Avian Assessment: Kotulo Tsatsi Solar PV1 Facility Development, near Kenhardt, Northern Cape

Prepared for:

savannah environmental

Prepared by:

BIRDS & BATS UNLIMITED
Environmental Consultants
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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).

1. 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** – 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 status** – 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.

2. 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 2017-18);
- 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** Kotulo + Gromis (Enertrag) 2019;
- Avian impacts along 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.

Name of Specialist: Dr R E Simmons
12 January 2021

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

Contents

1 SUMMARY

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

The objective of the study was to

(i) determine areas of high avian sensitivity throughout the expanded area where may occur; and
(ii) record the avian use of the areas specifically proposed for development of the photovoltaic facilities 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 exclude the Groot Vloere pan.

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

1. The expanded site (100-km^2), located north of CSP 4, CSP3 and CSP 1
2. Sites for PV1, PV3 and PV4, located directly adjacent to CSP 1 and CSP 2 projects.

This report summarises the findings from the December 2020 site visit to identify the most sensitive areas and assesses the impacts of the proposed developments 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.

- Four red-listed birds were previously recorded over the larger site, (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 in 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 densities of smaller birds averaged nine species per kilometre and 21 birds per kilometre. Few aerial birds were recorded, but sandgrouse were present and breeding.

DEFINITIONS AND ACRONYMS

CSP	Concentrated Solar Power (typically refers to a power tower, lit by giant mirrors focused on it)
Hotspot	An area of high biodiversity or biological activity
IBA	Important Bird Area (an area recognized for its high diversity of species or large numbers of birds)
Priority Species	The top 100 bird species susceptible to collision with turbines, power lines (Birdlife South Africa
PV	Photo- Voltaic (direct capturing of sunlight to generate electricity)
SABAP 2	Southern African Bird Atlas Project 2, administered from the University of Cape Town
Vloere	Dry pans in the Bushmanland area inundated only after good rains
VP	Vantage Point, a location from which 6h observation for Priority Species is undertaken

No part of the proposed PV site 1, lies within the 3-km buffer around the inactive 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 other raptors 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 found. We conclude that:

- Few avian risks were associated with the proposed PV site.
- The development area of PV 1 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 PV site be given authorisation and a full post-construction monitoring programme of 12 months be carried out by a competent avian specialist to systematically determine avian fatalities.

2 BACKGROUND

2.1 PV: PHOTO-VOLTAIC SOLAR FARMS

Renewable energy is generated by harnessing water, wind or solar power and is a rapidly expanding industry in South Africa with over 400 Renewable Energy Applications (REAs). Green energy sources are those that emit no greenhouse gases or other pollutants. Southern Africa's arid region, located within the Northern Cape Province, is one of the Earth's hot spots for solar radiation because deserts provide some of the longest periods of continuous sunlight in the world (http://www.iir-sa.gr/files/news/csp.pdf).

Three methods are typically used to generate power:

- Concentrated solar power (**CSP power towers**) focus incoming radiation onto a central tower by tracking the suns movement across the sky. The heliostats, concentrate the radiation onto the central tower which heats water or salt, creating steam which drives a conventional turbine to produce electrical power.

- **CSP trough technology** also involves an array of moveable parabolic mirrors (in the form of a long trough) but with no central tower. Solar radiation is focussed on a long, continuous vacuum tube within a metre of the mirrors. That is then heated, and water and steam is created in a power island with a heat transfer fluid (HTF) system. Water that has been used is re-used and water evaporation ponds aren't required.

(i) **Photovoltaic (PV) technology** is the more conventional and least environmentally costly. Sunlight creates electricity directly from a thin wafer of semi-conductor materials that release electrons when struck by photons. There are fewer direct risks associated with this type of development from an avian perspective other than birds possibly mistaking the shiny surfaces for water and being drawn to them (as may happen with heliostat or trough mirrors). This is reflected in a much lower mortality rate in reviews of CSP technology impacts vs. PV technology impacts (Walston et al. 2016).

2.2 THE SITE AND GOALS

The Applicant, Kotulo Tsatsi Energy (Pty) Ltd, proposes the construction of a photovoltaic (PV) solar energy facility (known as the Kotulo Tsatsi Energy PV1) located on a site located approximately 70km south-west of the town of Kenhardt and 60 km north east 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 200MW. The facility will be located within the farm Portion 3 of Farm Styns Vley 280. The PV facility is planned

to be located adjacent to the authorised 100MW Kotulo Tsatsi PV2 facility, and within an area previously authorised for CSP project infrastructure. The project site[1] 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 from the R27.

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 3 of Farm Styns Vley 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[2], 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 PV1 will be bid in the Department of Mineral Resources and Energy's (DMRE) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme with the aim of exporting power generated into the national grid. This will aid in the diversification and stabilisation of the country's electricity supply with Kotulo Tsatsi Energy PV1 set to inject up to 200MW$_{AC}$.

A development envelope of ~847-ha was defined through the Scoping evaluation of the site and has now been assessed for the project which includes the PV infrastructure required to generate 200MW of electricity. The infrastructure to be developed within the development envelope will be known as the development footprint and will have an extent of ~810-ha. The infrastructure associated with this PV development includes:

A 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.

An 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:

- 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.

[1] The project site is defined as Portion 3 of Farm Styns Vley 280, which has the extent of ~ 2560ha.

2 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.

Other associated infrastructure:

- facility man camp (including on-site accommodation),
- all water reservoirs and pipelines,
- power block and thermal storage solution.

2.3 Potential Avian Impacts

As with any type of large-scale development, the habitat may be permanently disturbed. Up to 1300-ha is required for the 200 MW solar array, and 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.

2.4 Aims, Methods and Terms of Reference

The following project development areas were surveyed for sensitive avian species during this hot season monitoring:

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

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:

- Coordinated Waterfowl Counts (CWAC),
- 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 north east.

We spent three days on site in 2020 and 25 full days on site in 2014-2015-2016.

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).

2.5 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 coincided with seven years of drought.

2.5.1 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.

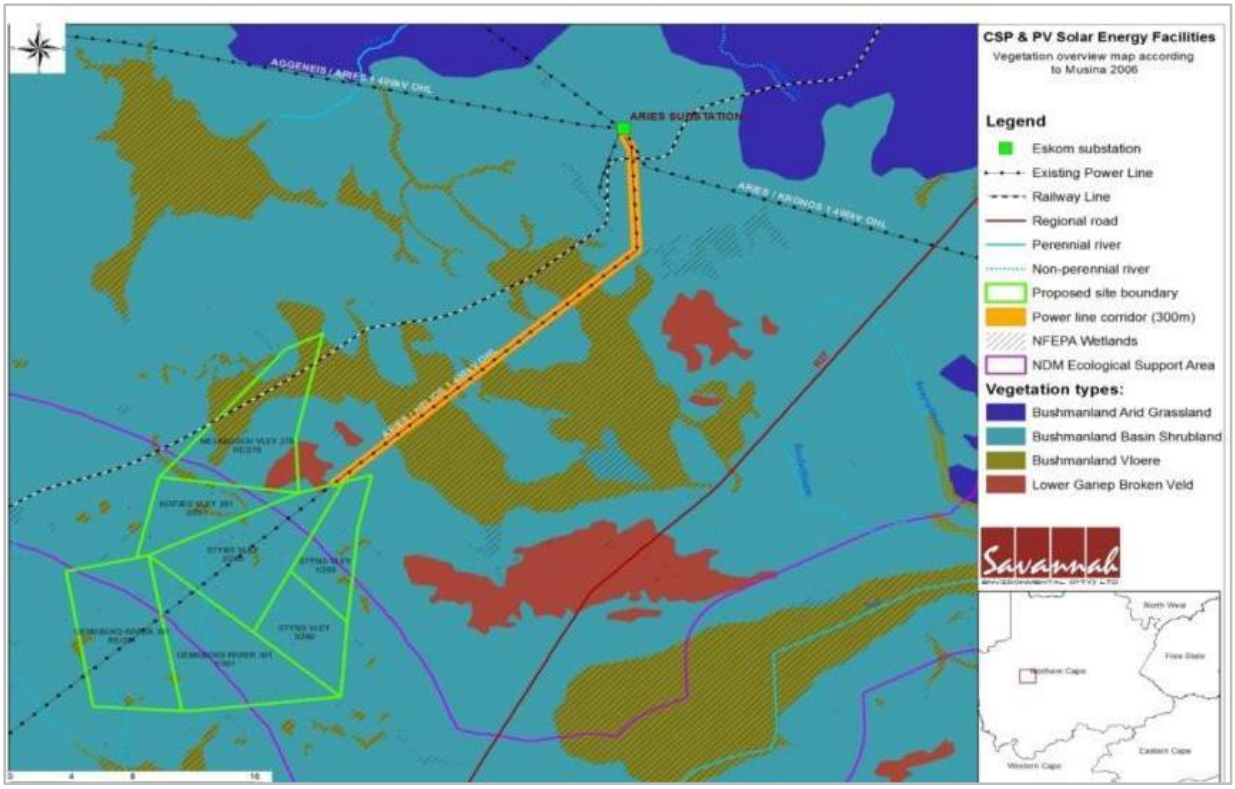

Figure 1: The proposed solar park study area (light green lines) and power line corridor in relation to vegetation types (from Mucina and Rutherford 2006) and the proposed, and existing, power line (orange line). Only the northern and central sections were re-visted in 2020.

2.5.2 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 also, larger dark rocky outcrops that support raptors and wheatears on the kopjes;
- the low shrubland bush (*Rhigozum spp*) which covers much of the lower lying areas, and is especially dense in the dry ephemeral river lines (Photo 1);

Photo 1: The two vegetation types used by the bird community. In the foreground is the more open grassy and rocky plains used by open country bird species such as larks and korhaans. These are interspersed with dry river washes supporting a low but dense stand of *Rhigozum* bushes (inset).

- 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 and when they are (rarely) inundated, may hold wetland species (e.g. flamingos) (photo 2);
- 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 nest on (eagles, chanting goshawks, and kestrels and falcons), while large numbers of smaller birds are attracted to over-flowing farmer's dams (photos 4 and 5). Each of the main habitat types was surveyed independently for bird species richness and bird abundance in the dry and wet seasons.

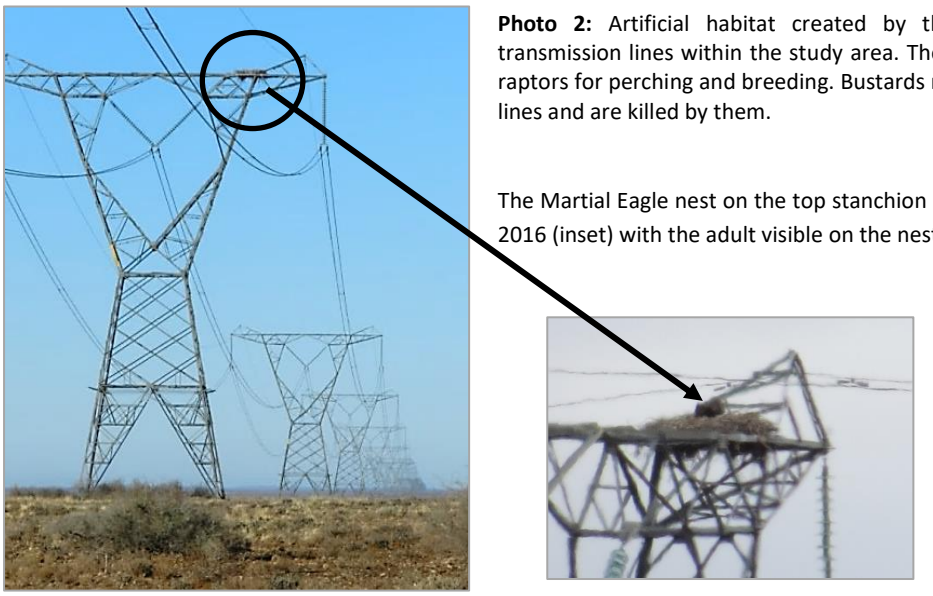

Photo 2: Artificial habitat created by the pylons and transmission lines within the study area. These are used by raptors for perching and breeding. Bustards regularly hit the lines and are killed by them.

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.

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

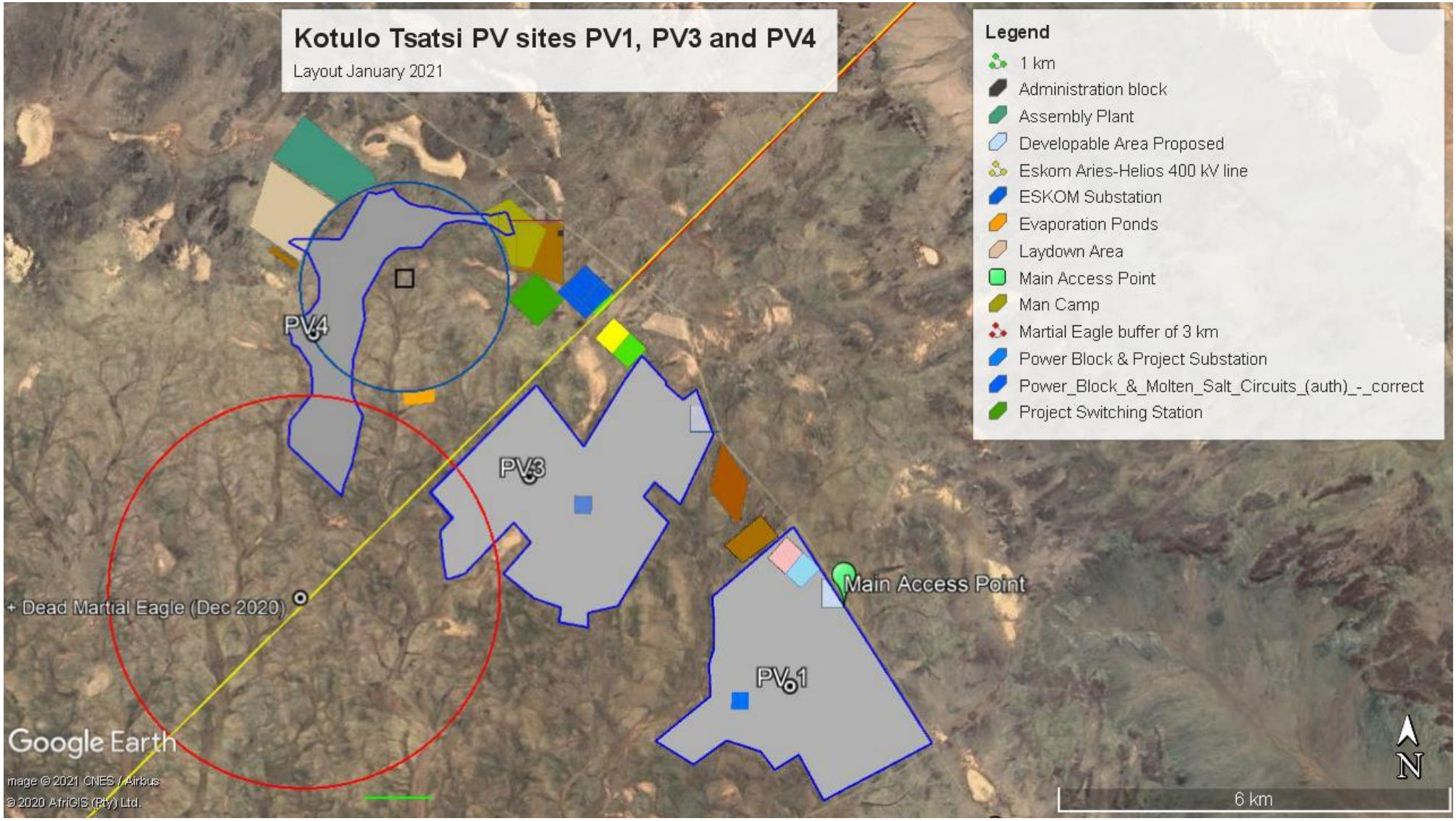

Figure 2: The study site at the Kotulo Tsatsi solar park where the original bird surveys in 2014-2015-2016 were based. The present photo-voltaic arrays areas (= PV1, PV3 and PV 4) were re-surveyed in summer 2020. PV3 and PV4 are no longer being considered for development following these surveys.

2.6 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 21 **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 20 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 against the pylons (of the 400 kV Aries-Helios line) that run across the study areas every 15 seconds for the duration of the flights.

In 2020 our coverage focussed on just the 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 outside the area to the north-east.

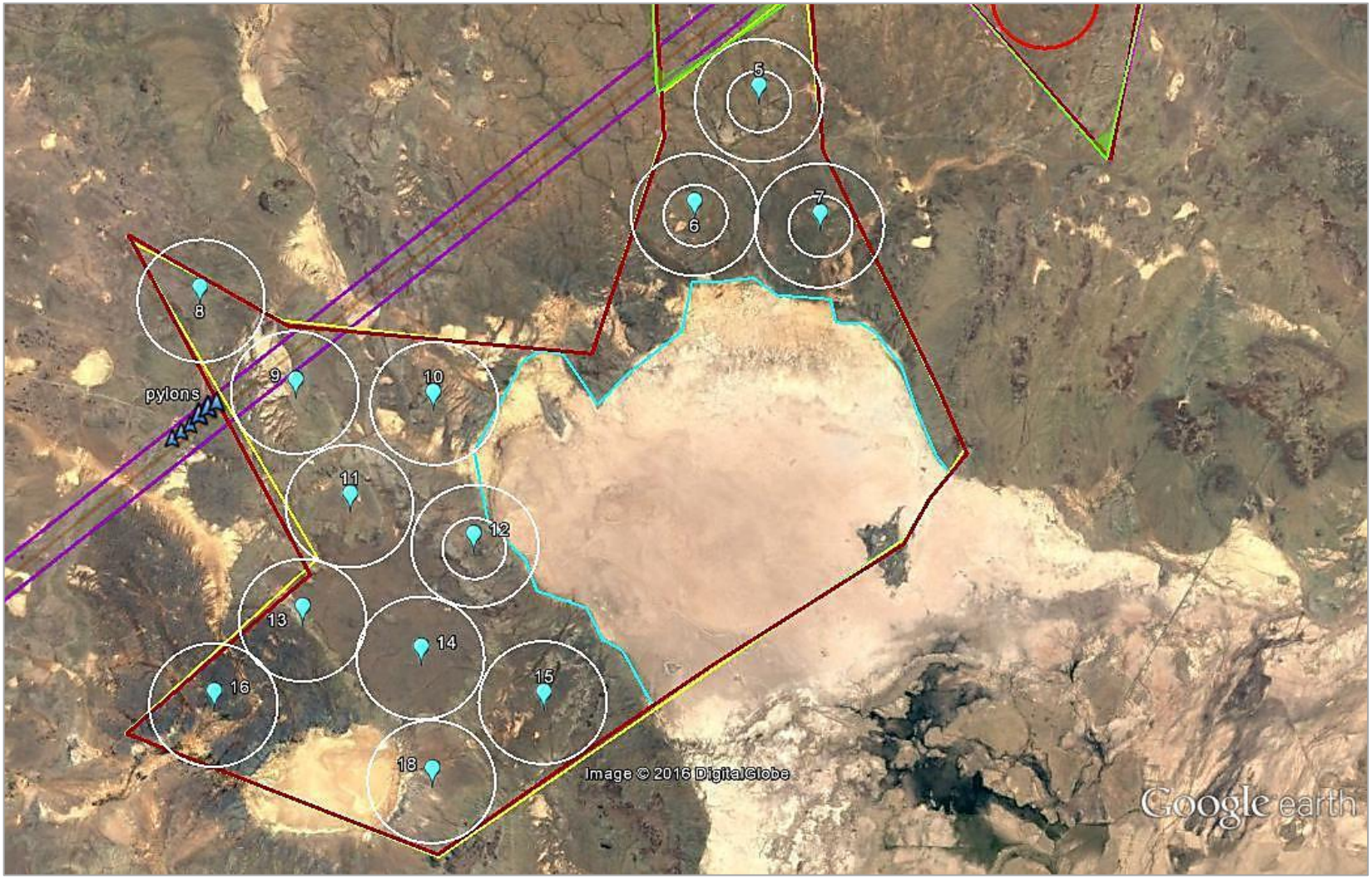

Figure 3: Vantage Points (VPs) and their viewsheds (white circles) of radius 2-km in the southern section of the 2016 study area. The pans were excluded. Overall bird densities and richness values are based largely on these surveys in 2014-2015 and 2016.

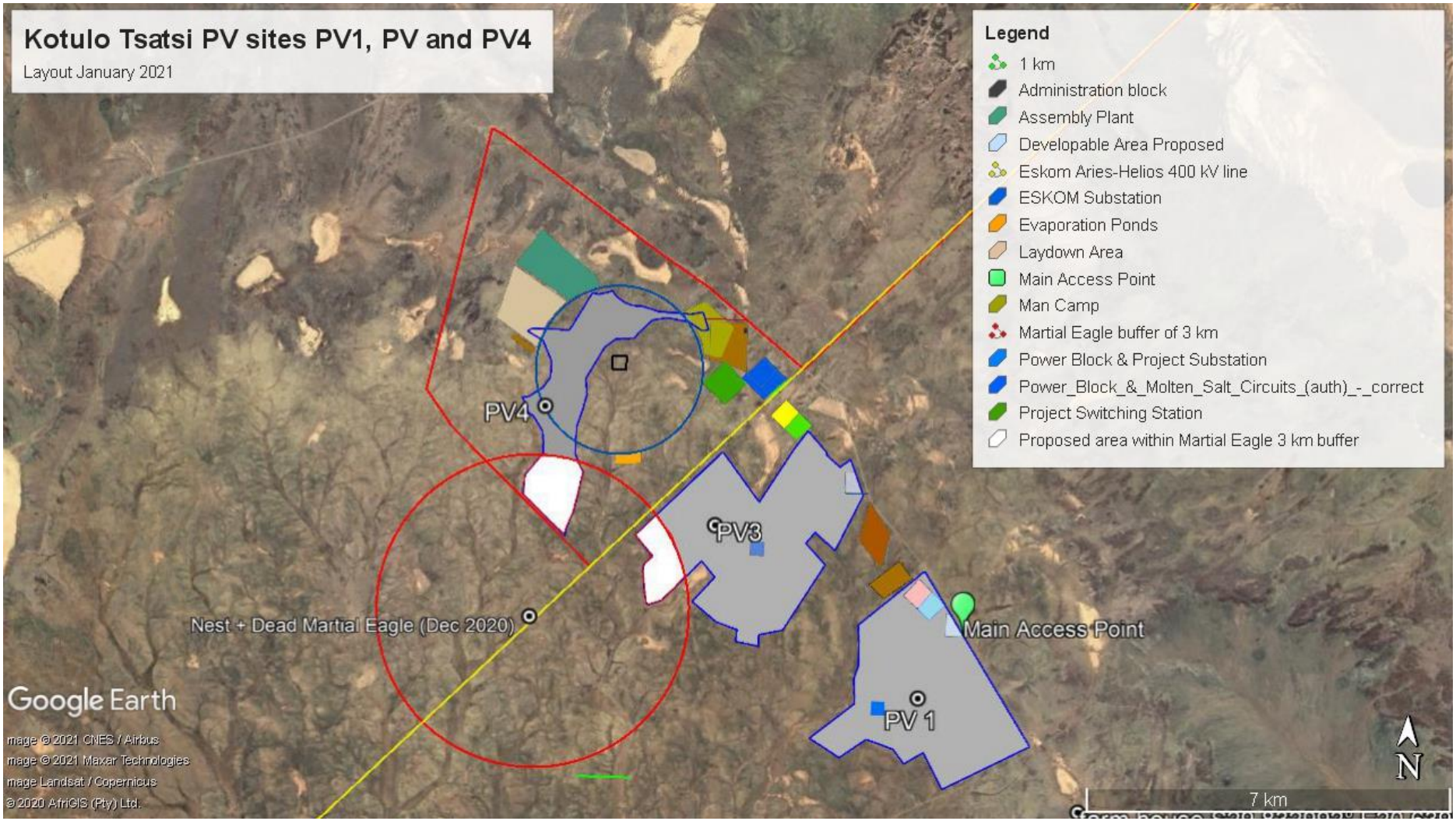

Figure 4: Location of all proposed Photo-voltaic (PV) sites (= grey polygons) in the Kotulo Tsatsi site. The Martial Eagle nest and 3-km buffer (= red circle) is illustrated to indicate the overlap with the previously proposed PV3 and PV4 sites. Some of these areas were surveyed in 2014-2016. Note that PV3 and PV4 are no longer being considered for development after these surveys.

3 RESULTS

3.1 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. Therefore, we relied, instead, on our own records captured over the 12-day period in the wet winter of June 2016 and combined these with data from September 2014 and March 2015 (Simmons & Martins 2015). Data from summer 2020 added only one species to our list – Stark's Lark – a nomadic, arid land endemic.

3.2 AVIAN SPECIES RICHNESS AND RED DATA SPECIES

The expanded site supports a low avian richness of only 71 species (Appendix 1). Almost two thirds of these (62%) are endemic species (Appendix 1).

They include five threatened (red-listed) species (Table 1), and those of most concern are the large nomadic Red Data bustards - Ludwig's *Neotis ludwigii* and Kori Bustard *Ardeotis kori*.

Also, *Endangered* Martial Eagles *Polemaetus bellicosus* twice bred (successfully) on the 400-kV pylons traversing the study area in 2014 and 2016. No breeding was evident in 2015 or 2020

Photo's 5(a) + (b): Red-listed Lanner Falcons (left) and a young Martial (above) were apparent in other sections of the study area.

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

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

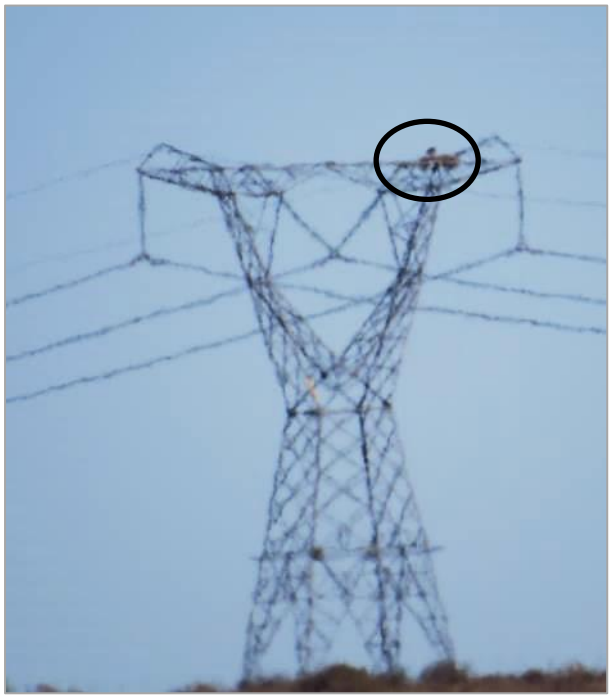

Photo 6: The active Martial Eagle nest within the development area (S 29°48'8.53" E 20°31'51.50"). This nest was active in 2014 and again in 2016, and young birds were recorded in the southern part of the study area (Photo 5(b).

3.3. 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 above) has been active since 2014 at the start of our studies. The pylon is 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 given on the understanding that poisoning of Red Data birds is strictly prohibited for the solar farm to proceed.

Table 1: Red Data bird species and their likelihood of occurrence in the Kotulo Tsatsi expanded site drawn from all (4) site visits June 2016 (12 days), March 2015 (5d), September 2014 (7d), December 2020 (2d).

Common name	Scientific name	Red-list category	Reporting Rate*	Habitat
Kori Bustard	*Ardeotis kori*	Near Threatened	1/26 = 4%	Open grassland and treed savanna
Ludwig's Bustard	*Neotis ludwigi*	Endangered	4/26 = 15%	Open grassland
Martial Eagle	*Polemaetus bellicosus*	Endangered	8/26 = 31%	All habitats including pylon lines
Lanner Falcon	*Falco biarmicus*	Vulnerable	2/26 = 8%	All habitats including pylon lines
Sclater's Lark	*Spizocorys sclateri*	Near Threatened	5/26 = 19%	Open rocky/grassland

* based on number of times observed in the 12 days of surveys in June 2016, 7-day + 5-day + 2-day surveys in September 2014, March 2015, June 2016, Dec 2020 = 26 days.

We recorded only one of the two red-listed larks (**Sclater's Lark: below**) expected in the study area and 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 area surveyed.

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.

3.2.1 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 right) is a *Near Threatened* and range-restricted endemic (Lloyd 2005). Only three birds were recorded in 2016, ~1.5 km south west of the proposed PV 1 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 of 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 over the stony ground for grass seeds.

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

3.2.2 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, and 2.5 birds/hour over the PV1 site. This may be an inflated rate 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 400-kV 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.

3.2.3 Martial Eagles and other priority species in the proposed Kotulo Tsatsi site

Given that the primary concern arising from the first surveys and assessment of the Kotulo Tsatsi site was the presence of an active Martial Eagle nest within 3-4 km of the originally planned CSP tower site, what does the 2020 survey of the PV site tell us?

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 (photo 8).

Photo 8: An inactive Martial Eagle nest just outside the southwest border of the study area, at S29°58'34.91" E20°19'42.63".

A juvenile bird, possibly from this nest was regular recorded in the southern section of the expanded site (Figure 5, Photo 9). 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 predication (penned in January 2021) has since been realised with the arrival of a subadult bird in March 2021 (photo 9). This emphasises the need to persist with the nest buffer around the nest.

Photo 9: Subadult Martial Eagles recorded perch-hunting within 2 km of the poisoned Martial nest March 2021.

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 is still recommended and 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 and PV4 sites, no longer considered for development, both overlapped this 3-km buffer (Figure 4).

These results suggest that Martial Eagles are the only species likely to be negatively influenced by the development of the PV sites.

The high sensitivity area arises from a 3-km buffer placed around the Martial Eagle nest recommended by Birdlife South Africa (Figure 4).

The combination of:

(i) relatively low small-bird species richness; but

(ii) the presence of a previously very active Martial Eagle nest means that the proposed PV area is unlikely to impact the avifauna of the area as long as all development is placed outside the 3-km buffer.

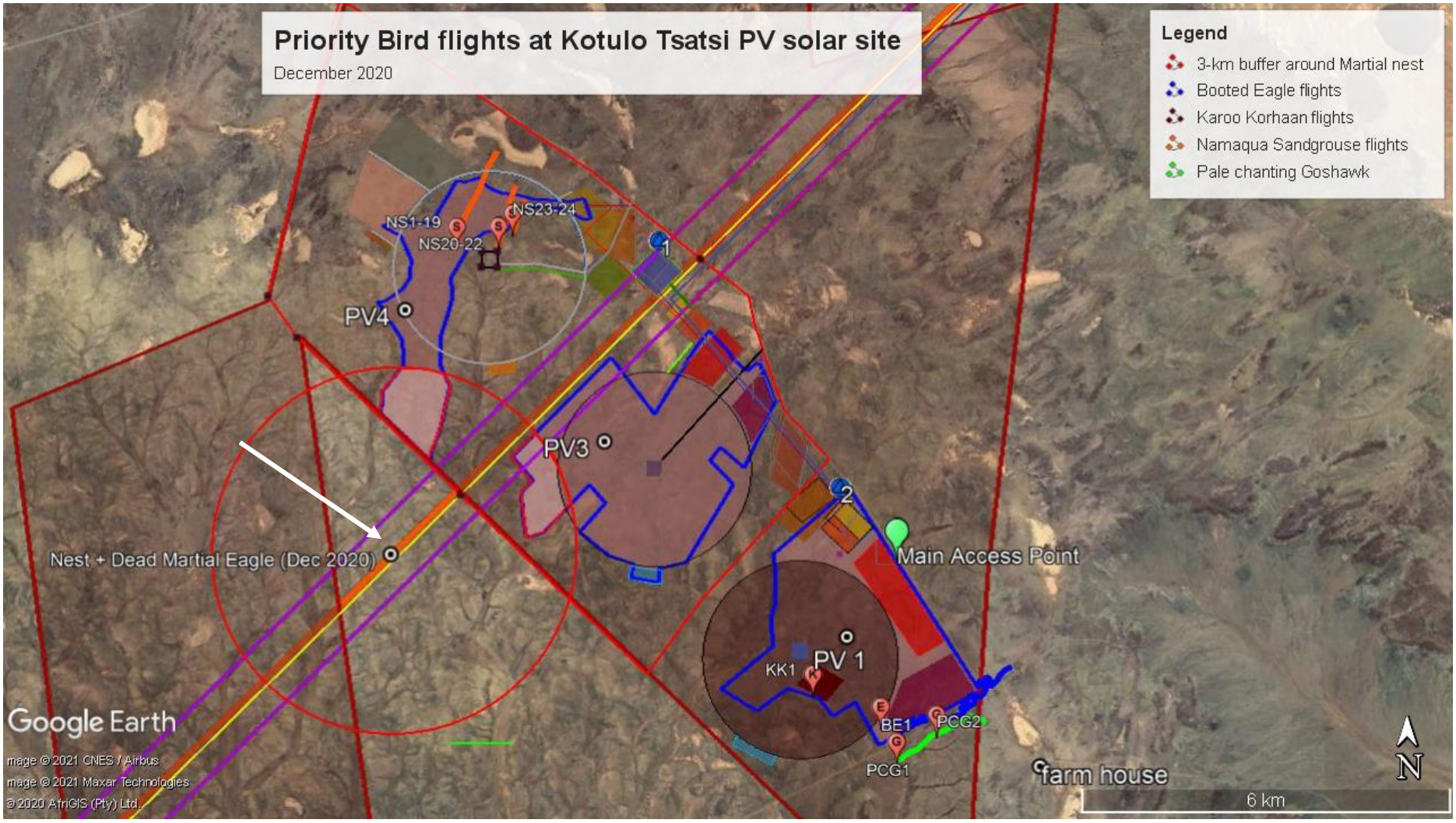

Figure 5: Flights of Priority birds recorded in December 2020 in all the proposed photo-voltaic sites. In the PV1 area Booted Eagle and Pale Chanting Goshawk were recorded. The Passage Rate of the priority birds (excluding the sandgrouse) were medium at 2.5 birds/hour in PV1. Overall, the Passage Rate was low at 0.5 birds/hours. The position of the Martial Eagle nest and probably poisoned carcass are shown (white arrow).

4 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.

	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 PV 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. Thus, we recommended that: (i) the Developer implements 12 months post-construction monitoring to assess the mortality of birds in the solar farm, through direct observation and carcass searches. This will assist in determining where specific mitigation measures are required to be implemented. These recommendations are based on those proposed by Birdlife South Africa for solar farms.

Residual impacts:

After mitigation, direct mortality through collision, or area avoidance, by the species identified above may still occur and further research and mitigation measures must be implemented in the case of Red Data species. This can only be undertaken in conjunction with the systematic monitoring programme suggested.

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.

	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. Thus, we recommended that: (i) the Developer implement 12 months post-construction monitoring to assess the mortality of birds in the solar farm, through direct observation and carcass searches. This will assist in determining where individual specific mitigation measures are required to be implemented.

Residual impacts:

After mitigation, direct mortality through collision, or area avoidance, by the species identified above may still occur and further research and mitigation measures must be implemented in the case of Red Data species. This can only be undertaken in conjunction with the systematic monitoring programme suggested.

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. Some of the proposed mitigations above will require further data regarding what levels of disturbance are acceptable. Thus, we recommended that: (i) the Developer implement 12-months post-construction monitoring to assess the mortality of birds in the solar farm, through direct observation and carcass searches. This will assist in determining where individual specific mitigation measures are required to be implemented.		
Residual impacts: After mitigation, direct mortality, or area avoidance, by the species identified above may still occur and further research and mitigation measures must be implemented in the case of Red Data species. This can only be undertaken in conjunction with the systematic monitoring programme suggested.		

4.1 CUMULATIVE IMPACTS

Cumulative impacts are defined as “impacts that result from incremental changes caused by either past, present or reasonably foreseeable actions together with the project” (Hyder, 1999, in Masden et al. 2010). In the case of renewable energy farms these apply mainly to the cumulative effect on priority birds of all solar and wind farms.

Thus, in this context, cumulative impacts are those that will impact the general avian communities in and around the Kotulo solar PV development in the Karoo. This will happen via the same factors identified here viz: collision, avoidance and displacement. As a starting point, the number of renewable energy developments within a 40-km radius of the site needs to be determined and secondly, to know their impact on avifauna.

Given the general assumption that footprint size and bird impacts are linearly related for solar farms, a starting point in determining cumulative impacts is to determine:

- the number of birds displaced per unit area, by habitat destruction, or disturbed or displaced by human activity;
- the number of birds killed by collision with the solar panels; and
- the number of birds killed by collision with infrastructure leading away from the site.

Four renewable energy developments occur within a 40-km radius of the Kotulo PV 1 site and are currently on record with the Department of Environmental Affairs (Table 5), (Figure 15). The combined energy output of the four “approved” or operational sites (with power data) is projected to be 110MW of solar PV energy and 400 MW of Concentrated Solar Power (Table 7).

Table 5: All renewable energy projects within a 40-km radius of the Kotulo PV 1 site , and their approval status with the DEA. Source: Savannah Environmental updated from http://egis.environment.gov.za/frontpage.aspx?m=27 DEA second quarter 2019.

	Project Title	Distance from KOTULO PV1	Technology	Megawatts	Current Status
1	Kotulo Tsatsi Energy CSP3	3km	Concentrated Solar Power tower	200	Authorised
2	Kotulo Tsatsi Energy CSP3	1km	Concentrated Solar Power tower	200	Authorised
3	Kotulo Tsatsi Energy PV2	1km	Photo-voltaic	100	Authorised
4	Aries PV	39 km	Photo-voltaic	10	Operational
Totals:	2 CSPs 2 PVs (no wind farms)				

We searched for data to populate the Cumulative Impacts table from published and unpublished studies and theses. We sourced data from:

(i) post-construction avian assessment of the 50 MW concentrated solar power tower (CSP) at the Khi site near Upington (van Heerden 2020)
(ii) Visser et al. (2019) for the only solar PV-avian fatality assessment from South Africa

These publications found that:

- In one year 324 fatalities (of 34 species, and two red data species) were recorded at the 50 MW CSP site giving an equivalent fatality estimate **6.48 birds per MW per year** (from data in van Heerden 2020).
- For solar PV sites the equivalent fatality estimates (based on one farm) was **4.5 birds per MW per year** (Visser et al. 2019).

Table 6: All renewable energy projects within a 40-km radius of the Kotulo PV 1 site and their predicted fatality rates based on published rates for solar PV and CSP site

	Project Title	Technology	Megawatts	Avian Fatalities per MW per year	Predicted fatalities per year
1	Kotulo Tsatsi Energy CSP2	Concentrated Solar Power tower	200	6.5	1300
2	Kotulo Tsatsi Energy CSP3	Concentrated Solar Power tower	200	6.5	1300

3	Kotulo Tsatsi Energy PV2	Photo-voltaic	100	4.5	450
4	Aries PV	Photo-voltaic	10	4.5	45
Totals: 2 CSPs 2 PVs (no wind farms) forecast to kill **3095 birds**					

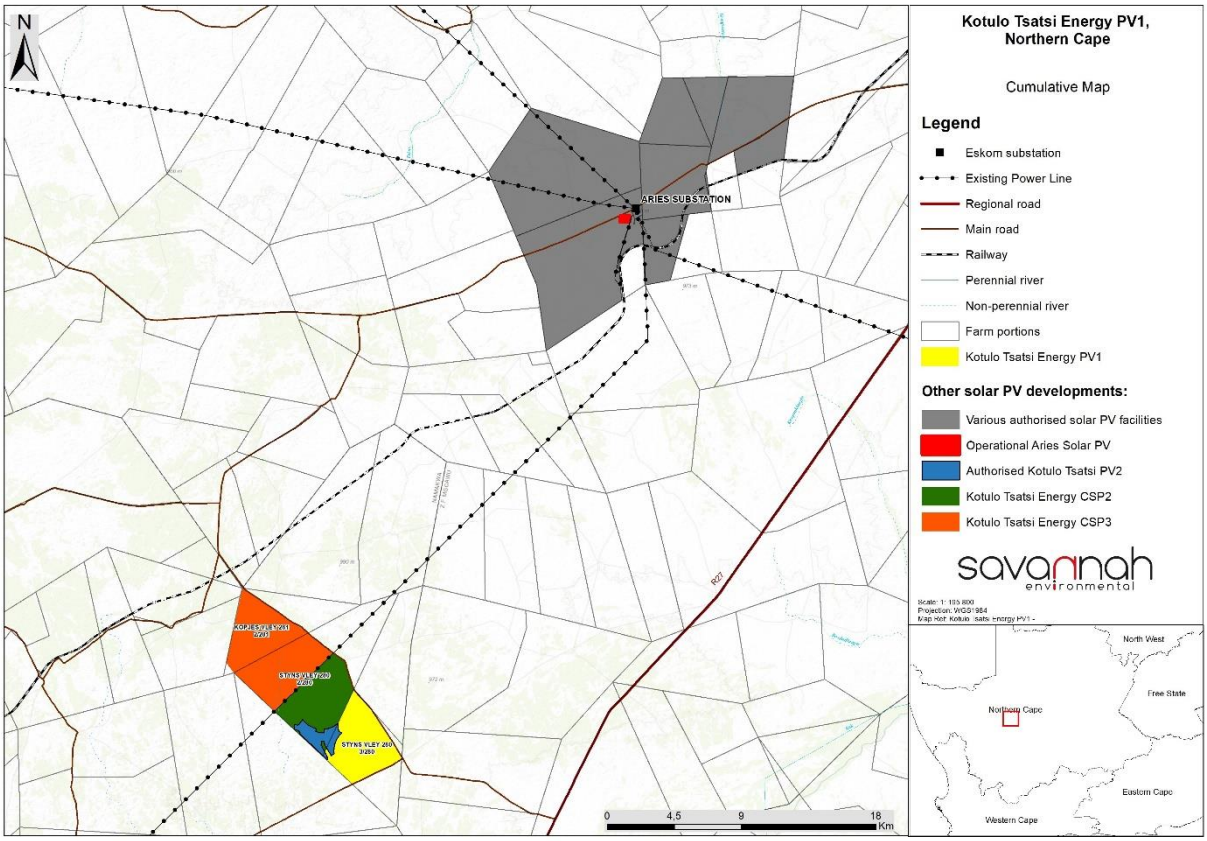

Figure 15: All proposed renewable energy (RE) developments within a 30-km radius of the Kotulo solar PV1 site (near blue polygon, bottom left). Only 4 renewable energy sites are found within that area.

We can estimate the potential cumulative number of fatalities using the known fatalities from the two sources above for all proposed CSP and PV solar farms within 40-km. The CSP towers are expected to be the biggest fatality trap and combined with the solar PV sites there are expected to be 3095 birds killed by all renewable energy facilities combined (Table 6.)

Van Heerden (2020) found 34 species in the fatalities at the Khi CSP tower site, many of which were flocking finches. However, two threatened red data species were also casualties, and these were the Vulnerable Lanner Falcon Falco biarmicus and the Vulnerable Great White Pelican *Pelicanus onocrotalus*.

Important Note: Vultures likely to be attracted to and killed by CSP towers

- Our February 2021 site visit to Kotulo revealed several new red data species, including over 100 vultures of three species, new to the area. These are:
- *Critically Endangered* White-backed Vultures (about 100 birds)

- *Endangered* Lappet-faced Vultures (about 10 birds)
- *Endangered* Cape Vulture (1 bird recorded)
- *Endangered* Martial Eagle (1 subadult re-occupying the territory vacated by the presumed poisoned adult)
- *Vulnerable* Red Lark – several birds calling
- *Vulnerable* Lanner Falcon – a breeding pair
- *Vulnerable* Kori Bustard – recorded in all trips

It is the vultures we are most concerned about. They arrived after our 2014-2016 site visits (within the last 12 months) and are species that look for thermals, or updrafts, to help them gain lift.

Power towers will be a major attraction therefore, as they heat up with the first rays of the sun. The vultures are also likely to be attracted to the towers for perching since they often use cliffs and tall trees.

Since the site was last surveys in 2016, the receiving environment has therefore changed and now accommodates three species of threatened vultures.

There are also no easy mitigations for CSP power towers. We don't know if shutting down the heliostats on demand can be done if a flock of vultures heads for the solar flux. Van Heerden (2020) discusses various mitigations to avoid collisions with vertically orientated heliostats in the standby position but none are known for the operational positions. Other visual and auditory deterrents generally fail because birds show habituation to them over time.

We conclude that We conclude that cumulatively other solar technology (especially CSP) may contribute significantly to vulture morality rates. However, the cumulative contribution from PV developments to avian mortality is likely to remain low.

Table 7: Impact assessment table of the Cumulative impacts for all renewable energy facilities within 40 km of the PV 1 site

Nature: The impact of the Kotulo PV1 solar facility as proposed in the Karoo is expected to be negative and local and arise from disturbance, displacement and collision for birds around the solar PV site.

The direct potential impact of the four other solar sites (Table 6) was gauged using data from van Heerden (2020) and Visser et al. (2016). The PV sites are relatively benign killing only 2.0 $\pm$ 1.3 birds per MW per year (and no red data birds), whereas the CSP towers killed on average 6.5 birds per MW per year (including red data species). This is likely to be larger with vultures in the area (not present in van Heerden's study area)

Using the mortality rate of between 2.0 and 6.5 birds/MW/year we estimate that over 3000 birds will be killed cumulatively per year. This will probably include vultures in the Kotulo area.

The cumulative impact varies from high without mitigation – and we know of no mitigation that will reduce this to lower levels.

	Contribution of proposed Kotulo solar PV site *	**Cumulative Impact of all projects within 40-km**
Extent	Local (1)	Regional (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (3)	High (8)
Probability	likely (3)	Probable (4)
Significance (E+D+M]P	**Low (24)**	**High (60)**
Status (positive/negative)	Negative	Negative
Reversibility	Medium	Low
Loss of resources/species?	Unlikely	Likely
Can impacts be mitigated?	Probably, Yes	Unlikely

Confidence in findings:

Medium: the mortality data within published papers and theses allows for the estimation only of the probable mortality, but they may under-estimate avian mortality rates in Kotulo. Passage Rates and occurrence of Collision-prone species are typically low when annual rainfall is low, and mortality is thus expected to fluctuate with weather conditions and increase at times of low rainfall when vultures are attracted into the area. There are no effective mitigation measures during operation of CSP towers to avoid major raptor/vulture fatalities. Without mitigation measures (i.e. the avoidance of high-use and high-risk areas) the chances of mortality will increase greatly.

Mitigation:

Reducing avian impacts at CSP solar or PV facilities include:

- avoiding all migration routes and major flyways in the placement of such facilities;

- avoid areas where accumulations of red data species occur;
- at the proposed Kotulo PV site mitigate appropriately with PV panels placed slightly apart ;
- to avoid collisions with heliostat mirrors, do not place them vertically but place them at an angle;
- no known effective mitigations for CSP towers in operation, but test audible or visual deterrence to deter birds from approaching close to the tower;
- both must be tested for efficacy if fatalities exceed one Red Data fatality per year at any bank of panels.
- employ radar or video detection of collision-prone birds to monitor the proximity of birds to dissuade them;

5 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 five Red Data species (Ludwig's and Kori Bustards, Martial Eagle, Lanner Falcon and Sclater's Lark) occur within the study site;
- A further 62% (44/71) of all the species recorded were endemics
- Most sections of the Kotulo site held very low species richness and abundance of priority collision-prone birds or Red Data species. 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 authorization must include a clause to highlight and prevent this.
- The PV sites closest (< 3-km) to the existing Martial Eagle nest will need to be re-designed such that any infra-structure falls outside this area recommended by Birdlife SA and as recommended previously (Simmons & Martins 2015). This area is not suitable for any form of development, including roads or power lines, as it will reduce the foraging area around the nest, and may force the pair to move away.

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 PV1 facility should not be developed. This should be undertaken in conjunction with an environmental management plan to systematically survey the facility for birds and fatalities for 12 months as detailed below.

6 ENVIRONMENTAL MANAGEMENT PROGRAMME

Given the possible impact of the proposed Kotulo Solar farm development, any impacts on avifaunal species requires systematic monitoring at 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 turbines.

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 12 months;
- 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 given the increasing number of solar and wind farms planned for South Africa.

6.1 MANAGEMENT INTERVENTIONS

Where avian fatalities are found to occur to:

(i) Red Data species; or
(ii) at unacceptably high levels, to priority species (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, or wilful destruction (i.e. poisoning) of the eagles (or other Red Data raptors on site).

Thus, experiments, for example, with bird deterrent techniques should be undertaken without delay to reduce fatality rates. The results of these experiments should also be publicised so that other solar farms, with similar issues, can be informed.

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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Revised: 24 July 2016 and 20 January 2021, 8 March 2021

8 APPENDICES

8.1 Appendix 1

The 72 bird species recorded in the Kotulo Tsatsi Solar Park 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 survey). The five **Red Data** species, and 44 **endemic** and **near-endemic** species are colour-coded.

Note 4 red data species were added to this list in the February 2021 site visit: Cape Vulture, White-backed Vulture, Lappet-faced Vulture and Red Lark

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		√	√	√
Yellow canary		√	√	√
Yellow-bellied eremomela		√	√	
TOTALS (72 species)	**12 species**	**54 species**	**44 species**	**48 species**

8.2 Appendix 2: Passage rates and flight heights of collision-prone birds through the expanded Kotulo Tsatsi 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	10-10-10-20-20-20-20-20-20-20-20-20-20-20
	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	60-60-70-70-80-90-90-90-100-100-150-150-150-150-150-150-200-200-200-200-200-200-200-10-40-40-40-50-60-60-60-80-80-100-100
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	50-50-50-60-60-60-50-50-60-60-60-60-50-50-50-50-50-50-60-60-60-60-70-70-70-70-70-70-70-70-80-80-80-80
	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: SclatersLark/ 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)