date	Time	Obsv period	Hrs	Vantage Point	No.	Species	GPS pos on map	Height
18/06/2016	10h00	09h30-15h30	6.00	**KT1-1**	2	Karoo korhaan	KK1-2	Heard only
	10h02				2	Karoo korhaan	KK3-4	Heard only
	10h39				1	Rock kestrel	RK1	20-20-20-20-20-20-20-20-0-10-10-15-20-20-20-20-20-20-20-20
	11h26				1	Rock kestrel	RK2	20-20-20-15-20-20-20-20-20-20
	11h29				1	Rock kestrel	RK3	15-15-15-20-20-20-15-15-15-15-0
	11h59				1	Rock kestrel	RK4	40-40-30-30-30-30-15-2-10-10-15-15-20-20-30-40-50-50-50-50-50-60-60-60
	12h12				1	Rock kestrel	RK5	40-40-30-30-20-20-30-30-20-20-20-15-15-15-10-10-2
	12h18				1	Rock kestrel	RK6	50-50-40-30-30-20-20-30-30-30-40-40-50-50-50-50-50

	12h22				1	Rock kestrel	RK7	10-10-20-20-30-30
18/06/2016	10h05	09h35-15h35	6.00	**KT2-1**	2	Karoo korhaan	KK5-6	Heard only
19/06/2016	09h58	09h55-15h55	6.00	**KT2-2**	1	Greater kestrel	GK1	Perching (8m pole)
	12h05				1	Pale chanting goshawk	PCG1	Perching (watertank)
18/06/2016	12h04	09h15-13h15	6.00	**KT3-1**	1	Pale chanting goshawk	PCG2	1-2-1-2
19/06/2016		10h00-16h00	6.00	**KT3-2**		**No Birds**	-	
19/06/2016	10h35	10h45-16h45	6.00	**KT4-1**	1	Pale chanting goshawk	PCG3	1m
	15h14			**(CSP5)**	1	Pale chanting goshawk	PCG4	5-5-5-15-15-20-20-5-2
20/06/2016		09h15-15h15	6.00	**KT4-2**		**No Birds**	-	
				(CSP5)				
16/06/2016	10h00	08h40-14h40	6.00	**KT5-1**	1	Northern black korhaan	NBK1	20-20-15
	11h41				2	Karoo korhaan	KK7-8	10-10-10m
17/06/2016		10h50-16h50	6.00	**KT5-2**		**No Birds**	-	
16/06/2016	9h16	09h00-15h00	6.00	**KT6-1**	2	Karoo korhaan	KK11-12	5-5-6-5-4-1
	9h26				1	Namaqua sandgrouse	NS1	Heard only (flying high)
	10h25				2	Namaqua sandgrouse	NS2-3	05-May
	10h39				10	Namaqua sandgrouse	NS4-13	10-10-10-20-20-20-20-20-20-20-20-20-20
	10h48				8	Namaqua sandgrouse	NS14-21	25-25-20-5-0
	11h30				1	Pale chanting goshawk	PCG5	Perched
	12h43				2	Karoo korhaan	KK21-22	Heard only (perched)
	13h37				2	Karoo korhaan	KK23-24	Heard only (perched)
17/06/2016		10h30-16h30	6.00	**KT6-2**	1	Northern black korhaan	NBK3	5-8-10-4-0
	11h43				1	Northern black korhaan	NBK4	8-8-8-2-0
	13h34				1	Karoo korhaan	KK25-26	Heard only (perched)
	14h15				1	Northern black korhaan	NBK5	10-10-0
16/06/2016	-	09h30-14h30	6.00	**KT7-1**	2	Karoo korhaan	KK27-28	-
17/06/2016	10h51	10h38-15h38	6.00	**KT7-2**	2	Karoo korhaan	KK29-30	2-5-5m
	12h40				1	Pale chanting goshawk	PCG6	6-6m
	12h59				1	Northern black korhaan	NBK6	10-15-20-20
	13h50				1	Northern black korhaan	NBK7	5-5-5m
	14h26				1	Karoo korhaan	KK31	10-20-20-20
	14h59				1	Northern black korhaan	NBK8	5-15-15-15
14/06/2016	09h05	08h30-14h30	6.00	**KT8-1**	8	Namaqua sandgrouse	NS22-29	40-45-45-45
	09h44				1	Namaqua sandgrouse	NS30	70-75-80-80-80-80-85-90-90
	09h56				6	Namaqua sandgrouse	NS31-36	35-35
	-				2	Karoo korhaan	KK31-32	12-15-10
	13h15				1	Northern black korhaan	-	15-20-20-15-20-15
14/06/2016		09h15-15h15	6.00	**KT9-1**	2	Karoo korhaan	KK33-34	5-10-5m
15/06/2016	12h19	10h30-16h30	6.00	**KT9-2**	1	Booted eagle	BEagle1	30-30-30-20-20-30-30-40-40-50-60-60-70-70-80-80-80-70-70-70-70
	13h06				1	Booted eagle	BEagle2	80-100-100-110-110-120-120-120-120-120-120-120-120-120-130-130-130
15/06/2016		10h45-16h45	6.00	**KT10-1**		**No Birds**	-	

12/06/2016	8h30	09h00-15h00	6.00	**KT11-1**	2	Karoo korhaan	KK35-36	Heard only (0)
13/06/2016	11h02	11h00-17h00	6.00	**KT11-2**	1	Namaqua sandgrouse	NS37	Heard only (0)
	16h06				2	Karoo korhaan	KK37-38	Heard only (0)
14/06/2016	9h18	08h30-14h30	6.00	**KT12-1**	1	**Ludwig's bustard**	LBust1	80-80-80-80-80-80-80-80-80-80-80-80-80-80-80
	14h30				1	**Ludwig's bustard**	LBust2	10-10-10-10-10-10-10
15/06/2016		10h30-16h30	6.00	**KT12-2**		**No Birds**	-	
12/06/2016	09h12	09h10-15h10	6.00	**KT13-1**	2	Karoo korhaan	KK39-40	10-10m
13/06/2016		11h00-17h00	6.00	**KT13-2**				
12/06/2016		08h40-14h40	6.00	**KT14-1**		**No Birds**	-	
13/06/2016		11h00-17h00	6.00	**KT14-2**		**No Birds**	-	
10/06/2016	10h50	09h30-15h30	6.00	**KT15-1**	1	Jackal buzzard	JB1	20-20-20-20-20-5
11/06/2016	-	08h40-14h40	6.00	**KT15-2**	2	Karoo korhaan	KK41-42	Heard only
	11h04				1	**Martial eagle**	MEagle1	40-40-45-45-60-60-70-70-80-80-80-90-90-90-90-100-100-100-120-120-120-150
	12h54				1	**Martial eagle**	MEagle2	60-60-70-70-80-90-90-90-100-100-150-150-150-150-150-150-200-200-200-200-200-200-10-40-40-40-50-60-60-60-80-80-100-100
10/06/2016	12h25	09h45-15h45	6.00	**KT16-1**	1	Jackal buzzard	JB2	8-5-2-3-3
	12h28				1	Jackal buzzard	JB3	30-30-40-45-45-40-45-45-45-45-45-45-45-45-45-45-45-45-45-45-45
	14h47				3	Karoo korhaan	KK45-47	10-10-7m
11/06/2016	09h15	09h10-15h10	6.00	**KT16-2**	2	Karoo korhaan	KK48-49	10-15-5
	09h38				1	Namaqua sandgrouse	NS38	100-100-110-120-120-120-120
	11h42				1	Pale chanting goshawk	PCG8	8-10-10m
	13h37				1	**Martial eagle**	MEagle3	50-55-60-65-70-75-80-80-80-85-90-90-95-90-90-90-95-100-100-110-110-120-120-130-130-140-140-145-145-150-150-150-150-150-150-150-145-140-140-130-130
10/06/2016	10h26	09h15-15h15	6.00	**KT18-1**	1	Namaqua sandgrouse	N39	Heard only (flying over)
11/06/2016	11h03	09h15-15h15	6.00	**KT18-2**	1	UnID raptor (**MEagle** jizz)	UnIDRapt1	50-50-50-60-60-60-50-50-60-60-60-60-50-50-50-50-50-50-50-60-60-60-60-70-70-70-70-70-70-70-70-80-80-80-80
	13h14				1	**Martial eagle** (juvenile)	MEagle4	50-50-50-30-30-30-30-30-40-40-40=50-50-50-40-40-30-30-30-50-50-60-60-70-70-70-80-80-80-80-90-90-90-100-100-100-100
20/06/2016	11h52	10h30-15h30	5.00	**CSP4-1**	3	Karoo korhaan	KK60-62	2-2-2m
21/06/2016	09h16	08h30-14h00	5.50	**CSP4-2**	3	Karoo korhaan	KK63-65	5-5-5-2-0
20/06/2016	12h00	09h00-14h00	5.00	**PV2A**	1	**Martial eagle**	??	On nest - incubating
	12h03				1	**Sclater's lark**	ScLark1	Feeding by trig beacon
21/06/2016	13h03	09h00-15h00	6.00	**PV2A**	1	**Martial eagle**	??	Perched - chick on nest
21/06/2016	09h59	09h00-15h00	6.00	**PV2B**	2	Karoo korhaan	KK66-67	Commuting 500m from observer
	13h04				1	Jackal buzzard	JB4	1000m from observer - mobbed by
	13h59				3	Northern black korhaan	NBK11-13	50-150m from observer
	Total HOURS		**213.50**	**BIRDS**	**86**			
				SPECIES	**9**	**Excludes: Sclater's/ Sandgrouse/ Swifts / Swallows**		
					126	**All aerial birds**		
Passage Rate	**86**	**birds in 213.50 h**				**0.40**	**birds/ h**	**Collision-prone birds (CPBs)**
Passage Rate	**126**	**birds in 213.5 h**				**0.59**	**birds/ h**	**All birds**

10 records of Red Data birds in this time - mainly Martials (7)