Avian Basic Impact Assessment of the Skuitdrift Solar Energy Facility, near Augrabies, Northern Cape: 2016

Prepared for: Savannah Environmental (PTY) Ltd

On behalf of: SCUITDRIFT SOLAR PROJECT (PTY) Ltd

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1 SUMMARY

This study reports on the avifauna likely to occur on the proposed Scuitdrift Solar Project (Pty) Ltd's PV project located on the farm 426 "Skuitdrift" south of the Orange River Augrabies, Northern Cape. Its specific objective is to determine the species of collision-prone birds likely to occur on the proposed photo-voltaic solar farm at Skuitdrift and possible impacts and mitigations. The broader study area assessed is approximately 45 ha whilst the development footprint intended for the proposed construction of the PV Facility is ~19 ha. The development footprint is being subjected to a basic assessment process. The possible impacts are: (i) collision with the PV facility itself from birds perceiving the panels as open water – the "Lake Effect"; (ii) disturbance by construction and maintenance activities, (iii) displacement through habitat removal/destruction and construction work, and (iv) direct collision with the power line network.

The Skuitdrift farm is an open arid Nama Karoo landscape, dotted with small inselbergs dominated by *Stipagrostis* grasses, and occasional *Acacia* trees in habitat classified as Blouputs Karooid thornveld. Recent bird atlas data reveals only 39 avian species recorded in or around Skuitdrift farm of which 2 were collision-prone (African Fish-Eagle *Haliaetus vocifer,* and the *Vulnerable* Verreaux's Eagle *Aquila verreauxii).* However, older bird atlas data indicates two other red-data species are also likely on site: the collision-prone Ludwig's Bustard *Neotis ludwigii* and Sclater's Lark *Spizocorys sclateri*.

To mitigate the possible problems of impacts with the solar panels, we recommend that: (i) bird scaring techniques including rotating prisms and experimental use of Torri lines to be used *if* birds are found to impact the PV panels; (ii) all power lines – *present and future* – must be marked with bird diverters to reduce the possible impact of the bustard species and bird-friendly power pole configuration to be used to avoid electrocutions of raptors; (iii) any Sociable Weaver nests built on the PV infra-structure should be removed as they are started. **On present evidence, this small site is likely to be of low risk to the birds present.**

If these mitigation measures are followed to minimize any impacts to the threatened species highlighted here, **our preliminary recommendation is that this solar development can go ahead, with a low level post-construction monitoring protocol in place as it does so.**

1.1 Consultant's declaration of Independence

Birds & Bats Unlimited are independent consultants to Savannah Environmental. They have no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work.

1.2 Qualifications of Specialist Consultant

Birds & Bats Unlimited Environmental Consultants (http://www.birds-and-bats-unlimited.com/), were approached by Savannah Environmental (Pty) Ltd to undertake the specialist avifaunal assessment for the pre-construction phase of the 10 MW photovoltaic (PV) solar energy facility proposed by Scuitdrift Solar Project (Pty) Ltd, northwest of Augrabies, Northern Cape. Dr Rob Simmons is an ornithologist, with 30 years' experience in avian research and impact assessment work. He has published over 100 peer-reviewed papers and 2 books, (see www.fitzpatrick.uct.ac.za/docs/robert.html for details). More than fifty avian impact assessments have been undertaken throughout Namibia and South Africa. He also undertakes long-term research on threatened species (raptors, flamingos and terns) and their predators (cats) at the FitzPatrick Institute, UCT.
Marlei Martins, co-director of Birds & Bats Unlimited, has over 5 years' consultancy experience in avian wind and solar farm impacts as well as environmental issues, and has been employed by several other consultancy companies all over South Africa because of her expertise in this field. She has published on her observations including a new raptor to South Africa https://www.linkedin.com/in/marlei-martins-a0374a27?trk=nav_responsive_tab_profile

2 BACKGROUND

2.1 Photo-voltaic solar power

Renewable energy is generally provided by water, wind or solar power and has the potential to supply the human population with unlimited non-polluting power. As a major greenhouse gas emitter South Africa is signatory of the Kyoto Protocol and the 2015 Paris Agreement and is committed to switching to green energy sources that emit no greenhouse gases or other pollutants. Southern Africa's Northern Cape region 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/PV.pdf. This makes it the ideal hub for solar projects that capture the sun's energy to provide an energy-hungry South Africa with the power it requires.

Three options are generally employed to capture solar energy: (i) Concentrated Solar Plants (CSPs) using heliostats that focus the sun's energy onto a central tower that heats a salt or oil liquid that drives a turbine (CSP tower); (ii) a CSP using trough technology with smaller parabolic mirrors that capture and focus the energy onto a central pipe that also employs a heat-transfer liquid to drive a turbine; or (iii) the preferred option by Scuitdrift Solar Project (Pty) Ltd that captures the sunlight using conventional **Photovoltaic (PV) technology**. This technology does not use concentrated heat but uses sunlight directly to create electricity. There are fewer direct risks associated with this from an avian perspective other than birds possibly perceiving the shiny mirror-surfaces for water, and being drawn to them (the so-called "Lake Effect" – Kagan et al. 2014). This latter technology is the only one assessed in this report for the Scuitdrift Solar Project (Pty) Ltd solar development.

The Skuitdrift Solar Energy Facility comprises an area of 45 ha (the broader study area) of which the development footprint of ~19 ha will be developed for the solar farm itself. Previous faunal and floral assessments (Todd 2012) have identified sensitive areas on the Skuitdrift farm, and the location of the 10MW solar site is best located in the south-eastern section of the farm (Figure 1). The development comprises:

- Photovoltaic panels: A series of single-axis tracker Photovoltaic (PV) solar arrays, which will cover an approximate footprint of 19 hectares.
- Associated infrastructure, with an approximate footprint of 2ha, will include to the following:
- Auxiliary buildings:

- administration / security offices (approximately 10m x 10m);
- ablution & workshop (approximately 20m x 20m); and
- storage area (approximately 20m x 10m).

- Inverter stations (built within transporter containers, 25m² in size);

- An on-site substation (including a transformer to allow the generated power to be connected to Eskom's electricity grid);
- A short overhead power line to distribute the generated electricity from the on-site substation to the existing Schuitdrift Eskom substation;
- An internal electrical reticulation network (underground cables);
- An access road aligned the existing farm access (& the required re-alignment of the farm road following the parameter fence to the north of the facility to link with and align along the existing farm road to the north of the 132kV Eskom transmission line);
- An internal road / track network;
- 10klitre rainwater tanks; and
- Perimeter fencing around the solar facility.

2.2 POTENTIAL AVIAN IMPACTS

As with any type of large scale development, habitat will be permanently disturbed, displacing the resident and migrant species. The development footprint of ~19 ha within the broader study area of 45 ha is proposed for the operation of the 10 MW PV facility, and this will reduce habitat availability for birds where construction takes place. It is a simple exercise to calculate the numbers potentially lost from estimates of birds per unit area. These are likely to be minimal considerations given that smaller birds generally occur at low densities in arid regions, breed faster than larger species, 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:

(i) displacement of nationally important species from their habitats;
(ii) loss of habitats for such species;
(iii) disturbance during construction, and operation of the facility;
(iv) collision with the photovoltaic panels (mistaking them for water bodies); or
(v) collision with associated infra-structure.

The nature and magnitude of impacts to birds from solar facilities is related to four factors: (i) location, (ii) size of the facility, (iii) the technology involved (i.e. Photovoltaic *vs* CSP trough *vs* CSP tower), and (iv) the collision-prone avian species in the area. Thus, the location in relation to avian flyways, wetlands, roost sites, nest sites and the habitat removed in the footprint may have an important effect on the impact to birds of the solar site. The size of the footprint will be directly related to the negative impact on birds, thus habitat of range-restricted or collision-prone species around the site must be determined with accuracy.

Avian fatalities at PV sites have been summarised from those investigated in the USA by two recent reports (Kagan et al. 2014, Walston et al. 2015). Of the three types of solar energy capture (Photo-voltaic, CSP troughs and CSP towers) the Photo-voltaic sites recorded medium levels of avian fatalities relative to the CSP trough and CSP towers in one review (Kagan et al. 2014).

Given that impact trauma was the most common cause of mortality at two of the three solar sites investigated, minimising the reasons for the cause of that trauma are paramount. Biologists believe that birds mistake the panels in the solar arrays for a body of water (the Lake effect – Kagan et al. 2014) and suffer physical trauma when they attempt to land on it. Wetland species, are often the main victims of this sort of impact.

In a comprehensive review of all bird fatalities at large scale operational solar plants across the world (mainly the USA but one in Israel) Walston et al. (2015) found that few solar plants had undertaken systematic monitoring of bird fatalities (Table 1).

Table 1. Summary of all avian fatality data from large-scale solar facilities from the USA (after Walston et al. 2015). The results for PV technology are given in **bold**.

Project Name	Avian Fatality Data – systematic or incidental?	Survey Period	Incidental Fatalities	Systematic Fatalities (Unadjusted)**
Mohave Solar (CSP trough)	Yes – Incidental	Aug. 2013–March 2014	14	None collected
Genesis (CSP trough)	Yes – Incidental	Jan. 2012–May 2014	183	None collected
California Valley Solar Ranch (PV)	Yes – Systematic	Aug. 2012–Aug. 2013	Not Available	368
Desert Sunlight (PV)	Yes – Incidental	Sept. 2011–March 2014	154	None collected
Topaz Solar Farm (PV)	Yes – Incidental and Systematic	Jan. 2013 –Jan. 2014	19	41
California Solar One (CSP tower)	Yes – Systematic	May 1982–May 1983 (40visits)	Not Available	70 (114 birds)
Crescent Dunes (CSP tower)	Yes - systematic	Under construction	Not available	Not available
Ivanpah (CSP Tower)	Yes – Systematic	Oct. 2013–March 2014	159	376 (includes 7 injured birds)

*Causes of death include: solar flux, impact trauma, predation, electrocution and emaciation
** Unadjusted refers to the fact that numbers are not adjusted for biases resulting from predator removal or human observer bias

In summarising the avian species fatalities, Walston et al. (2015) noted:

- most birds were small passerines (40%-63% at 7 solar farms);
- Kagan et al. (2014) also found 20 of the 30 birds identified at the Genesis (trough) site in California were smaller passerine birds or swallows;
- Waterbirds such as grebes, herons and gulls were also killed suggesting these species may be attracted by the *perceived* availability of water or the lake effect (Kagan et al. 2014);
- waterbirds averaged 11% of the fatalities at solar farms, but reached 46% of all fatalities at one solar PV facility (Desert Sunlight) in California;
- too few fatalities at different types of facilities occur to test the Lake Effect of Kagan et al. (2014) (i.e. wetland and nomadic birds are attracted to the mirrors because they mistake them for open water); and
- there was a clear trend at all solar facilities for resident species to dominate the fatalities. For example at the Genesis facility 64% of the fatalities were resident species, meaning that 36% were migrant, the highest among those reviewed.

Tabulating fatalities of birds at solar sites is not enough to determine the impact to birds of conservation significance. They must be collected systematically and account for human error in (not) finding carcasses, and the rate of carcass removal by scavengers.

2.2.1 Habitat loss – Destruction, Disturbance and Displacement

The construction and maintenance of PV technology causes mainly permanent habitat destruction and disturbance. Maintenance activities are likely to cause some disturbance to birds in the general surrounds, and especially the shy or ground-nesting species resident in the area. Mitigation of such effects requires that best-practice principles be rigorously applied – i.e. sites are selected to avoid the destruction of key habitats for red data species, and the disturbance and construction and the final footprint size, for key species, should all be kept to a minimum. Construction time for each facility is unknown.

From the habitat destruction point of view, it is a simple exercise to calculate the numbers of birds potentially lost from a 45 ha site with PV footprint of 20 ha, and density estimates of important species or individuals per unit area of habitat. These are likely to be minimal considerations given that smaller birds are generally more common than larger birds, breed faster, and are less likely to suffer high population reduction. However, where range-restricted species occur on sites ear-marked for development this can have a larger impact.

Our assessment of recent bird atlas data uncovered 38 species that could be displaced by habitat removal (Appendix1).

Because photo-voltaic facilities are relatively new in South Africa, and there are no *published* studies of avian mortalities here and few in other parts of the world (Table 1), this section is necessarily brief and is in need of further study in southern Africa.

2.2.2 Collision – with reticulation lines and PV panels

Several bird species are well known to collide with overhead power lines, fences, towers and other aerial objects (Jenkins et al. 2010). These have been tabulated and the reasons for their propensity for collision investigated (Martin and Shaw 2010). The critical factors were then extrapolated to all South African species based on wing loading, aerial flights, nocturnal activity, red-data status (Taylor et al. 2015) and several other contributing factors (BARESG 2014). We have used Birdlife South Africa's list and taken the top 100 species as the most likely to collide with power lines. The most collision-prone species are generally the larger scavenging species such as vultures, but also raptors and bustard species. It is somewhat surprising that birds also collide with ground-based structures and, as mentioned above (Table 1), these include passerine and wetland birds in collision with photo-voltaic panels in the USA. While we do not know which species will be similarly prone in South Africa, they are likely to be a similar suite of birds (i.e. wetland and aerial species) and it is these that should be assessed during a wet-season pre-construction survey.

2.3 Study methods

2.3.1 Aims, methods and Terms of Reference

The primary aims of the avian pre-construction monitoring at the PV site proposed by Scuitdrift Solar Project (Pty) Ltd at Skuitdrift farm located 50km northwest of Augrabies, Northern Cape are to:

1. Determine the densities of birds regularly present, or resident, within the impact area of the PVs before the construction phase;
2. Document the patterns and movements of birds in the vicinity of the proposed PVs before their construction;

3. Monitor the patterns and movements of birds in the PV areas in relation to time of day, and over a wet and dry season when bird numbers and species richness may change;
4. Establish a pre-impact baseline for all Red data and endemic bird species including all breeding birds within the study area;
5. Quantify the impacts before and after mitigation;
6. Inform final design, construction and management strategy of development with a view to mitigating potential impacts.

We consulted several published sources of bird data including the Coordinated Waterfowl Counts (CWAC), Coordinated Avifaunal Road Count (CAR) of the Animal Demography Unit, University of Cape Town, (www.adu.car.co.za) the Important Bird Areas Programme (IBA) of Birdlife South Africa (Barnes 1998), and the Southern African Bird Atlas Programme (SABAP) to determine if previous data was available for this area. Because of the remoteness of the site little SABAP2 data http://sabap2.adu.org.za/index.php were available for this region.

We therefore also used older SABAP1 records from 1987-1992 (Harrison et al. 1997) to augment the more recent SABAP2 data;

The short notice for this Basic Report however, disallowed a site visit to record bird presence and activity on site in the PV area. Such a visit may be conducted before construction activities can commence, as suggested by the draft BARESG avian monitoring guidelines for solar farms (Jenkins et al. 2015).

Some *ad hoc* data were present in a site visit in February 2012 by Todd (2012), in which he noted: "… *bird species that were observed to be common at the site include Sociable Weaver* Philetairus socius*, Dusky Sunbird* Cinnyris fuscus*, Capped Wheatear* Oenanthe pileata *and Verreaux's Eagle* Aquila verreauxii*. Verreaux's Eagle is potentially impacted by habitat loss as it may avoid the vicinity of the development and is also vulnerable to electrocution with transmission lines. However, the extent of the development is very small in relation to the home range of this species and the impact on this species is likely to be negligible. Other bird species vulnerable to electrocution which probably occur in the area include Martial Eagle, and both the Spotted and Cape Eagle-Owl.*

2.3.2 Limitations and assumptions

Inaccuracies in the above sources of information can limit or bias this study in the following ways:

- The SABAP1 data for this area is over 20 years old (Harrison et al. 1997), so we have also used the newer SABAP 2 data set. This has a higher spatial resolution and is up to date (2007 to 2016). However, only 13 full protocol cards were available for the four pentads that cover the Skuitdrift farm and proposed solar park;
- Use of the older SABAP 1 data set include species that are found in an area 9-fold larger area (i.e. in a quarter-degree square) than found in a smaller pentad of 9 km x 8 km, artificially inflating the species totals given;
- We operate in a near complete vacuum of data on the effects of solar farms on Southern African avifauna. This arises mainly through the recent advent of solar farms in South Africa (13 are in operation in 2016 and none have released data on what species are being killed or displaced).

2.4 STUDY AREA

The 45 ha broader study area with a 25 ha development footprint for the PV solar park to be developed by Scuitdrift Solar Project (Pty) Ltd is located on the remaining extent of farm 426 Skuitdrift, approximately 50 km north west of Augrabies in the Northern Cape. The farm Skuitdrift, is centred on S 28° 35' 20.3″ E19° 44' 51.8″.

2.4.1 Vegetation of the study area

The study area habitat is classified as Blouputs Karooid Thornveld (Mucina and Rutherford 2006). The open area is dominated by *Stipagrostis* grasses interspersed with Camelthorn trees (A*cacia erioloba*), *A. melifera* and *Boscia* trees in the dry river lines. A sparse covering of *Rhigozum* shrubs indicates grazing pressure by livestock (sheep and goats) also occur (Todd 2012). Grass cover is highly variable depending on rain and grazing pressure. The study area experiences summer-autumn rainfall averaging 62 mm per annum, with most falling in March but with high variability. Average midday temperatures vary from 20°C in winter to 33oC in summer while average night-time temperature vary from 3°C in July to 17°C in summer (Mucina and Rutherford 2006).

2.4.2 Avian microhabitats

Avian habitat in the region comprise mainly open grassland habitat that supports bustard, lark and pipit species, while the river washes support Camelthorn and *Boscia foetidae* that are used by perching raptors and passerine birds. Two studies in the

Kalahari have indicated that taller trees add significantly to the avian species richness of an area (because of the diverse niches they offer), and their removal, therefore, can reduce species richness (Seymour and Simmons 2008, Seymour and Dean 2010). Mature Camelthorn trees are also favoured by Sociable Weavers in which to construct their nests and this species occurred on site (Todd 2012). Artificial habitats are provided by land owners in the form of windmills, farm reservoirs and the power line and pylons that bisect the site. Pylons provide perch sites for raptors, and nest sites for Sociable Weavers. No pans are found in the study area.

3 RESULTS

3.1 PRESENCE AND MOVEMENTS OF SENSITIVE SPECIES

Large sensitive species are defined as those species that are known, or expected, to be at risk from the PV infrastructure, or attracted by the reflective surfaces of the PV panels. These species are typically threatened red data species that occur in the study areas (e.g. bustards and raptors), but could include wetland species attracted by the panels. Some data were available from bird atlas cards of Southern African Bird Atlas Projects (SABAP), website (http://sabap2.adu.org.za/index.php).

3.2 AVIAN SPECIES RICHNESS AND RED DATA SPECIES

A total of only 39 bird species have been recorded around the Skuitdrift farm from recent bird atlas data (present on 13 cards). Two of these were collision-prone species, the Verreaux's Eagle *Aquila verreauxii* and African Fish-Eagle *Haliaetus vocifer*. From the larger but older data set from SABAP1 a total of 124 species have been recorded, from the same area, comprising several wetland species that are unlikely to occur regularly over the proposed PV site 11.7 km from the Orange River.

The greater species richness was also reflected in the greater number of collision-prone species numbering 12 species of which 3 were red data species (Table 2).

Table 2. Red-listed (**in red**) and collision-prone bird species (**in bold**) likely to occur over the proposed PV Scuitdrift Solar Project (Pty) Ltd development at Skuitdrift farm drawn from 13 recent (SABAP2) atlas cards and

Common name	Scientific name	Red-list status	Reporting Rate[a]	Collision Rank[b]	Disturbance
Verreaux's Eagle	*Aquila verreauxii*	Vulnerable	15.4%	2	High
Ludwig's Bustard	*Neotis ludwigii*	Endangered	16.7%	8	High

Common name	Scientific name	Red-list status	Reporting Rate[a]	Collision Rank[b]	Disturbance
African Fish-Eagle	*Haliaetus vocifer*	-	15.4%	23	medium
Jackal Buzzard	*Buteo rufofuscus*	-	22.2%	44	low
Sclater's Lark	*Spizocorys sclateri*	Near threatened	(16-20%)[c]	50	Low
Booted Eagle	*Aquila pennatus*	-	11.1%	56	low
White Stork	*Ciconia ciconia*	-	11.1%	58	Low
Karoo Korhaan	*Eupodotis vigorsii*	-	13.3%	78	Low
Northern Black Korhaan	*Afrotis afroides*	-	26.7%	89	Low
Greater Kestrel	*Falco rupicoloides*	-	13.0%	94	Low
Black-shouldered Kite	*Elanus caeruleus*	-	22.2%	96	low
Spotted Eagle Owl	*Bubo africanus*	-	20.0%	100	low

[a]Reporting rate is a measure of the likelihood of occurrence, as recorded in the atlas period.

[b] Collision rank derived from the BAWESG 2014 guidelines. Smaller numbers denote more collision-prone.

[c] Reporting rates in adjacent pentads to south-east

The collision-prone species were dominated by raptors, including three eagles. The highly collision-prone Ludwig's Bustard *Neotis ludwigii* was also present. All 12 species occurred at a reporting rate above 10% which means they are all likely to be regular on the site (Table 2).

The Sclater's Lark is a Near-Threatened species that is endemic to South Africa and Namibia (Taylor et al. 2015). While it was not recorded in the pentads covering the Skuitdrift farm, it is an elusive species recorded in the pentad immediately south-east of the farm and thus very likely to occur in the proposed site.

Photo 1: Sclater's Lark is an elusive red data species likely to be found on site.

The three red data species (an eagle, a bustard and a lark) are all likely to occur irregularly as ideal habitat is present in the form of open grassy plains for the Sclater's

Lark *Spizocorys sclateri* and Ludwig's Bustard, and the presence of small koppies across the landscape is ideal for Verreaux's Eagles (and Jackal Buzzards) for perching and as refugia for their main hyrax prey (Simmons 2005).

In summary, a total of **12 collision-prone species** potentially occur on the site, **of which three are red-listed.**

Seasonal differences in the composition of the bird community are expected to be large in an arid environment (Dean 2004). This arises for several reasons for different groups of birds: wetland species (e.g. geese, stilts and crakes) are attracted by the sudden appearance of wetlands that were not available prior to pans flooding. They follow rain fronts to find such ephemeral wetlands (Simmons et al. 1999, Henry et al. 2016). Other birds, including sandgrouse, will use pans that fill with water. For other nomadic species (e.g. bustards, larks) they are attracted to high rainfall areas because of the flush of insects that follow rains (Allan and Osborne 2005). Thus, an arid area such as this is very much a "boom or bust" landscape and one dry season visit can give a biased impression relative to the explosion in biodiversity that can follow high rainfall events (Lloyd 1999). A wet-season site visit to measure the avian diversity after rains is thus important to verify and measure the density of the species found in the bird atlas data.

The only other species of note that may create some issues for the developers is the Sociable Weaver *Philetairus soceus* that occurs on site. They typically target mature trees but they have learned to build on metal pylons. They may try to nest on the structures supporting the PV panels, and nests would have to be cleared on a regular basis.

In summary, 12 collision-prone species have been recorded over the site, but the small size of the PV site is likely to cause little disruption to the resident avifauna.

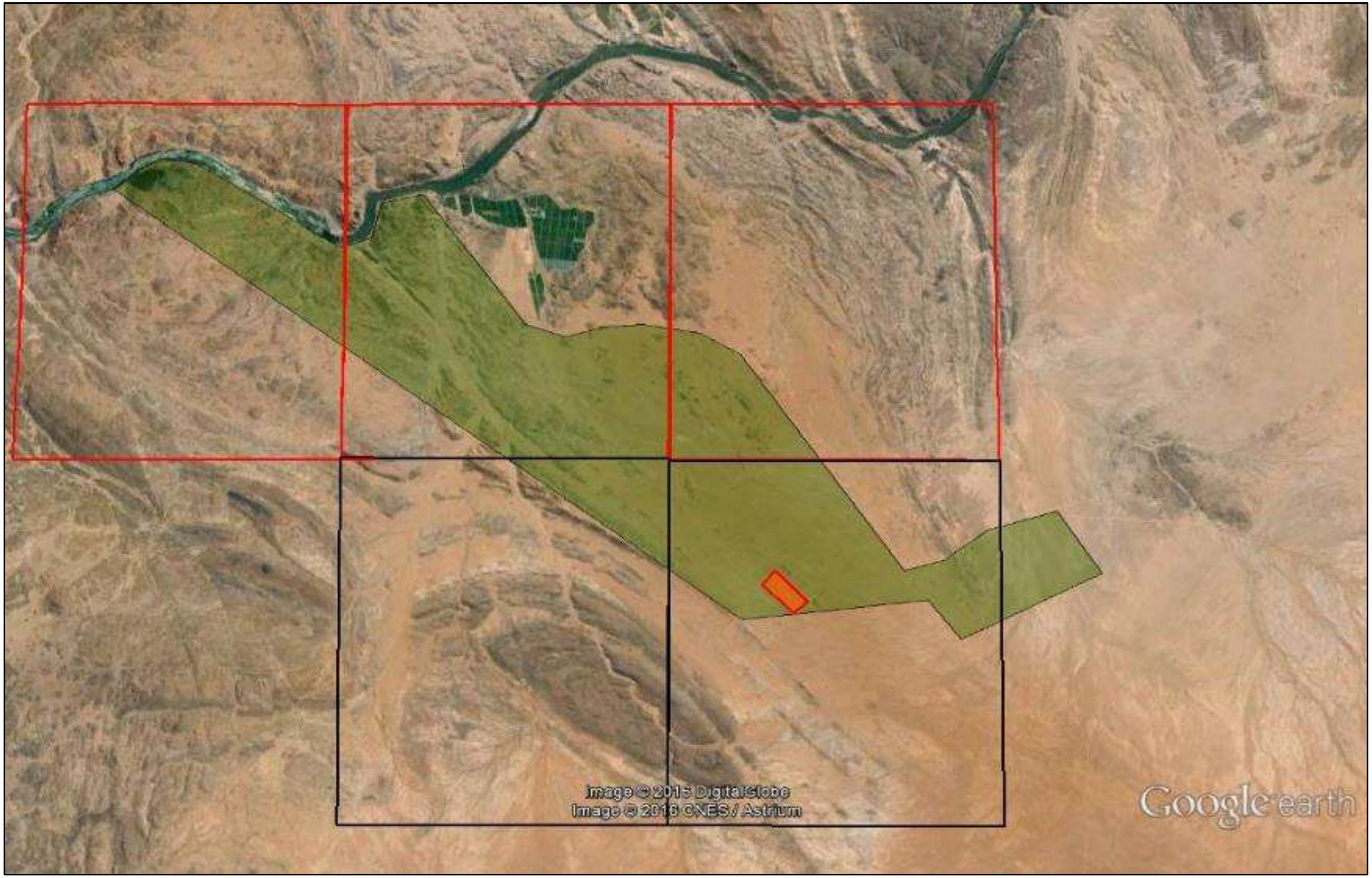

Figure 1: The Skuitdrift farm boundary (green) and the proposed 45ha broader study area (orange) in relation to the Orange River. The pentads from which the bird atlas data were drawn are shown. Red borders indicate recent (SABAP2) data available, black borders indicate no recent data available.

Figure 2: The Skuitdrift farm boundary (green) and the proposed 17 ha PV development footprint (orange) in relation to the farm boundary and the Schuitdrift substation.

4 QUANTIFYING THE IMPACTS

We can semi-quantify the impacts by giving values to variables influencing the impact to sensitive red data or collision-prone birds that occur on site. These comprise the Extent (E: a measure of the area or length of habitat affected), the Duration (D: a measure of the time the impact will be in effect), the Magnitude (M: a measure of the size of the impact which can differ for different species depending on their susceptibility or sensitivity), the Probability of occurrence (P: a proportion reflecting the likelihood the impact will be felt).

The Significance (S) of the impact can then be quantified using the formula: S = (E+D+M)P. Because this may change with mitigation a before-and-after Significance value can be calculated.

The Significance scale varies from 0 (no significance) to 100 (highly significant and unacceptable). A score above 50 is considered an impact of high significance and mitigation is required.

The Significance may also differ for the different stages or components of the PV facility so the level of Significance of the impact must be calculated independently for (i) the PV facility and (ii) the transmission line from the PV facility to the existing Schuitdrift substation.

(i) Construction and post–construction habitat displacement, avoidance and impact with the PV facility

Nature: The impact of the proposed PV areas will generally be negative given the certainty that: (i) ~20 ha will be transformed and the associated bird habitat destroyed; (ii) birds may collide with the panels if they mistakenly perceive them as open water; and (iii) collision-prone species living around the periphery may collide with the power lines linking the solar development to the substation.

It must be noted that the pylons (as opposed to the transmission lines they carry) can also be considered positive for the raptors and Sociable Weavers given that they provide perching and nesting sites for them in a tree-less environment.

The Extent (**E,** from 1-5) of the impact will occur within the chosen PV area (of 20 ha) = **(1),** and along the short reticulation lines = **(3)**

The Duration (**D**, from 1-5) will be long-term **(4)** for the lifetime of the PV area and the transmission lines for all species.

The Magnitude (**M,** from 0-10) of the impact of displacement from the PV areas is expected to have a low impact **(2)** for the raptors, bustards and Sclater's Lark; for the transmission line raptors both benefit (perch sites) and together with the bustards may be killed through impact or electrocution, giving a medium-high Magnitude of **(7).**

For any wetland birds, some **(1)** may be killed by collision with the panels (Kagen et al. 2014) or the transmission lines (Jenkins et al. 2010). Few smaller birds will be displaced by habitat destruction of 20 ha, and this includes some nomadic Sclater's Larks.

The Probability of occurrence (**P,** from 1-5) of the raptors and bustards having a negative interaction with the PV panels is ranked medium low **(2)** but for the transmission lines it is ranked medium high **(4)** because of their propensity to collide with them, but at a lower than maximum likelihood, because of their relatively low probability of occurrence on site (17%: Table 2). For the wetland birds, the probability of occurrence is very low **(1)** because they were not recorded on any bird atlas cards.

The Significance S, [calculated as **S = (E+D+M)P**], is as follows (Table 3) for the species identified as at risk in the (i) PV site, and (ii) from the adjacent power line.

Table 3. A summary of the quantified impacts to the collision-prone raptors and wetland bird species likely to be impacted by the (i) proposed PV plant and (ii) new power lines.

(i) Within the PV site itself **Nature:** Mostly negative due to direct impact mortality (or avoidance of area) around the **PV site** for the Red-listed bird groups identified as at risk above. (**BRAP**= Bustards + Raptors, **WB** = Wetland birds):		
	Without mitigation	**With mitigation**
Extent	**1**	**1**
Duration	**4**	**4**
Magnitude	**2 (BRAP), 1 (WB)**	**1 (BRAP), 1 (WB)**
Probability	**2 (BRAP), 1 (WB)**	**1 (BRAP), 1(WB)**
Significance (E+D+M)P	**14 (BRAP), 6 (WB)** **Low risk**	**6 (BRAP), 6 (WB)** **Very Low risk**

Status (+ve or –ve)	Negative	Neutral
Reversibility	Low	(mitigations untested)
Irreplaceable loss of species?	No, few red data species occur and are unlikely to be killed by the PV array. The Verreaux's Eagle and Ludwig's Bustards will lose ~20ha of foraging habitat which is likely to have a negligible impact on their occurrence and survival.	
Can impacts be mitigated?	Probably yes: if species are found to be attracted to and killed by impacting the solar panels then various mitigation measures (below) can be tried.	

Mitigation for impacts for the PV panels

There are two classes of mitigation for the PV panels: (i) move them away from bird-sensitive areas (especially pans or other well-used bird areas), or (ii) employ bird-diverters to deter birds mistaking the panels for open water from landing on them.

It is also recommended that should bird deaths be recorded that Scuitdrift Solar Project (Pty) Ltd install video cameras above some panels for post-construction monitoring of any mortality of birds in the vicinity, through direct observation and carcass searches in a systematic and regular fashion.

Cumulative impacts:

For the PV itself the mortality and displacement impact on birds is poorly known, but several solar farms are now being constructed in the Kalahari/Karoo and more will occur in the future: thus more research and monitoring of the combined impacts is required. See below.

Residual impacts:

After mitigation, direct mortality through collision or area avoidance by the species identified above may still occur. An environmental management programme will assess the efficacy of the mitigations to reduce direct impacts or any problems with eagles, bustards or larks, and further research and mitigation can then be suggested and tested as the need arises.

(ii) Along the reticulation lines from the PV site to the substation
Nature: Negative due to direct impact mortality due to **new transmission line** for the collision-prone bird groups identified as at risk above.
(**BRAP** = bustards + raptors, **WB** = Wetland birds):

	Without mitigation	**With mitigation**
Extent	**3**	**2**
Duration	**4**	**4**
Magnitude	**7(BRAP)**, **2 (WB)**	**5(BRAP), 1 (WB)**
Probability	**4(BRAP), 1 (WB)**	**3(BRAP), 1 (WB)**

Significance (E+D+M)P	**56 (BRAP), 9 (WB)** **(high for bustards and raptors - mitigation required)**	**33 (BRAP), 7 (WB)** **(medium)**
Status (+ve or –ve)	Negative	Neutral
Reversibility	Medium- High	Medium-High
Irreplaceable loss of species?	No, but some loss of red data bustards and Verreaux's Eagles through collision/electrocution along the line.	
Can impacts be mitigated?	Yes, by marking the earth wire of all existing and all future lines with bird diverters. Experiments in the Karoo by the EWT indicate that mortalities from impacts with transmission lines fitted with bird diverters can reduce mortality by 80% for some bird groups (C. Hoogstadt pers comm.) For electrocutions, use power pole configurations where the conductors are strung below the poles, so perching eagles or buzzards cannot bridge the air-gap.	

(ii) Mitigation for power lines:

There are three classes of mitigation for birds around **power lines**: (i) re-position the lines to avoid intersecting the movements of the birds, (ii) add bird diverters to <u>all</u> new lines and motivate Eskom to mark all existing lines that are killing birds, such that collision-prone species more readily detect and avoid contact, or (iii) bury the lines. Use power poles configured to hang the conductors below the supporting structures to reduce the risk of large birds bridging the air gap.

We suggest that there is now enough long-term and well-executed research to show that un-marked lines are killing such large numbers of birds (such as vultures and bustards) that we recommend that **all new transmission lines be marked with bird diverters,** <u>as</u> they go up. The priority areas - those with the highest mortality rate - should be considered first.

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).

Thus, in this context, cumulative impacts are those that will impact the general avian communities in and around the proposed development, mainly by other solar farms and associated infrastructure. This will happen via the same factors identified here viz: collision, avoidance and displacement. Therefore, we need to know, as a starting point, the number of solar farms within 50 km around the region, 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 bird displaced per unit area, by habitat destruction, or disturbed or displaced by human activity;
- the number of birds killed by collision with the structures on site;
- the number of birds killed by collision with infrastructure leading away from the site;
- the number of birds killed by flying through the solar flux of CSP tower sites adjacent to this PV site.

By the end of 2015 there were 7 proposed or approved renewable energy farms of various sizes within 50 km of Skuitdrift. We have attached a map (Figure 3) depicting the sites proposed within a 50 km radius, as they are the most likely to have a cumulative impact. Most of the solar farms are photo-voltaic in design (one at Pofadder is a Concentrated Solar Power design) and all will generate 20 MW or less of energy.

Because there are no post-construction mortality data or displacement data for any of the variables mentioned above in South Africa, it is impossible to even attempt to semi-quantify the Cumulative Impacts for birds in and around the solar sites. Once the data is collected and published (or released to other specialists) for a minimum of a year's monitoring, we can then start to quantify this aspect. On present data we cannot even guesstimate the cumulative impacts.

However, our considered estimate, based on relatively low rates of avian impacts at PV sites in the USA, and the small size of the majority of the PV sites planned or approved within 50 km of the proposed Skuitdrift Solar Energy Facility site, is that the Cumulative impacts will be minimal. Some systematic monitoring (and release of that data) will increase the predictive power of our assessments of the solar energy sites in this region.

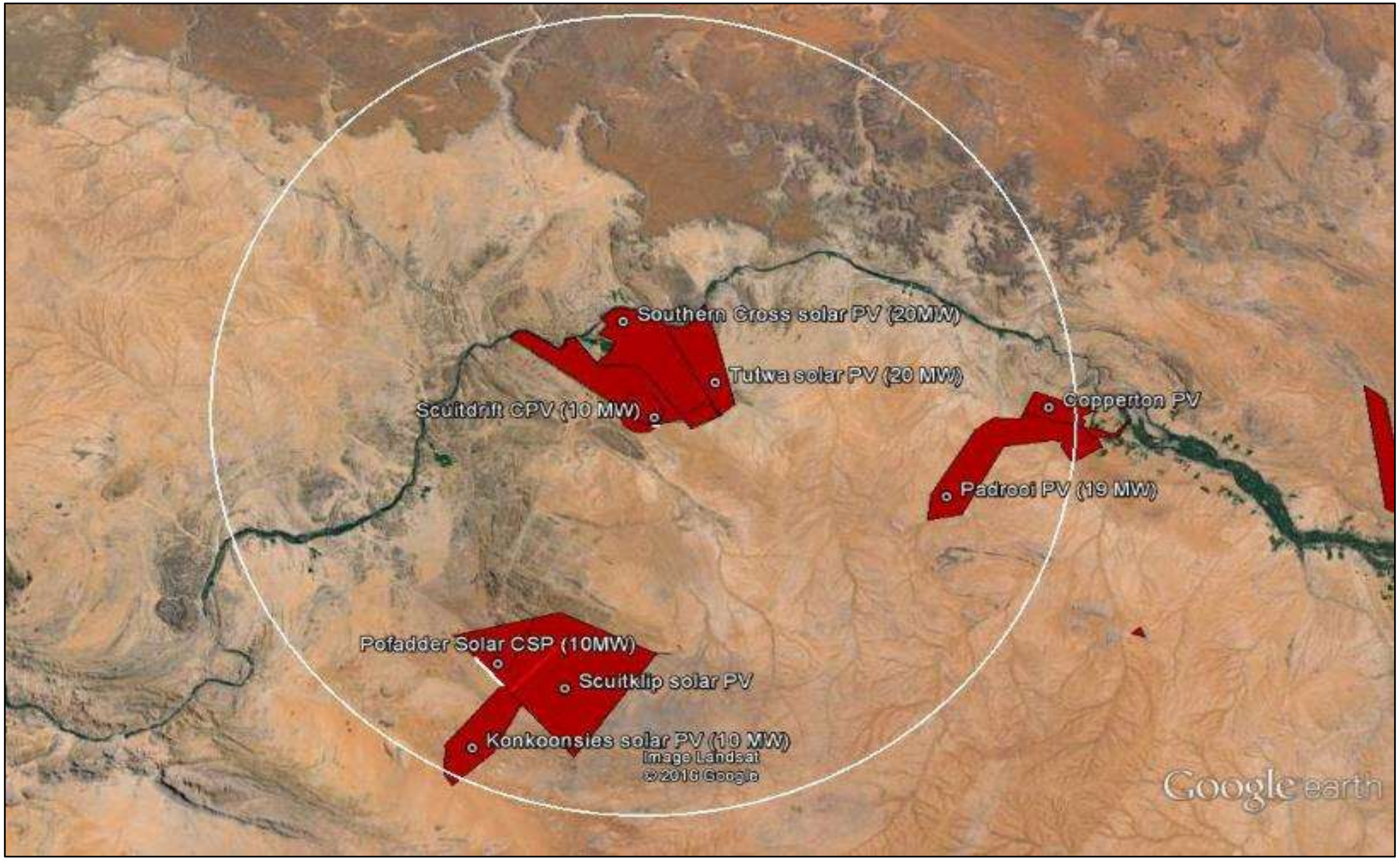

Figure 3: The proposed Skuitdrift Solar Energy Facility site (centre) in relation to all (7) other proposed or approved renewable PV or CSP solar farms of various sizes within 50km radius (white circle). Source: http://egis.environment.gov.za/frontpage.aspx?m=27 Directorate of Environmental Affairs) last quarter 2015.

5 CONCLUSIONS AND RECOMMENDATIONS

The proposed Scuitdrift Solar Project (Pty) Ltd PV plant on Skuitdrift farm, is located 50km northwest of Augrabies, in the Northern Cape and is one of many such renewable energy initiatives that are be proposed for this high-flux solar radiation region of South Africa.

The avifauna of the area may be affected by the infrastructure of the solar PV plant and our analysis of the atlas data of birds on the sites suggests the impact will be minimal for the PV solar farm itself but may be higher for possible collisions and electrocutions along the power lines linking the solar farm to the Schuitdrift substation.

Given that the area is irregularly used by two of South Africa's most collision prone red-data species – Verreaux's Eagles and Ludwig's Bustards – all power lines in this area should be marked with bird diverters. These are preliminary conclusions, because they are based on the low certainty of how often the bustards and eagles occur on site.

Too little research in South Africa is presently available to determine the impacts of solar PV sites, and thus ad hoc, post-construction monitoring at this site is a further recommendation.
In an arid environment where sensitive species may not occur at all if rains do not fall, even a full year's monitoring may be insufficient. Thus, pre-construction visits must be timed to coincide with the most productive time of year – even if they are minimal rains as in an El Niño year.

Therefore, this Scuitdrift Solar Project (Pty) Ltd site should be *systematically* monitored by ornithologists familiar with these birds, to determine movements occurring through the proposed sites during rain events. More importantly, appropriate mitigation measures would need to be sought if significant mortalities of sensitive species were found. As a relatively new field, and with the burgeoning solar farm industry in South Africa focussed on the Kalahari region surrounding the Orange River, we need to be pro-active in our research and innovative in the designs to reduce avian mortality. However, some methods are already being used at facilities in the USA and these include audible bird scaring devices, visual devices to reduce attraction, and mechanical spikes and other measures to prevent birds from perching on dangerous surfaces (treated below).

We also recommend that all available precautions are taken to avoid the threatened raptors and bustards being attracted to the panels. If birds are attracted and collide with the panels by mistaking it for open water, then we recommend that innovative bird deterrent techniques are used.

If these recommendations can be followed and prove effective, we believe that the Skuitdrift Solar Energy Facility can be allowed to proceed with the least impact to the avifauna of the area.

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7 APPENDICES

Appendix 1: Bird species in the Skuitdrift area – Bird atlas data

List of all bird species that were recorded in the Skuitdfit Solar Facility and the Broader Skuitdrift farm and their likelihood of occurrence from the pentads **2830_1935; 2830_1940; 2835_1940; 2835_1945**. **Threatened species are given in red,** **collision-prone species in bold,** wetland species are highlighted in blue**.**

Pentads: 2830_1935; 2830_1940; 2835_1940; 2835_1945

Species name	Taxonomic name	Full protocol	
		Rep Rate (%)	n/13 cards
Barbet, Acacia Pied	*Tricholaema leucomelas*	7.69	1
Batis, Pririt	*Batis pririt*	7.69	1
Bee-eater, Swallow-tailed	*Merops hirundineus*	15.38	2
Bokmakierie,	*Telophorus zeylonus*	7.69	1
Bulbul, African Red-eyed	*Pycnonotus nigricans*	15.38	2
Canary, White-throated	*Crithagra albogularis*	15.38	2
Chat, Familiar	*Cercomela familiaris*	15.38	2
Cormorant, White-breasted	*Phalacrocorax carbo*	15.38	2
Darter, African	*Anhinga rufa*	7.69	1
Dove, Laughing	*Streptopelia senegalensis*	7.69	1
Dove, Namaqua	*Oena capensis*	15.38	2
Dove, Red-eyed	*Streptopelia semitorquata*	7.69	1
Eagle, Verreaux's	***Aquila verreauxii***	**15.38**	**2**
Egret, Cattle	*Bubulcus ibis*	7.69	1
Fish-eagle, African	***Haliaeetus vocifer***	**15.38**	**2**
Grebe, Little	*Tachybaptus ruficollis*	7.69	1
Hamerkop, Hamerkop	*Scopus umbretta*	15.38	2
Heron, Goliath	*Ardea goliath*	15.38	2
Heron, Grey	*Ardea cinerea*	7.69	1
Honeyguide, Greater	*Indicator indicator*	15.38	2
Ibis, Hadeda	*Bostrychia hagedash*	7.69	1
Kingfisher, Malachite	*Alcedo cristata*	7.69	1
Lovebird, Rosy-faced	*Agapornis roseicollis*	7.69	1
Martin, Brown-throated	*Riparia paludicola*	7.69	1
Martin, Rock	*Hirundo fuligula*	15.38	2
Mousebird, White-backed	*Colius colius*	7.69	1
Ostrich, Common	*Struthio camelus*	15.38	2
Pigeon, Speckled	*Columba guinea*	15.38	2
Robin-chat, Cape	*Cossypha caffra*	15.38	2
Scimitarbill, Common	*Rhinopomastus cyanomelas*	15.38	2
Shelduck, South African	*Tadorna cana*	7.69	1
Sparrow, House	*Passer domesticus*	15.38	2
Sunbird, Dusky	*Cinnyris fuscus*	15.38	2
Thrush, Karoo	*Turdus smithi*	7.69	1
Turtle-dove, Cape	*Streptopelia capicola*	7.69	1
Wagtail, Cape	*Motacilla capensis*	7.69	1
Waxbill, Common	*Estrilda astrild*	7.69	1
Wheatear, Mountain	*Oenanthe monticola*	15.38	2
White-eye, Orange River	*Zosterops pallidus*	7.69	1

39 species on 13 atlas cards from river (Full Protocol only).
Threatened Ludwig's Bustard and Sclater's Lark were both present in the quarter degree square for this area