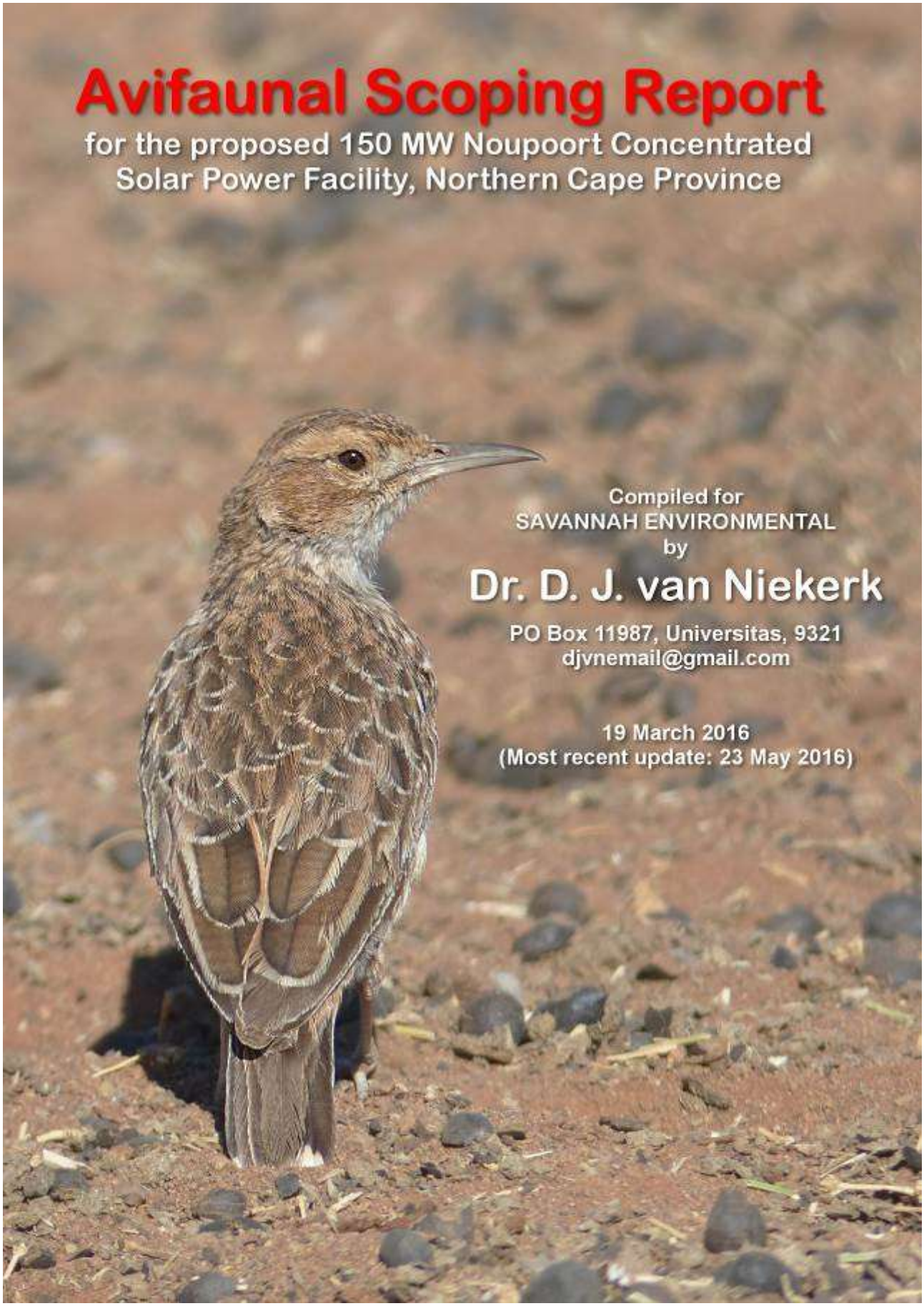
Avifaunal Scoping Report

for the proposed 150 MW Noupoort Concentrated Solar Power Facility, Northern Cape Province



Compiled for
SAVANNAH ENVIRONMENTAL
by

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AVIFAUNAL SCOPING REPORT FOR THE PROPOSED 150 MW NOUPOORT CONCENTRATED SOLAR POWER FACILITY, NORTHERN CAPE PROVINCE.

Consultant background and declaration of independence in accordance with the National Environmental Management Act (107 of 1998): Environmental Impact Assessment Regulations (2014):

I, Johan van Niekerk (PhD Zoology), am an ornithologist with 13 years of experience as an independent environmental consultant specialising in birds. During this period I successfully completed a number of environmental impact assessments, bird monitoring and risk assessment studies. My curriculum vitae is included in Appendix A.

Savannah Environmental appointed me as an independent specialist to conduct the Avifaunal Impact Assessment for the proposed 150 MW Noupoort Concentrated Solar Power Facility. This document represents the Avifaunal Scoping Report.

I declare:

» I act/acted as the independent specialist in this application;

» I will perform/preformed the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;

» There are no circumstances that compromised my objectivity in performing such work;

» I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;

» I will comply with the Act, Regulations and all other applicable legislation;

» I have no, and will not engage in, conflicting interests in the undertaking of the activity;

» I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; all the particulars furnished by me in this form are true and correct; and

» I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Johan van Niekerk

19 March 2016

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EXECUTIVE SUMMARY

CRESCO Energy (Pty) Ltd proposes the development of a 150 MW parabolic trough Concentrated Solar Power (ptCSP) facility on Portions 1 and 4 of the farm Carolus Poort 167 and the Remaining Extent of Farm 207, all located north-west of the town Noupoort in the Northern Cape Province of South Africa. The total area is approximately 3 460 ha in size of which approximately 900 ha will be required for the proposed ptCSP facility. The focus of this report is on the avifaunal component of the Scoping phase of the project. The study was based on a review of the relevant literature and three site surveys.

The habitat of the proposed ptCSP site consists mostly of Eastern Upper Karoo dwarf shrubland ranging from areas dominated by shrubs to areas dominated by grass. Rocky outcroppings and ridges occur in certain areas and a low mountain range forms the northern border of the site. The site contains the confluence of two major branches of the Noupoortspruit.

Five major No-Go areas were identified. The first encompasses an ephemeral wetland system in the south-east where several wetlands with open water occur during the rainy season. Because these wetlands attract many birds when inundated, it is best to avoid development there in order to reduce the risk of birds colliding with project infrastructure. A second No-Go area was defined in the south-west based on the presence of one breeding Vulnerable species (Secretarybird *Sagittarius serpentarius*) and two Near-Threatened species of which the Karoo Korhaan *Eupodotis vigorsii* is likely to be a breeding resident while the Blue Crane *Anthropoides paradiseus* utilizes the area for feeding and resting. In addition, in the southern part of the area there are many places where rainwater would form temporary wetlands which could attract birds such as Blue Cranes. An adjacent area to the north of this No-Go zone was determined to be a high sensitive zone. Both the eastern and western branches of the Noupoortspruit were also determined to be No-Go areas. The mountain range on the northern border of the site provides habitat for two Red Data species (Verreauxs' Eagle *Aquila verreauxii* & African Rock Pipit *Anthus crenatus*) and is also a No-Go area.

Outside of the above mentioned No-Go and sensitive areas there are also smaller wetland features and livestock water/feeding troughs which attract birds. Unless these places are transformed in a way which would make them unattractive to birds, a buffers zone around them would be required.

Places outside the No-Go and sensitive zones are being used by a variety of bird species. The Red Data species in this group is unlikely to use this part of the area for breeding purposes while the species that do represent non-threatened taxa. Therefore, if the No-Go areas are strictly enforced, there do not appear to be significant concerns with regards to birds, at least not at this early stage — the occurrence and movement patterns of birds still needs to be quantified during a wet period. Recommendations are given in this regard.

Because the alignment and design of the proposed new power line that will evacuate the generate power have not yet been established, a detailed assessment of the significance of its impact is not yet possible.

ABBREVIATIONS, ACRONYMS AND DEFINITIONS

CSP: Concentrated solar power

ELP: Ecological light pollution (see Section 2.1.3)

ha: Hectare

kV: Kilovolt = 1 000 volts

MAMSL: Metres above mean sea level

MW: Megawatts = 1 000 000 watts

Pentad: A 5' latitude by 5' longitude block

ptCSP: Parabolic trough concentrated solar power

PV: Photovoltaic

QDGC: Quarter degree grid cell. A 15' latitude by 15' longitude block

Resident: Any bird species, including migrant and nomadic taxa, utilising the indicated area continuously (visiting it at least once a week) for an extended period of time (a month or more)

SABAP1: The first Southern African Bird Atlas Project (1987–1991; Harrison *et al*. 1997a,b).

SABAP12: Data from SABAP1 and SABAP2 combined.

SABAP2: The second Southern African Bird Atlas Project (2007 to present; http://sabap2.adu.org.za).

SAC9Q-block: Study area centred 9-QDGC block

Wetland: "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil." (National Water Act (No. 36 of 1998)); "Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt. ... Also land where the water table is, at least periodically, at or above the land surface for long enough to promote the formation of hydric (waterlogged) soils and the growth of aquatic plants" (Mucina & Rutherford 2006).

WLS: Wetland system

WTW: Water treatment works

VPS: View point survey

1 INTRODUCTION

CRESCO Energy (Pty) Ltd proposes the development of a 150 MW parabolic trough Concentrated Solar Power (ptCSP) facility (Fig. 1) on Portions 1 & 4 of the farm Carolus Poort 167 and the Remaining Extent of Farm 207, all located north-west of the town Noupoort and situated within the Umsobomvu (NC072) Local Municipality area of jurisdiction in the Northern Cape Province of South Africa (Fig. 2; Fig. 3). The proposed site is approximately 3 460 ha in size, of which approximately 900 ha will be required for the proposed ptCSP development. The generated power will be evacuated into the Eskom electricity grid. The project is proposed to be bid in the Department of Energy's (DoE) Renewable Energy Independent Power Producer Procurement Programme (REIPPPP).

CRESCO Energy (Pty) Ltd appointed Savannah Environmental as independent environmental consultant to undertake the required Scoping and EIA processes to identify and assess all the potential environmental impacts associated with the proposed project, and to propose appropriate mitigation and management measures in an Environmental Management Programme (EMPr). Subsequently Savannah Environmental appointed Dr. D. J. van Niekerk to conduct the avifaunal component of the project.

1.1 Planned ptCSP infrastructure

The infrastructure associated with the proposed ptCSP Plant will consist of the following:

» Parabolic trough technology utilising a heat transfer fluid. In this system a parabolic trough reflector concentrates incoming solar radiation onto a cylindrical tube (i.e. the receiver) running across the focal line of the parabola with the aim of heating heat transfer fluid inside the tube — in a later process this heat will be used to create steam which will drive turbines which generate electricity. Collectively the reflector and receiver form a solar collector assembly which tracks the sun in order to maximise generation capacity. The solar collectors at a ptCSP facility is collectively known as the solar field;

» Energy Centre. The Energy Centre is built from larger heat exchanger units consisting of tubes for the heat transfer media coming from the solar field and for the water/steam media, working in counter-flow. Condensed water enters in a counter flow and comes out as a superheated steam at 480-500ºC. The space between tubes is filled with the storage media.

» Power Block, consisting of the steam turbine and generator, as well as the air-cooled condenser and associated feedwater system.

» Water supply pipeline;

» Water storage tanks/reservoirs;

» Water treatment facility;

» Lined evaporation ponds;

» Workshop and office buildings;

» Access roads and fencing around the development area;

» Plant assembly facility;

» On-site substation and 132kV overhead power line (to connect to Eskom's electricity grid); and

» Temporary laydown areas.

1.2 Terms of reference

The terms of reference for the Avifaunal Impact Assessment were as follow:

» Desktop study;

» Site survey;

» Review of literature;

» Identification of high risk species, particularly Red Data species and other priority species that might be impacted by the proposed facility;

» Description and assessment of the significance of likely impacts on priority avifauna;

» Provision of mitigation measures to reduce the envisaged impacts.

1.3 Assumptions, uncertainties and gaps in knowledge

Assumptions, uncertainties and gaps in knowledge applicable to this investigation appear as underlined text throughout this report. The following is a summary of the main issues:

» No provisional layout of the proposed ptCSP facility's components was available when this scoping report was compiled.

» No provisional alignment or other details of the electricity evacuation system was available when this scoping report was compiled.

» Knowledge on bird distribution and movement patterns in and around the proposed ptCSP development is incomplete and it is difficult to assess if, when and how these patterns will change over time.

» This scoping report is based on three surveys, each focussing on a different part of the proposed ptCSP site. In addition, whereas relatively intensive observations were conducted during the first two site surveys, the data collection effort during the third visit on the Remaining Extent of Farm 207 was limited to surveys from a vehicle and short transects on foot due to time constraints. Furthermore, whereas the first survey was conducted during a widespread drought, some rain has fallen in parts of the proposed ptCSP site subsequently.

» Our present understanding of the causes of avian fatalities at ptCSP facilities, and the extent of the problem, is too limited to make accurate predictions of which species will be most at risk and the effectiveness of mitigation options.

» It is assumed that this report will be distributed and consulted in its entirety. The specialist who compiled this report does not accept any responsibility for subsequent amendments effected without his specific and written consent. In case of any uncertainty, please direct your enquiries to djvnemail@gmail.com.

2 THE IMPACT OF ptCSP FACILITIES ON BIRDS

In a move anticipated in the 1998 White Paper on the energy policy of South Africa (Department of Minerals & Energy 1998), Cabinet in 2003 approved the participation of the private-sector in the electricity industry, with a decision being made that future power generation capacity should be divided between Eskom (70%) and Independent Power Producers, or IPPs (30%) (Department of Energy 2003; see also Department of Energy 2011a). Subsequently the Department of Energy announced the Renewable Energy Independent Power Producer Program (REIPPP) in 2011, involving 3 725 MW (Department of Energy 2011b) to be allotted to IPPs according to a procurement program which is well underway (see www.ipprenewables.co.za). On 10 December 2012 a sod-turning ceremony inaugurating the Solar Capital De Aar Project marked the launch of the first official REIPPP project (Peters 2012). Partly as a consequence of it being a recent development, very little research has been conducted to date on the interaction between wildlife and utility scale solar renewable energy facilities, with most of the information available on birds being from the south-western part of the USA (Lovich & Ennen 2011; Walston *et al*. 2015).

A utility-scale solar energy development has the potential to impact birds and bird communities in a number of ways. In the remainder of this section the relevant literature on the impact of ptCSP facilities on birds is reviewed.

2.1 ptCSP infrastructure

During its operational phase the proposed ptCSP infrastructure will likely be in place for a few decades. In addition to its solar field, supporting infrastructure associated with the security of, and access to, the primary solar field structures responsible for the reflection and collection of solar energy can also have an impact on birds.

2.1.1 ptCSP solar field

According to a recent review of the limited information that is available, there are two known types of bird fatalities occurring at operational solar facilities (Fig. 4), namely fatalities caused when birds collide with project structures, and fatalities after birds have passed through the area of solar flux (Walston *et al*. 2015). Since solar-flux-related fatalities have only been observed at facilities employing CSP power towers (*e.g.* McCrary *et al*. 1986; Fig. 1), they are irrelevant to the Noupoort ptCSP project and will not be considered further. On the other hand, collision-related fatalities have been recorded at solar projects involving all types of technologies (Kagan *et al*. 2014; Walston *et al*. 2015). With regards to operational ptCSP facilities, data from at least one installation in southern California, the Genesis Solar Energy Project, demonstrated that avian fatalities involve an array of bird taxa from large to small birds; aerial-, terrestrial- and aquatic feeders; resident and migrant species; nocturnal and diurnal species (Kagan *et al*. 2014; Western EcoSystems Technology 2015). The same facility was also in the news in 2014 when 64 birds died after gaining access to harmful waste water after protective netting was destroyed during a thunderstorm (Anonymous 2014; Danelski 2014).

2.1.2 Roads

Depending on the circumstances roads can have a range of negative impact on the environment (for reviews, see Forman & Alexander 1998; Trombulak & Frissell 2000). For

example, the construction of a road can have a negative impact on the breeding success of local birds through disturbance and or destruction of active nesting sites. Roads can also change the habitat in ways that could render the habitat unsuitable for resident species. Once in place, a road can change the routing of shallow groundwater and surface flow in ways that may trigger erosion (Forman & Alexander 1998; Trombulak & Frissell 2000). Roads can also provide optimal habitat for invasive/exotic plant species (Forman & Alexander 1998; Kuvlesky *et al*. 2007; Trombulak & Frissell 2000). Chemical control of these plants and other pests can have a negative impact on birds and other animals if food that was in contact with these herbicides or pesticides are ingested. Moisture and sediment deposits from road drainage may also benefit patches of local plants (Forman & Alexander 1998) and may lead to the establishment of habitats where insects flourish. This, in turn, could attract insect eating birds to the area. Furthermore, dust mobilised and spread by road traffic could potentially have a negative impact on nearby plants (Trombulak & Frissell 2000). In addition, dust settling on solar energy collectors or reflectors can impacted the efficiency of these systems (Lovich & Ennen 2011).

2.1.3 Lighting

Ecological light pollution (ELP) "includes chronic or periodically increased illumination, unexpected changes in illumination, and direct glare" (Longcore & Rich 2004). The impact of ELP on birds and other animals has been reviewed in recent years (Bruce-White & Shardlow 2011; Longcore & Rich 2004; Navara & Nelson 2007). Among its many impacts on birds and other animals (see Bruce-White & Shardlow 2011; Longcore & Rich 2004; Navara & Nelson 2007; Perry *et al*. 2008) we will focus on only two aspects. Firstly, security lighting often attracts insects, which can easily serve as food for birds and other predators (Frank 1988). This may become an attractant for birds and may possibly lead to collisions with project infrastructure. Secondly, nocturnal migrating birds can get entrapped by artificial light and may then collide with structures close to the light source, die of exhaustion, or be exposed to an increased risk of predation (Ogden 1996). It is agreed with The Royal Commission on Environmental Pollution (2009) that, while further research is evidently needed, the information at hand justify concern regarding the potential adverse ecological impact of ELP.

2.1.4 Fencing

Security fencing around solar energy facilities could present a collision risk for some bird species (RSPB 2011), while others may find it suitable for perching or breeding. By monitoring the occurrence of these incidents it may be possible to pinpoint problem areas and device effective mitigation strategies.

2.1.5 Water

Birds commonly exploit both ephemeral and permanent open water sources. For example, during the site surveys it was clear that the water (and feeding) troughs for livestock is visited by a variety of birds. Once birds have discovered a specific water source, they will often continue to use it for as long as it remains suitable for them. The construction of open ponds to store water, e.g. for dust suppression purposes during construction, is likely to attract birds. The resultant movement of birds to and from the waterbody can potentially increase their risk of colliding with project infrastructure.

2.2 Power evacuation infrastructure

2.2.1 Bird collision risk

In principle, any bird capable of flight, including small species, are at risk of colliding with power lines (Bevanger 1998; Haas *et al*. 2005; Hunting 2002; Janss 2000; Jenkins *et al*. 2010). Factors contributing to this risk are considered in the paragraphs below.

The proximity to locations where birds tend to congregate is an important factor to take into account when planning the route of a new power line (Avian Power Line Interaction Committee (APLIC) 2012; Brown *et al*. 1987; Faanes 1987; Prinsen *et al*. 2011). For example, during carcass searches along existing power lines inside and outside of the proposed ptCSP site, a concentration of dead bird remains was typically located close to wetland systems.

Earth wires on top of electricity infrastructure, which is supposed to protect the phase conductors from lightning strikes (Avian Power Line Interaction Committee (APLIC) 2012; Hunting 2002), are often the primary cause of avian collision incidents (*e.g.* Brown *et al*. 1987; Faanes 1987; Jenkins *et al*. 2010; Savereno *et al*. 1996; Scott *et al*. 1972; Van Rooyen 2003). Observations of collision incidents suggests that birds often see the conductors but not the earth wires (Bevanger 1994; Faanes 1987; Savereno *et al*. 1996; Scott *et al*. 1972; Thompson 1978), which is typically thinner and less obvious than the conductors. However, heavy mortalities also occur in the absence of earth wires (Bevanger 1994).

It has been suggested that power lines running parallel and in the same right-of-way could help to reduce collision risk (Thompson 1978). The reasoning behind it is twofold: 1) It would tend to make the lines more visible; 2) A bird would only require a single ascent and descent to cross the lines instead of more than one avoidance manoeuvre (Thompson 1978). Although this have been around for nearly four decades, and in spite of the fact that Thompson (1978) himself noted that the "relative effect on mortality rates of separate versus clustered lines depends on many site-specific factors and deserves further study", there appears to be no such studies as reviews touching on the subject (*e.g.* Avian Power Line Interaction Committee (APLIC) 2012; Bevanger 1994) all refer back to Thompson's (1978) original suggestion. Thompson (1978) also noted that birds flying "during periods of decreased visibility" may actually be at a greater risk of colliding with lines if they are clustered together (Thompson 1978).

2.2.2 Bird electrocution risk

A birds may be electrocuted on power line infrastructure when it causes an electrical short circuit by physically bridging the air gap between live components and/or other live and grounded components (Bevanger 1998; Van Rooyen 2003). The resulting flow of current through the body of the bird is lethal (Van Rooyen 2003). These type of incidents occur especially when the feathers of the bird is wet (Bevanger 1998).

In cases where the long ejected excreta (called a streamer) of a bird bridge the air insulation between a live conductor and the power line tower structure it could cause a flash-over and on rare occasions the death of the bird (Van Rooyen 2003).

2.2.3 Birds nesting on power line towers

In addition to providing perching sites, power line towers associated with power lines are frequently used by birds for breeding purposes as well. Species which are known to breed on power line towers (Anderson 2013; Boshoff *et al*. 1990; Dean 1975; Machange 2003) and which occur in the area of the ptCSP site include the Verreauxs' Eagle R131, Martial Eagle R140, Black-chested Snake-Eagle R143, Jackal Buzzard R152, Southern Pale Chanting Goshawk R162, Lanner Falcon R172, Rock Kestrel R181, Greater Kestrel R182, Cape Crow R547 and Pied Crow R548. The Greater Kestrel R182 does not build its own nest, but use the old stick nests of other species, particularly those of crows (Brown *et al*. 1987; Steyn 1982; Tarboton & Allan 1984). Nesting material, including wires and plant material, can result in flash-overs when it comes into simultaneous contact with two conductors, particularly during wet conditions (Anderson 2013; Van Rooyen 2003).

3 GENERAL DESCRIPTION OF THE RECEIVING ENVIRONMENT

The town Noupoort is located in the south-eastern corner of the Northern Cape Province of South Africa (Fig. 2). The area normally receives approximately 260 mm of rain per year with most of it falling during January, February and March (http://www.saexplorer.co.za/south-africa/climate/noupoort_climate.asp). Located a few kilometres north-west of Noupoort, Portions 1 and 4 of the Farm Carolus Poort and the Remaining Extent of Farm 207 collectively constitute the proposed ptCSP site (c. 31°09'S; 24°54'E; Fig. 3). It is located in the eastern part of the Nama-Karoo Biome, specifically in the Eastern Upper Karoo (NKu 4; Least threatened) vegetation unit of the Upper Karoo Bioregion (Fig. 2; Mucina & Rutherford 2006). This vegetation unit is characterised by a landscape dominated by flats and gently sloping plains (interspersed with hills and rocky areas) dominated by dwarf microphyllous shrubs, with `white' grasses of the genera *Aristida* and *Eragrostis* which become especially prominent in the early autumn months after good rains (Mucina & Rutherford 2006). A low mountain range with Tarkastad Montane Shrubland (Gs 17; Mucina & Rutherford 2006) forms the northern border of the proposed ptCSP site (Fig. 3).

The proposed ptCSP site is currently used for grazing. It is located at the confluence of two major branches of Noupoortspruit — an ephemeral wetland system, sections of which retain water for an extended period after rain — flowing through the eastern and western aspects of the northern portion of the site (Fig. 3; Fig. 5). In this part of its flow Noupoortspruit is embedded in typical Eastern Upper Karoo habitat consisting of dwarf shrubland ranging from areas dominated by low shrubs to areas dominated by grass (Fig. 6). However, the habitat in the immediate vicinity of the eastern branch of Noupoortspruit is characterised by tall bushes in contrast to the western branch where it is typical Eastern Upper Karoo veld (Fig. 7). Elsewhere, trees and bushes are mainly confined to rocky outcrops and ridges — the main components of which are located in the south-western part of the site (Fig. 6 B) — and the low mountain range running along the northern border of the site (Fig. 3) which constitutes the north-western extreme of the Tarkastad Montane Shrubland vegetation unit of Mucina & Rutherford (2006).

An ephemeral tributary of the eastern branch of Noupoortspruit flows through the south-eastern section of the proposed ptCSP site (Fig. 3, WLS1; Fig. 8). All of the dams/pans associated with it were dry during the December 2015 survey, but subsequent rains have inundated them shortly before the February 2016 survey. Outside this wetland system there

are also a linear ephemeral wetland (WLS2) running along a contour line (at c. 1475 MAMSL) and another one in the south along a ditch next to the remnant of an old road along the southern border of portion 4 of the farm (WLS3; Fig. 9) (Fig. 3). The area around and north of WLS3 has many patches where rainwater would collect after rain. There are also a number of localised ephemeral wetlands and livestock water/feeding troughs, including those associated with windmills, which attract birds (Fig. 3). In some cases, *e.g.* the windmill located in the northern part of Portion 1 of the farm Carolus Poort (see Figure 10), the overflow from reservoirs creates small wetlands which attract a number of bird species, including Blue Cranes R208. The Noupoort WTW located east of the proposed ptCSP site (<1 km; Fig. 3) represents the nearest permanent open water source.

There are a few areas with some form of conservation status within 100 km from the proposed CSP site. Formally conserved areas are located beyond the 80 km mark to the north around Vanderkloof Dam (Rolfontein Nature Reserve & Doornkloof Private Nature Reserve) and north-east around Gariep Dam (Gariep Dam Nature Reserve & Oviston Nature Reserve). The latter also forms part of the Upper Orange River Important Bird Area (IBA), formerly known as Gariep-Oviston-Tussen die Riviere IBA (Marnewich *et al*. 2015). The only other IBA within 100 km is the Platberg–Karoo Conservancy IBA which covers the De Aar, Philipstown and Hanover districts (Marnewich *et al*. 2015) and is located 15–150 km from Carolus Poort. The only informally protected area is the Karoo Safaris Game Farm located more than 90 km to the south.

4 METHODS

For ease of reference the so-called Roberts number as per Maclean (1985) is included together with the name of bird species whenever they are mentioned, *e.g.* Blue Crane R208. Thus given it is easy to locate the species in Table 1 where the birds within each group (see below) are sorted by their Roberts number. In cases where changes in taxonomy subsequent to Maclean (1985) resulted in a taxon being split into more than one species (*e.g.* Eastern Long-billed Lark R500c) or when new species were admitted to the southern African list (*e.g.* Mallard R104n), a number was improvised. In cases were a species is mentioned which does not occur in the SAC9Q-block, its English named is followed by its scientific name. The taxonomy follows BirdLife South Africa (2015).

4.1 Bird species occurrence

At the core of any avifaunal impact assessment is a list of bird species likely to be found in the proposed development site and environs (see Table 1). Because the proposed ptCSP development is likely to be in operation for a few decades, it would be ideal to consider all species which would occur in the area over that period. However, as will be illustrated in Section 5 below, two factors make this difficult: 1) Our current knowledge on the distribution of birds in and around the proposed ptCSP complex is incomplete; 2) The distribution of species may change over time and for any given species it is difficult to predict if, when and how this will happen.

The approach followed here was to include all species recorded in 3124BB, i.e. the quarter degree grid cell (QDGC) in which the proposed ptCSP facility is to be located in, as well as those recorded in the eight surrounding QDGCs during the first Southern African Bird Atlas Project (SABAP1; 1987-1991; Harrison *et al*. 1997a,b), and second Southern African Bird Atlas

Project (SABAP2, 2007-present; sabap2.adu.org.za). These nine QDGCs will be referred to as the Study Area Centred 9-QDGC block, or simply the SAC9Q-block (Fig. 11). SABAP2's coverage of the SAC9Q-block, specifically the number of `full protocol' checklists per pentad (i.e. a 5' latitude by 5' longitude block), is illustrated in Figure 11. The spatial resolution of SABAP1 was QDGCs; there are 9 pentads in a QDGC (Fig. 11).

4.1.1 Field observations

The data from the two bird atlas projects referred to above will be supplemented by observations made during data collection trips to the proposed ptCSP site and environs. Initially only Portion 1 of the farm Carolus Poort 167 was considered by Cresco Energy for the proposed development. However, No-Go areas delineated after the first site survey (7–11 December 2015) meant that the remaining area would not have been large enough for the proposed development. Cresco Energy subsequently added adjacent Portion 4 of Carolus Poort 167 to the footprint area (Fig. 3). This new area was the focus of a second site survey (1–4 February 2016). Subsequent changes in the design of the proposed ptCSP facility meant that the area available for development was still too small. Consequently the adjacent farm north of the above mentioned farm portions were included in the footprint area. This new area was the focus of a third site survey (9–12 March 2016). Environmental conditions differed between the respective site surveys. In particular, whereas the December 2015 survey coincided with a widespread drought, the February and March 2016 site surveys followed on rainfall in the area. This rainfall was unevenly distributed. For example, by February 2016 only the catchment of WLS1 in the south-east received significant rain compared to the rest of the proposed ptCSP site which remained very dry.

The following field-data collection methods were employed:

- *Vantage point surveys* (VPS) were conducted to determine the general movement patterns of birds and to monitor usage of the site by birds. In addition to continuous observations for movement of birds, a scan over the observation area was conducted each 10 minutes in order to determine utilisation of the site by birds. The following VPS were conducted:
  - The first VPS was conducted on 8 December 2015 from dawn to dusk from VPS1 located in the rocky area in the south (Fig. 3). This site offers good views over most of the south-eastern part of the proposed ptCSP site;
  - The second VPS was conducted on 9 December 2015 during a four hour period which commenced 37 minutes after sunrise from VPS2 on the eastern border of the proposed ptCSP site (Fig. 3).
  - The third VPS was conducted on 2 February 2016 from dawn to dusk from the top of the grassland covered rise in the north-west (Fig. 3, VPS3).
  - The fourth VPS was conducted on 3 February 2016 from dawn to dusk from a rocky lookout point which afforded a good view over the southern part and the proposed ptCSP site (Fig. 3, VPS4).
  - Due to time constraints no VPS were conducted on the Remaining Extent of Farm 207.
- *Transects on foot*. A handheld GPS unit (Garmin eTrex Vista HCx) recorded the route followed in all cases.

» *Determining the composition of the resident bird community*. Species lists were compiled for each consecutive 5-minute period with each species heard or seen recorded only once per list. These lists were compiled continuously. For example, at the end of a hour-long transect one would have 12 (60/5) such species lists. Analysis of this data entails the calculation of reporting rates, i.e. the percentage of 5-minute lists on which a particular species appears. In addition to several shorter transects not specified herein, the following five long transects were completed as follow:

- During the morning of 8 December 2015 a 15 km-long transect covering all major habitats within farm Portion 1 was completed. This transect commenced at dawn in the north and concluded in the south.
- During the morning of 9 December 2015 a 12 km-long transect covering all major habitats within farm Portion 1 was completed. The first part of the transect focused on the southern part and thereafter the northern part of the farm protion.
- During the mornings of 10 December 2015 and 4 February 2016 an 11.4 km long transect was completed along the power line running from the Newgate substation westwards. The transect followed this power line to the western border of the proposed ptCSP site (Fig. 3). This transect was identified as a control site during the December 2015 site survey, but it subsequently became part of the actual development footprint.
- During the morning of 2 February 2016 an 11.5 km-long transect was completed covering all major habitats in farm Portion 4 from the rocky ridge northwards.
- During the morning of 3 February 2016 an 11.2 km-long transect was completed covering all major habitats in farm Portion 4 from the rocky ridge southwards.
- Due to time constraints no long transects were completed in the Remaining Extent of Farm 207.

» The incidence of avifaunal power line casualties was determined by walking along specific sections of power lines. In all cases the one side of the power line was first patrolled followed by the other side on the return journey. Two observers were involved in all cases, except in one case were three observers were involved. In all instances observer A walked below the outer power line and observer B approximately 20 meters further out. When three observers were available observers B and C walked approximately 20 m on either side of the power line and would chance sides on the return journey. The following power line sections where patrolled (the actual distance walked in each case is more than double the indicated distances):

- 7 December 2015, c. 2 km along the power line running north-south below a large (empty) farm dam on the farm Falsefontein 1/165, approximately 10 km north of the proposed ptCSP site;
- 9 & 11 December 2015, all power lines in the proposed ptCSP site (c. 3.25 km) (Fig. 3);
- 9 & 11 December 2015, c. 2.4 km of the power line passing east of the Noupoort WTW (Fig. 3);

- 10 December 2015 and 4 February 2016, the power line which runs from the Newgate substation westwards (Fig. 3);
- 4 February 2016, the southern 1.2 km of the power line going south from Newgate substation.
- Due to time constraints no power line surveys were conducted during the March 2016 site survey.

» A camera trap was deployed at one of the watering points in the proposed ptCSP site during the December 2015 and February 2016 site surveys in order to monitor the activity of birds there.

» The Noupoort WTW was visited at least once each day from 7 to 11 December 2015, and once on 1 February 2016 and once on 9 March 2016 in order to characterise its avifauna.

» Birds were recorded from a vehicle along all major tar and gravel roads within 10 km from the proposed ptCSP site during the December 2015 and February 2016 site surveys.

While this scoping report draws on the information collected during the above mentioned activities, the data was primarily collected for use during the Environmental Impact Assessment phase and is not analysed in detail here.

4.2 Habitat preference

Although birds are highly mobile, many species utilise only specific habitats, with habitat diversity playing an important role in determining avifaunal diversity (Cody 1985). The hierarchical habitat classification system of Harrison *et al*. (1994) was used to characterise the habitat preferences of each species. Only primary habitat levels were used, which include marine (MA), aquatic (AQ), montane/rocky (RC), grassland (GR), scrub (SC), woodland (WO) and forest (FR) habitats. In addition, "habitat-unspecific" species were placed into a `habitat generalist' category. For the purposes of this assessment, the term `waterbird' refers to all species associated with aquatic habitats according to the system of Harrison *et al*. (1994). The habitat preferences of all species is shown in Table 1 and summarised in Figures 12 and 13.

4.3 Species of special concern

Particular emphasis is placed on species appearing on the Red Data list (Taylor *et al*. 2015), species endemic or at least near-endemic to South Africa, Lesotho and Swaziland (all will be referred to as `endemic' in the text), range restricted species (Marnewich *et al*. 2015), and species which may potentially interact with, or be affected by, the proposed ptCSP facility and associated infrastructure. All of this information is summarise in Table 1 for each species. Waterbirds are highlighted in Table 1 by printing their risk assessment in blue, except in cases where the risk is high in which case it appears in red print.

Two categories of negative impacts are distinguished, namely those associated with the proposed ptCSP facility (Renewable Energy Facility risk, REFrisk), excluding the electricity evacuation system (power lines, etc.; See EESrisk below) which is the second category. The term `resident' is used here to mean species present at (or at least regularly visiting) the indicated area for an extended period of time (a month or more) and include migrating

species. The risk categories distinguished below refer to the situation before consideration of mitigation measures.

4.3.1 Renewable Energy Facility risk (REFrisk)

A distinction is made between the risk of disturbance and the risk of accidents. **Disturbance** refers to any action by humans which deprives a bird species of its habitat. This includes the physical destruction or alteration of habitat in a way that causes displacement, as well as disturbance which have a negative impact on breeding success. In general this type of disturbance is primarily associated with the construction phase of the project. The following negative impact levels are distinguished:

» unlikely: The species is either unlikely to occur at the proposed ptCSP site, a possible transient visitor there, and/or otherwise unlikely to be disturbed;

» low: The species is a resident or have an unknown status at the proposed ptCSP site, but the risk of disturbance is likely to be minimal (*e.g.* species with large territories and species which utilise the area mainly for activities other than breeding);

» Moderate: The species is a resident in the proposed ptCSP site and the risk of disturbance is likely to be moderate (*e.g.* species which may potentially breed in the affected area);

» HIGH: The species is a resident in proposed ptCSP site and the risk of disturbance is likely to be high (*e.g.* species which probably breed in the affected area).

When disturbance of species are predicted, the only viable mitigation option may be to schedule the development's activities which would cause these disturbances to occur outside the breeding season. However, the more species that are involved the less likely it would become to find a period outside the breeding season of all of them. This was the case in the present study. In order to determine the time of the year when the least number of species would be impacted, the Median Breeding Index method developed by Van Niekerk (2015) was used. This method entails the calculation of the Median Breeding Index for each month based on the months in which egg laying were recorded. In this particular case, information in Hockey *et al*. (2005) was used to score each month for each potentially disturbed species with a zero (0, not breeding) or a one (1, breeding) if there is no peak breeding season, or else 0 (no breeding records), 0.5 (breeding outside peak period) and 1 (peak breeding months). The median was then calculated for each month. Theoretically speaking, the predicted disturbances would affect the least number of species during the months with the lowest Median Breeding Index.

Accidents refer to incidents involving the ptCSP solar field and associated infrastructure (excluding the power evacuation system) which could lead to the injury or death of birds once the facility is completed and operational. Accurate assessment of this risk is presently difficult to make because only limited research that has been done in this regard (see Section 2 above). No specific assessment was made for this Scoping report.

4.3.2 Electricity Evacuation System risk (EESrisk)

Since there is no information currently available on how the electricity generated by the proposed ptCSP facility will be distributed, evaluation of the risks associated with the new power line will be limited to a general consideration of potential collision and electrocution

related incidents; an assessment of the risk of disturbance caused to birds will only be possible once the alignment of the new power line is available.

Information on confirmed collision (c) and electrocution (e) incidents involving power lines and associated infrastructure were obtained for species occurring in South Africa, Lesotho and or Swaziland from published sources referring to incidents recorded in southern Africa (Anderson 2000; Anonymous 2008; Diamond 2008; Diamond *et al*. 2010; Jenkins 2008; Krüger *et al*. 2015; Prinsen *et al*. 2011; Shaw *et al*. 2010; Van Niekerk 2013; Van Rooyen & Ledger 1999; Vosloo & Van Rooyen 2009) and elsewhere in the African-Eurasian region (Barrientos *et al*. 2012; Ferrer 2012; Janss & Ferrer 1998; Prinsen *et al*. 2011; Scott *et al*. 1972; Shobrak 2012). There are probably more species involved as it is likely that a large number of incidents go unreported (Vosloo & Van Rooyen 2008). For example, smaller species may be easily overlooked and carcasses of dead birds are removed by scavengers at a relatively rapid rate (Drewitt & Langston 2006; Flint *et al*. 2010; Hunting 2002; Scott *et al*. 1972; Smallwood 2007; Van Niekerk 2012). Incidents recorded outside southern Africa are indicated with an asterisk. An "x" indicates cases where the type of incident (either collision or electrocution, but probably the former in most cases) was not specified. A question mark indicates cases with no confirmed incidents, but where it may possibly occur based on incidents involving similar species and other information. The following risk levels were used (levels above the 'low' category are applicable to collision risk only):

» unlikely: There is no known collision or electrocution cases involving this species on record;

» low: Collision incidents involving electricity infrastructure have been recorded in this species. However, the species is probably a transient visitor to the affected area or are otherwise unlikely to be affected;

» Moderate: Collision incidents involving electricity infrastructure have been recorded in this species. In addition, the species is expected to occur regularly in the area of the proposed development, which could potentially render it vulnerable to accidents under certain circumstances.

» HIGH: Power lines often cause injury or death in the species through collisions and local conditions is likely to lead to these type of incidents.

5 THE AVIFAUNA

The 260 birds listed in Table 1 include the following species recorded during SABAP1 and/or SABAP2: 175 species recorded in 3124BB (see Fig. 11), and an additional 85 species not recorded in 3124BB but in one or more of the eight adjacent QDGCs (Table 2, 8QDGC). One species, the Maccoa Duck R117, have not been recorded in the area during SABAP1 or SABAP2, but was recorded during the December 2015 site survey (see below).

The reason for the inclusion of birds recorded outside 3124BB was to help compensate for the two factors mentioned earlier. The first factor, *i.e.* the incompleteness of our current knowledge on bird distribution in and around the proposed ptCSP facility is readily illustrated. In spite of receiving some attention from SABAP2 bird atlasers (Fig. 11), the SABAP2 bird species lists for each of the four pentads in which the proposed ptCSP site is located in are clearly incomplete with between 22 and 90 'new' species being recorded for the first time during the three site surveys (Table 3 A). When the data for the four pentads are combined, there is 33 `new' species relative to SABAP2 data (Table 3 A), 19 of which have been recorded

in the proposed ptCSP site during the three site surveys. A similar trend is evident if one considers all the SABAP2 data for the entire 3124BB QDGC (Table 3 A). Even when considering the data of both SABAP1 & SABAP2, the three site surveys to the four pentads still added 23 `new' species to 3124BB, 15 of which have been recorded in the proposed ptCSP site. Even at the SAC9Q-block level the bird atlas data is incomplete: A female Maccoa Duck R117 seen at the Noupoort WTW during the December 2015 site survey represents the first record for the region.

Many of the 33 `new' species highlighted above are probably resident within 3124BB but have been overlooked during the respective atlas projects. The same probably also applies to many of the species indicated in Table 2 which have been recorded exclusively during either SABAP1 or SABAP2. Collectively all this data demonstrates clearly the incompleteness of the SABAP12 dataset. The datas*et al*so illustrates the dynamic nature of bird distributions. For example, SABAP12 data suggests that 15 species are expanding their ranges towards 3124BB. However, the who, where and when of range expansions remain difficult to predict.

5.1 Priority species

Three groups of priority species can be described following the surveys undertaken as part of the on-site monitoring, namely Red Data species, the resident avifaunal community, and waterbirds. No range restricted species are known to occur in the vicinity of the proposed ptCSP project site.

5.1.1 Red Data species

The 23 Red Data species recorded in the SAC9Q-block during SABAP1 and SABAP2 are listed in Table 1 A. They include eight Endangered species, six Vulnerable species, and nine Near-Threatened species. The following seven species were recorded in the proposed ptCSP site during at least one of the three site surveys:

» Martial Eagle R140 (Endangered): Occasional visitor. An adult was seen perched on a power line tower during the March 2016 survey. It is expected that this species would visit the site from time to time. In addition to utilising power line towers for nesting (Dean 1975; Tarboton & Allan 1984; D. J. van Niekerk, pers. obs.), these birds are also susceptible to collisions with power lines and electrocution incidents with electricity infrastructure has been reported (e.g. Anderson 2000a).

» Ludwig's Bustard R232 (Endangered): Occasional visitor. Single adults were recorded during the December 2015 site survey. The most serious threat that the proposed ptCSP site will pose to these birds will be the potential for collision with the overhead power lines. According to Jenkins & Smallie (2009) these birds "may have the worst avian collision risk profile on record", referring specifically to collisions with power lines.

» Secretarybird R118 (Vulnerable): Breeding resident. During the December 2015 survey an adult foraged daily in the proposed ptCSP site while an adult was seen roosting on a tree south-west of VPS3 during February 2016 (Fig. 3). In the recent past they have also nested in a tree along the southern border of the proposed ptCSP site (Fig. 3; Fig. 9) where an adult was seen foraging in the field during the March 2016 survey. No active nesting activity was recorded during the surveys. It is recommended that the footprint of

the proposed development exclude the south-western portion of the proposed ptCSP site as indicated in Figure 3.

» Verreauxs' Eagle R131 (Vulnerable): Breeding resident. A pair was seen on a number of occasions along the low mountain north of the project site where they probably breed. In the proposed ptCSP site this species have not yet been recorded away from this mountain during the site surveys, reflecting their typical close association with mountains and rocky areas with cliffs, which also provides suitable habitat for their main prey, the Rock Hyrax *Procavia capensis* (Boshoff *et al*. 1991; Davies 1994; Gargett 1990; Steyn 1982). It is not currently known how these eagles will react to utility scale solar energy developments. Because these birds are known to inhabit urban environments with suitable habitat and abundant prey populations (*e.g.* Kruger 2010; Symes & Kruger 2012; Tame Times 2015), it is perhaps reasonable to assume that the proposed ptCSP development will not have a negative impact on these eagles as long as the development does not encroach on their mountain habitat or have a negative impact on their prey base. It is concordantly recommended that a 750 m-wide No-Go buffer zone should be established around the mountain in the north (Figure 3) in order to help minimise a negative impact risk. Furthermore, the location of all nesting sites along the mountain range should be established during the EIA phase and used to refine the No-Go buffer zone.

» Blue Crane R208 (Near-Threatened): Breeding resident. They make frequent use of the proposed ptCSP project site for feeding and resting, often in the vicinity of water and livestock feeding troughs. In addition, breeding has been recorded in the western branch of Noupoortspruit by the landowner (H. du Toit, pers. comm.). During the March 2016 survey an immature crane accompanied by what was assumed to be its parents were also recorded in the same area. Several carcasses of these birds were found underneath existing power lines in the proposed ptCSP site during this study and additional power lines are likely to exacerbate the problem. Implementation of the No-Go areas and high sensitive area indicated in Figure 3 is recommended.

» Karoo Korhaan R235 (Near-Threatened): Breeding resident. At least three pairs hold territories in the following areas within the proposed ptCSP site (see Figure 3): 1) South-eastern No-Go area; 2) Eastern part of the south-western No-Go area; 3) Northern half of the high sensitive area. As far as could be determined there are no cases on record of these birds being involved in collisions with power lines. However, collisions have been recorded for similar species such as the Blue Korhaan R234 and it is likely that the Karoo Korhaan would also be vulnerable to this type of accidents. In addition, the proposed ptCSP development may cause the birds to abandon the area.

» African Rock Pipit R721 (Near-Threatened): Breeding resident. This species is closely associated with the mountain range north of the study area. The No-Go buffer zone around the mountain established for the Verreauxs' Eagle R131 should be sufficient to protect this pipit species from the proposed ptCSP development.

The following species have not been recorded during the surveys but are considered likely to utilise the project site as occasional visitors:

» Greater Flamingo R096 & Lesser Flamingo R097 (Near-Threatened): Occasional visitors? These two flamingo species have been recorded in the surrounding QDGCs during SABAP12 and it is possible that they will visit wetlands in the proposed ptCSP site (Fig. 3; Fig. 8 A)

when inundated. Both species are vulnerable to collisions with power lines, partly due to their behaviour of flying at night (Prinsen*et al*. 2011; Van Rooyen 2003).

The remaining 14 Red Data species listed in Table 1 A are unlikely to utilize the proposed ptCSP site to any great extent. However, some of them may visit it occasionally.

5.1.2 Resident avifaunal community

The resident avifaunal community of the proposed ptCSP site comprises five Red Data species (Secretarybird R118; Verreauxs' Eagle R131; Blue Crane R208; Karoo Korhaan R235; African Rock Pipit R721), ten endemic species (*i.e.* the latter three Red Data species plus: Grey-winged Francolin R190; Blue Korhaan R234; Large-billed Lark R512; Sickle-winged Chat R591; Karoo Scrub-Robin R614; Cloud Cisticola R666; Karoo Prinia R686a), plus 30 other more widespread taxa (Table 1 B). All of these species can potentially be negative impacted during the construction phase of the proposed ptCSP project, particularly if the planned large-scale habitat clearance coincides or overlaps with the breeding season of these birds. Although the suggested mitigation will reduce the risk of active nests and their contents being destroyed in most species (see Section 6.2.1), the proposed development will permanently transform the habitat in the footprint area in ways which will render it unsuitable for most species.

During its operational phase, the proposed ptCSP development could have a direct and/or indirect negative impact on resident species. Apart from the permanent exclusion of birds, there is the possibility that birds may collide with structures in the solar field. However, our present understanding of the causes of avian fatalities at ptCSP facilities and the extent of the problem is presently too limited to make accurate predictions of which species will be most at risk and the effectiveness of mitigation measures.

The proposed power line that will be required to conduct the electricity generated in the ptCSP site to the Newgate substation may pose a significant threat to several bird species, including several Red Data taxa (Table 1 A & B). A more detailed analysis of the risks involved should be conducted as further details about this new power line (alignment, *etc.*) becomes available.

5.1.3 Waterbirds

Wetlands typically represent discrete habitats within landscapes, *e.g.* rivers, dams and pans. When they have water they attract a variety of animals, leading to a concentration of biota. Most prominent among these are birds, in particular waterbirds, many of which are also known to colonise ephemeral wetlands soon after they received water. Because of its potential of attracting birds to a specific location, a wetland in an area often implies increased bird movements there. Therefore, in cases where man-made structures poses some form of danger to birds, the presence of a wetland in the same area can greatly increase the potential for undesirable incidents, particularly since many waterbird species are flying around between dusk and dawn (Avian Power Line Interaction Committee (APLIC) 2012). Power lines near wetlands are known to cause high mortalities in waterbirds (*e.g.* Faanes 1987). In this assessment, all waterbirds are highlighted in Table 1 by printing their risk assessment in blue, except in cases where the risk is high in which case it is typed in red.

Waterbirds constitutes more than a quarter (26.2%) of all bird species likely to be found in the SAC9Q-block (Fig. 12). The nearest permanent open water source to the proposed ptCSP development is the Noupoort WTW located approximately 1km to the east of the site (Fig. 3;

Fig. 5). This wetland complex was visited on a number occasions during the December 2015 survey with more than a third (37.0%) of the 73 species recorded there being waterbirds (Fig. 14 A). By contrast, only six (9.5%) of the 63 species recorded in the proposed ptCSP site during December 2015 represented aquatic species (Fig. 14 A).

The WTW was visited only once during February 2016 and its data is not directly comparable to that obtained during the December survey. However, even though the two site surveys focused on different areas of the proposed CSP site, the data on the habitat preference of the recorded species is broadly comparable. The most significant difference between the two site surveys is the striking increase in the number of waterbirds, from the six recorded in December to the 15 recorded in February (Fig. 14). This difference neatly reflects the contrasting ecological condition of the wetlands in WLS1 (Fig. 3) which became inundated shortly before the latter survey.

If the construction phase coincides with the inundation phase of the local wetlands, it can cause disturbance of the birds then present, and once operational the facility may pose a long-term threat to some of the many waterbirds (and other species) if they collide with project infrastructure. Since the extent of this type of interaction is still poorly studied (see Section 2), it is advisable to apply the precautionary principle and monitor the situation at the proposed ptCSP site closely. The location of wetlands and the occurrence of many waterbird species in the area, including eight Red Data species and many others (Table 1 A, C & D; Fig. 12), implies that there will probably be regular movement of birds over the proposed ptCSP site during the day and night at certain times of the year, particularly when the ephemeral wetlands are inundated. Incidental observations made during the February 2016 site survey already indicated such movement on a north-east — south-west axis across WLS1 (Fig. 3). Therefore, at this early stage it is already clear that power lines across this flight path will be problematic and should be avoided.

5.2 Receiving environment from an avifaunal perspective

In this section, consideration is given to each habitat occurring in the proposed ptCSP site and environs and the bird species associated with each. Habitat Generalists are considered separately at the end.

5.2.1 Aquatic

Aquatic species are the most diverse category of birds known to occur in the SAC9Q-block (Fig. 12). They were already considered in section 5.1.3 above. All 11 species shown in Figure 12 to be associated with marine habitats are also associated with freshwater habitats (Fig. 13).

5.2.2 Scrub

Bird species associated with scrub habitats constitutes an important component of the avifauna found in the SAC9Q-block with almost a third of them being endemic (Fig. 12). Many species associated with scrub are also associated with other habitats, particularly grassland (33.3%) and woodland (28.1%) (Fig. 13). Since scrubland is common in the proposed ptCSP site (Fig. 6 A), it is not surprising that birds associated with it was one of the dominant groups recorded in the proposed ptCSP site during the three site surveys (Fig. 14). This includes 22 species, including two Red Data species, which may experience disturbance during the construction

phase of the proposed ptCSP project (Table 1 A & B). At least seven of them may also collide with power lines (Table 1 A & B).

5.2.3 Grassland

Grassland species also constitutes an import component of the SAC9Q-block's avifauna with more than a quarter (26.5%) of them also being endemics (Fig. 12). A number of species are also associated with other habitats, mostly with scrub (38.8%) (Fig. 13). Grassland species were one of the dominant groups encountered in the proposed ptCSP site during the three site surveys (Fig. 14). Of particular importance is the utilisation of the site by two Red Data species, namely the Blue Crane R208 and Karoo Korhaan R235 (Table 1 A). An additional 20 grassland species also utilise the grassland in the site and is likely to experience disturbance during the construction phase of the proposed ptCSP project (Table 1 B). If habitat clearance coincides with their breeding season, then there would be a real risk that nests and their contents will be destroyed. In addition, some of the species are at risk of colliding with power lines (Table 1 A & B).

5.2.4 Woodland

Almost a quarter (24.2%) of species known to occur in the SAC9Q-block shows a preference for woodland habitats (Fig. 12), of which almost half (46.0%) also show a preference for grassland, scrub and/or forest habitats (Fig. 13). Woodland type of habitats are largely confined to outcrops, ridges and the low mountain in the north (Fig. 6 B). Seven resident species are associated with woodland habits (Table 1 B). The site is presently on the edge of the distribution of the Kori Bustard R230 and European Roller R446, which are the only two woodland species which appear on the Red Data list (Table 1 A).

5.2.5 Montane/Rocky

Only 6.5% of the species known to occur in the SAC9Q-block are associated with montane/rocky habitats (Fig. 12). At the proposed ptCSP site this type of habitat occurs mostly in the south-west and along the northern border (Fig. 3; Fig. 6 B). Two of the four resident species associated with montane/rocky habitats also appear on the Red Data list (Table 1 A & B).

5.2.6 Other habitats

Neither forest nor marine habitats occur in the immediate vicinity of the proposed ptCSP development. All 11 species associated with marine habitats are also associated with freshwater systems. Of the 14 species associated with forest, 13 are also associated with woodland (five of which are also associated with scrub) and one associated with scrub.

5.2.7 Habitat generalists

One fifth of the species occurring in the SAC9Q-block are classified as habitat generalists (Fig. 12). This includes five Red Data species (Table 1 A) of which only the Secretarybird R118 is a resident in the proposed ptCSP site while the rest is unlikely to visit the site frequently. There are only three other habitat generalist which are residents, namely the Spotted Thick-knee R297, Cape Turtle-Dove R354 and Familiar Chat R589 (Table 1 B). These resident species are most likely to experience disturbance during the construction phase of the proposed ptCSP project. In addition to two Red Data species (Secretarybird R118 and Martial

Eagle R140; Table 1 A), the Cattle Egret R071, African Sacred Ibis R091, Booted Eagle R136, Speckled Pigeon R349, Common Swift R411 and Barn Swallow R518 are all habitat generalists which will be exposed to a moderate or high risk of colliding with power lines (Table 1 C).

6 ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION MEASURES

6.1 No-Go areas and buffer zones

The following areas are of particular concern (see Figure 3):

» WLS1, which is located in the south-eastern part of the proposed ptCSP site, attracts many bird species when inundated, including Blue Cranes R208 which roost there. The resultant movement of birds within this system, as well as to and from areas further afield (*e.g.* the Noupoort WTW in the north-east), is likely to increase the risk of collisions with project infrastructure. Furthermore, WLS1 is occupied by a resident Karoo Korhaan R235 pair, which is Near-Threatened species. It is recommended therefore that WLS1, including a 100 m buffer, should be managed as a No-Go area as indicated in Figure 3.

» The south-western part of the proposed ptCSP site is considered to be a sensitive area for the following reasons (see Figure 3): 1) It forms part of the breeding (Fig. 9), feeding and roosting range of Secretarybirds R118 , which is a Vulnerable species; 2) A pair of the Near-Threatened Karoo Korhaan R235 have a territory in the south-east; 3) Another Karoo Korhaan R235 pair occupies a territory south of the power line; 4) The area is commonly used by Blue Cranes R208 (Near-Threatened) for feeding and resting during the day and possibly also for roosting during the night; 4) In its southern part there are many places where open standing water would be present after rain (*e.g.* WLS3, Fig. 9) which would attract birds such as Blue Cranes. The following recommendations are made: 1) The area from the rocky ridge complex westwards and southwards should be managed as a No-Go area; 2) The area to the north up to the power line (see Figure 3) should be managed as an area of high sensitivity; the eastern and northern borders of this area should be refined during the EIA phase of the project.

» The western branch of Noupoortspruit (Fig. 7 A) constitutes an important feeding and breeding habitat for the Near-Threatened Blue Crane R208. When inundated it is also likely to attract a variety of waterbirds to the area. Therefore, it is recommended that it should be managed as a No-Go area which should also include a 100 m buffer.

» The eastern branch of Noupoortspruit (Fig. 7 B) is likely to attract a variety of waterbirds when inundated and should be managed as a No-Go area which should also include a 100 m buffer.

» The low mountain range in the north provides habitat for two resident Red Data species, namely the Verreauxs' Eagle R131 and African Rock Pipit R721. It is recommended that this mountain should be protected by managing it and a 750 m buffer zone around it as a No-Go zone as indicated in Figure 3 (see text on Verreauxs' Eagle in Section 5.1.1).

Outside the above-mentioned No-Go and sensitive areas, in other words the central parts of the proposed ptCSP site (Fig. 3), there are the following areas of concern:

» Water accumulating in WLS2 (Fig. 3) after rain is likely to attract birds such as Blue Cranes R208. In order to minimise the risk of collisions with the proposed ptCSP infrastructure a

100 m medium sensitive buffer zone should be established around it. Alternatively, WLS2 can be transformed in a way that prevent the occurrence of open standing water after rain, in which case no buffer zone would be required.

» The localised ephemeral wetlands and water/feeding troughs indicated in Figure 3 (*e.g.* Fig. 10) are frequented by many birds, including Blue Cranes R208 and Spur-winged Geese R116. In order to minimise the risk of collisions with the proposed ptCSP infrastructure a 100 m medium sensitive buffer zone should be established around them. Alternatively, no buffers zones would be required if the proposed ptCSP development would entail the elimination of these features.

At this early stage the buffer areas specified above are considered to be sufficient to reduce the risk of negative impacts to acceptable levels for birds utilising the indicated areas. However, the projected effectiveness of these buffers must be re-evaluated as more information on the movement patterns of birds, *etc*., becomes available during the EIA phase of the project.

6.2 ptCSP facility

In this section it is assumed that the development footprint of the proposed ptCSP facility will be limited to the area indicated in Figure 3. Furthermore, if the the No-Go areas and buffer zones recommend above are enforced, it implies that the actual development footprint will be limited to part of the original footprint area between the eastern and western wetland systems (Fig. 3).

Since there is a clear difference between the construction and operational phases of a solar energy project in terms of the type of impact it can have on birds (Fig. 4), these two phases are considered separately below.

6.2.1 Construction phase

During the construction phase, which will probably take place over a period of months, the habitat will probably be cleared. This activity will force birds which are present there at the time to relocate. While these birds could potentially resettle successfully in adjacent areas, the displacement of individuals of territorial species may have a ripple effect, causing temporary upheaval in the surrounding area (or places further afield) as the displaced males/pairs/family groups compete with established individuals elsewhere for territories. In addition, the construction activities are likely to cause the destruction of any nests which are actively used at the time. It is unlikely that any Red Data species would be affected by this if the No-Go areas and buffers zones specified earlier are strictly enforced. Nevertheless, in order to minimise the general impact on the birds of the area it is recommended that construction should be scheduled to occur outside the breeding season of as many species as possible. Examination of the monthly Median Breeding Index in Figure 15 indicates that the optimum time for construction (at least the clearance of habitat) would be from April to July, and that it should be avoided if at all possible from September to January.

In addition to species which may potentially breed in the affected area, there are others which could be expected to visit it frequently. Although there are many species which may potentially do so (Fig. 14), only Red Data species are highlighted here. Red Data species which are most likely to visit the actual development footprint on a regular basis, but which

are unlikely to breed there, include the Secretarybird R118 and Blue Crane R208. During the construction phase these species are likely to avoid the area and utilise other areas instead.

See also Table 4.

6.2.2 Operational phase

Apart from the likely displacement of local resident species, the impact that the proposed ptCSP facility will have on birds during its operational phase is not yet clear. The limited information available suggests that collision-related fatalities involving ptCSP structures could potentially occur, but it is not yet possible to predict which species will be most affected by this (see also Table 5). This should be further investigated during the EIA phase of the project. However, open water sources are likely to attract birds and this type of situations should be avoided. Other potential impacts include the following:

» In the proposed ptCSP site dust is easily mobilised by vehicle traffic. In addition, there are areas which are highly susceptible for erosion (*e.g.* Fig. 5 C). The following road related mitigation measures are recommended:
  » The road network should be carefully designed in order to avoid erosion over the long term;
  » Dust suppressants other than pure water should be used only as a last resort, and then only after very careful research were conducted as it could potentially have adverse environmental impacts (Lovich & Ennen 2011; Piechota *et al*. 2002);
  » Wherever possible, grazing or mechanical methods should be used instead of chemical alternatives to keep the vegetation in check where necessary. In this way they possible poisoning for birds and other animals will be avoided;
» Gaston *et al*. (2012) recently investigated options for reducing the ecological consequences of ELP. They concluded that the most effective option would probably be to maintain and increase natural unlit areas. Relevant mitigation options in this regard include the following (see Gaston *et al*. (2012) for more information):
  » Maintain and increase natural unlit areas;
  » Security lighting should be installed only where it is absolutely essential;
  » Avoid illumination of any ptCSP structures;
  » Reduce the trespass of lighting by using luminaires that prevents light from shining beyond the intended area and eliminates light directed upwards or at the horizontal;
  » Decreasing light intensity will reduce energy consumption and limit both skyglow and the area impacted by high-intensity direct light;
  » Lighting technologies emitting a narrow spectrum of light are likely to have less ecological impact compared to broader spectrum light sources.
» Birds may collide with the security fence surrounding the facility. If this occurs relatively frequently it should be further investigated and appropriate steps taken to minimize or eliminate the threat. One area where this may become a problem is at places close to the No-Go areas.

6.3 Power lines

The proposed ptCSP plant will include an on-site substation and overhead power line to the existing Newgate substation located just outside the north-eastern border of the facility (Fig. 3). However, because the alignment and design of the proposed new power line have not yet been established, an detailed assessment of the significance of the impact is not yet possible (Table 6).

Cases of collisions with electrical infrastructure are known for 15 Red Data species occurring in the SAC9Q-block (Table 1 A). The Karoo Korhaan R235 was added to this list since it closely resembles similar species such as the Blue Korhaan R234 for which there is collision records. Many of these Red Data species are probably only transient visitors to the proposed ptCSP site and consequently their risk of colliding with new power lines at the site is considered to be low (Table 1 A). However, eight species use, or are likely to use, the proposed ptCSP site more regularly and are considered to be at a moderate or high risk of colliding with power lines (Table 1 A; See also section 5.1.1). Of particular concern is the Blue Crane R208 of which several carcasses were found under existing power lines in the proposed ptCSP site. It is highly probable that any new power lines crossing wetland systems will exacerbate an already problematic situation.

As far as non-threatened species are concerned, eight of the resident birds are considered to be at risk of colliding with power lines (Table 1 B). Most of the 48 species listed in Table 1 C have been involved in fatal collision incidents (some were involved in electrocution incidents only). The majority of these are either habitat generalists (n=23 species) or waterbirds (14) (Table 1 C). Seventeen of these species are expected to be relatively common in the study area (at least during certain times of the year) and regarded to be at a moderate risk of colliding with power lines (Table 1 C). In addition to the waterbirds already included in the groups considered above, 40 others may also occur in the area (Table 1 D). Although there are no confirmed collision incidents involving these species on record, they may nonetheless be susceptible to this type of interactions.

In summary, the power line that will evacuate the electricity generated by the proposed ptCSP development to the Newgate substation could potentially pose a risk to the birds occurring in the area. Mitigation options considered include the following:

» The surest way of preventing birds from colliding with power lines is to place the lines underground (Hunting 2002). Technical feasibility of undergrounding have been demonstrated for power lines up to 500 kV (Elinfrastrukturudvalget (Denmark) 2008; Rosa 2010; Umeda *et al*. 2007). For example, a Danish study concluded that undergrounding of 132 kV power lines can be done without any significant technological problems (Elinfrastrukturudvalget (Denmark) 2008). In fact, a 24.6 km long, 132 kV underground power line was installed in Botswana already in 2000-2001 using cross-linked polyethylene (XLPE; also called solid dielectric) cables (ABB 2006). The use of underground cables is gaining momentum in Europe (Energinet DK 2009) and the USA (Hall 2012) and installation guides are available (*e.g.* Williams 2013). Although it is a more expensive option than overhead power lines — and while it is noted that cost estimation can be erroneously skewed in favour of overhead lines, especially when life-cycle costs are excluded (The Campaign to Protect Rural England (CPRE) *et al*. 2010) —

underground installations are superior in many other respects including installation safety, visual, environmental and avifaunal impact, ground use, *etc.*(Rosa 2010).

» There is general agreement amongst researchers that "vertically separated arrays of lines should be avoided as much as possible" (Jenkins *et al*. 2010). Horizontal designs where conductors are all on the same height is regarded to be saver as it presents a smaller vertical collision zone (Bevanger 1994; Drewitt & Langston 2008).

» The removal of earth wires has been shown to reduce collision incidents substantially (Bevanger 1994; Bevanger & Brøseth 2001; Brown *et al*. 1987). However, Noupoort is located in a "severe" lightning strike risk zone (Gijben 2012), which necessitates the use of earth wires.

» Another strategy would be the use of thicker cabling (Jenkins *et al*. 2010), the idea being that it would then make it easier for birds to see the wires (Avian Power Line Interaction Committee (APLIC) 2012). However, in one study this was found to be not nearly as effective as removing the earth wires (Brown *et al*. 1987), while a few other studies have shown that heavy mortalities can occur on transmission and distribution lines without earth wires (Bevanger 1994; Janss & Ferrer 1998). Although there are anecdotal reports which suggest that larger diameter earth wires is effective, studies of its effectiveness are needed before it can be recommended for reducing collision risk (Avian Power Line Interaction Committee (APLIC) 2012).

» Another option is to mark earth wires and or conductors in order to make them more visible to birds,*e.g.* by using bird flight diverters (Fig. 16). This strategy have been used with some success in the past, particularly when a sufficiently large marker — *i.e.* those which thickens the appearance of the line at that point by at least 20 cm over a length of at least 10 cm — spaced at regular intervals no greater than 10 m apart was used (Jenkins *et al*. 2010). This refers to static devices with no moving parts (*e.g.* pigtails/spirals; Fig. 16). Dynamic (including most "suspended") devices ("bird flappers") have moving parts and is more visible to birds, but unfortunately they are also less durable than static devices and may damage the power line to which it is attached (Vosloo & Van Rooyen 2009). All birds are not created equal and they differ in ways which seem to demand the need for various types of visual and non-visual devices to safeguard them all against the risk of colliding with power lines. For example, standard markers may not reduce the number of collisions involving crepuscular or nocturnal species (Barrientos *et al*. 2011) and research on the development of alternative markers is lacking (Jenkins *et al*. 2010). Furthermore, in diurnal species with narrow visual fields (*e.g.* bustards and cranes), visual markers may have limited success (Martin & Shaw 2010).

The following mitigation strategies seem most appropriate for the proposed ptCSP development. The alignment of the new power line must avoid any sensitive areas. Placing the proposed new power line underground would reduce the collision risk to zero. If that option is not feasible, then the proposed new power line should be of a horizontal design where conductors are all on the same height. In addition, bird flight diverters should be fitted to the earth wires (see Figure 16) following the guidelines provided by Jenkins *et al*. (2010). Once implemented, the effectiveness of these devices should be monitored through a monitoring program incorporated into the operational phase of the project. This will be a specialised activity and would require the services of an independent ornithologist. As a minimum,

approximately 20 m wide strips under each power line and adjacent to each line should be covered during zigzagging transects on foot, at least once a month. All carcasses found during these transects should be identified to species level if possible, photographed, their position marked with a GPS and recorded into an incident register. If the fitted markers turn out to be ineffective, an effort should be made to improve on them.

Of the species occurring in the SAC9Q-block, cases of electrocution involving electrical infrastructure are known for eight Red Data species and several others (Table 1 A, B & C). Electrocution risk is a function of power line tower design and bird body size and behaviour (Van Rooyen 2003). Since the best strategy for avoiding bird electrocution is to use low risk power line tower designs (Van Rooyen 2003), it is recommended that such designs must be used for the proposed ptCSP project following available guidelines (e.g. Ferrer 2012; Van Rooyen 2003).

7 RECOMMENDATIONS FOR FURTHER STUDY

The site survey during December 2015 coincided with a widespread drought and all the major wetlands in WLS1 were dry. Subsequent rainfall inundated these wetlands and incidental observation during the February and March 2016 site surveys indicated that they attract many birds. Due to time constraints it was not possible to formally quantify the resultant increase in movement of birds in and around the proposed ptCSP facility. From an impact assessment perspective this will be an important of the annual cycle to monitor. According to the landowners the dams in the area are currently inundated, in part due to good rains which fell during early May 2016 (J. de Villiers & H. du Toit, pers. comm.). Therefore, it is recommended that the next data collection trip should be scheduled for end May/early June 2016. The need for subsequent surveys will be assessed during the latter survey. During each survey information should be collected on the following aspects using the methods explained in Section 4.1.1 where applicable:

» Movement patterns of birds: This information is to be collected from fixed vantage points. As a minimum the same four vantage points used during the first two site surveys should be used (see VPS1, VPS2, VPS3 & VPS4 in Figure 3). Additional vantage points should be established in the Remaining Extent of Farm 207.

» Bird community composition: This should be determined primarily by walking random transects on foot throughout the proposed ptCSP site and recoding birds using the methods described earlier in this report. A record should also be kept of all bird species recorded on the site at other times.

» The northern and eastern borders of the south-western high sensitive area should be refined through observations focusing on the use of the area by Red Data species.

» Determine the location of all Verreauxs' Eagle R131 nesting sites along the mountain on the northern border and adjust the relevant No-Go area if necessary.

» Avifaunal power lines casualties: The same sections of power line should be covered using the methods described in Section 4.1.1.

» During each survey the Noupoort WTW should be visited during different times of the day. During each visit all birds present should be recorded and the more visible species such as ducks, geese and coots counted.

» Transects by vehicle along all major tar and gravel roads up to 10 km from the proposed ptCSP site can provide valuable insights into the occurrence and movements of Blue Cranes R208 and other large species in the area.

Finally, the alignment and design of the proposed power line to the Newgate substation should be properly evaluated.

REFERENCES

ABB 2006. Cost efficient design open doors in Botswana. Available athttp://www05.abb.com/global/scot/scot245.nsf/veritydisplay/8361fa737aa882e8c1256e3600486c76/$file/Project%20Botswana%20132%20kV%20XLPE%20land-.pdf[accessed on 12 November 2013].

ANDERSON, M. D. 2000. Raptor conservation in the Northern Cape Province, South Africa. *Ostrich*71(1-2):25–32.

ANDERSON, M. D. 2013. *Guidelines for communication companies: raptor and crow nests on manmade structures*.

ANONYMOUS 2008. Annual report April 2007 to March 2008, The Eskom – Endangered Wildlife Trust Strategic Partnership.

ANONYMOUS 2014. Bird deaths at toxic heap leach ponds. Available athttp://www.basinandrangewatch.org/Genesis-Updates.html [accessed on 13 January 2016].

AVIAN POWER LINE INTERACTION COMMITTEE (APLIC) 2012. *Reducing avian collisions with power lines: the state of the art in 2012*. Edison Electric Institute & APLIC, Washington, D.C.

BARRIENTOS, R., ALONSO, J. C., PONCE, C. & PALACÍN, C. 2011. Meta-analysis of the effectiveness of marked wire in reducing avian collisions with power lines. *Conservation Biology* 25(5):893–903.

BARRIENTOS, R., PONCE, C., PALACÍN, C., MARTÍN, C. A., MARTÍN, B. & ALONSO, J. C. 2012. Wire marking results in a small but significant reduction in avian mortality at power lines: a BACI designed study. *PLoS ONE* 7(3):e32569.

BEVANGER, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. *Ibis* 136(4):412–425.

BEVANGER, K. 1998. Biological and conservation aspects of bird mortality caused by electricity power lines: a review. *Biological Conservation* 86(1):67–76.

BEVANGER, K. & BRØSETH, H. 2001. Bird collisions with power lines - an experiment with ptarmigan (*Lagopus* spp.). *Biological Conservation* 99:341–346.

BIRDLIFE SOUTH AFRICA 2015. BirdLife South Africa checklist of birds in South Africa 2015 (2 November 2015 update). Available at http://www.birdlife.org.za/component/docman/doc_download/327-blsa-checklist-2015?Itemid=533 [accessed on 4 November 2015].

BOSHOFF, A. F., PALMER, N. G. & AVERY, G. 1990. Regional variation in the diet of Martial Eagles in the Cape Province, South Africa. *South African Journal of Wildlife Research* 20(2):57–68.

BOSHOFF, A. F., PALMER, N. G., AVERY, G., DAVIES, R. A. G. & JARVIS, M. J. F. 1991. Biogeographical and topographical variation in the prey of the black eagle in the cape province, south africa. *Ostrich* 62(1-2):59–72.

BROWN, C. J., PAXTON, M. W. & HENRICHSEN, I. 1987. Aspects of the biology of the Greater Kestrel in SWA/Namibia. *Madoqua* 15(2):147–156.

BROWN, W. M., DREWIEN, R. C. & BIZEAU, E. G. 1987. Mortality of cranes and waterfowl from powerline collisions in the San Luis Valley, Colorado. Pages 128–136 in: Cody, M. L. (ed.) *Proceedings 1985 Crane Workshop, Platte River Whooping Crane Maintenance Trust, Grand Island, NE*. .

BRUCE-WHITE, C. & SHARDLOW, M. 2011. *A review of the impact of artificial light on invertebrates*. Buglife, Peterborough.

CODY, M. L. 1985. An introduction of habitat selection in birds. Pages 3–56 in: Cody, M. L. (ed.)*Habitat selection in birds*, Academic Press, Inc. Orlando, Florida.

DANELSKI, D. 2014. Blythe: Toxic ponds uncovered at solar plant where birds died. Available athttp://www.pe.com/articles/birds-753040-plant-ponds.html [accessed on 13 January 2016].

DAVIES, R. A. G. 1994. Black Eagle *Aquila verreauxii* predation on Rock Hyrax *{Procavia capensis*and other prey in the Karoo. PhD thesis, Faculty of Science, University of Pretoria, Pretoria.

DEAN, W. R. J. 1975. Martial Eagles nesting on high tension pylons. *Ostrich* 46(1):116–117.

DEPARTMENT OF ENERGY, RSA 2003. Independent Power Producers. Available athttp://www.energy.gov.za/files/electricity_frame.html [accessed on 6 May 2013].

DEPARTMENT OF ENERGY, RSA 2011a. Electricity Regulation Act No. 4 of 2006: Electricity Regulations on the Integrated Resource Plan 2010 - 2030. *Government Gazette* 6 May 2011:3–71.

DEPARTMENT OF ENERGY, RSA 2011b. Renewable Energy Independent Power Producer Programme. Available athttp://www.energy.gov.za/files/media/pr/2011/Renewable%20Energy%20Independent%20Power%20Producer%20Programme.pdf[accessed on 6 May 2013].

DEPARTMENT OF MINERALS & ENERGY, RSA 1998. White paper on the energy policy of the Republic of South Africa. Available at http://www.info.gov.za/whitepapers/1998/energywp98.htm [accessed on 6 May 2013].

DEVAULT, T. L., SEAMANS, T. W., SCHMIDT, J. A., BELANT, J. L., BLACKWELL, B. F., MOOERS, N., TYSON, L. A. & VAN PELT, L. 2014. Bird use of solar photovoltaic installations at US airports: Implications for aviation safety. *Landscape and Urban Planning* 112:122–128.

DIAMOND, M. 2008. The Distribution Desk. Available athttp://www.ewt.org.za/programmes/WEP/Newsletters/Wildlife%20WATTch%20Dec%202008.pdf [accessed on 2 November 2013].

DIAMOND, M., SMALLIE, J., STRUGNELL, L. & GOLDING, M. 2010. Annual report April 2009 - March 2010, The Eskom – Endangered Wildlife Trust Strategic Partnership.

DREWITT, A. L. & LANGSTON, R. H. W. 2006. Assessing the impacts of wind farms on birds. *Ibis*148:29–42.

DREWITT, A. L. & LANGSTON, R. H. W. 2008. Collision effects of wind-power generators and other obstacles on birds. *Annals of the New York Academy of Sciences* 1134(1):233–266.

EARLÉ, R. A. 1997a. South African Cliff Swallow *Hirundo spilodera*. Pages 62–63 in: Harrison *et al.*(eds.). *The atlas of southern African birds*, Vol.~2. BirdLife South Africa, Johannesburg.

EARLÉ, R. A. 1997b. Greater Striped Swallow *Hirundo cucullata*. Pages 64–65 in: Harrison *et al.*(eds.). *The atlas of southern African birds*, Vol.~2. BirdLife South Africa, Johannesburg.

ELINFRASTRUKTURUDVALGET (DENMARK) 2008. Technical report on the future expansion and undergrounding of the electricity transmission grid – Summary. Available athttps://www.atvinnuvegaraduneyti.is/media/fylgigogn-raflinur-i-jord/5-Elinfrastrukturudvalget.pdf [accessed on 12 November 2013].

ENERGINET DK 2009. Cable action plan 132 - 150 kV grids – March 2009. Available athttp://energinet.dk/SiteCollectionDocuments/Engelske%20dokumenter/Om%20os/Cable%20Action%20Plan%20-%202008-2009.pdf [accessed on 12 November 2013].

FAANES, C. A. 1987. *Bird behavior and mortality in relation to power lines in prairie habitats*. Fish and Wildlife Technical Report 7. Fish and Wildlife Service, United States Department of the Interior, Washington, DC.

FERRER, M. 2012. *Birds and power lines: from conflict to solution*. Endesa & Migres Foundation, Spain.

FIRST SOLAR 2011. PV technology comparison. Available athttp://dev.firstsolar.com//~/media/Files/Products%20and%20Services%20-%20Product%20Documentation/Technology/PV%20Technology%20Comparison%20-%20English.ashx[accessed on 29 May 2013].

FLINT, P. L., LANCE, E. W., SOWL, K. M. & DONNELLY, T. F. 2010. Estimating carcass persistence and scavenging bias in a human-influenced landscape in western Alaska. *Journal of Field Ornithology*81(2):206–214.

FORMAN, R. T. T. & ALEXANDER, L. E. 1998. Roads and their major ecological effects. *Annual Review of Ecology and Systematics* 29:207–231+C2.

FRANK, K. D. 1988. Impact of outdoor lighting on moths: an assessment. *Journal of the Lepidopterists' Society* 42(2):63–93.

GARGETT, V. 1990. *The Black Eagle*. Acorn Books and Russel Friedman Books, Johannesburg.

GASTON, K. J., DAVIES, T. W., BENNIE, J. & HOPKINS, J. 2012. Reducing the ecological consequences of night-time light pollution: options and developments. *Journal of Applied Ecology*49(6):1256–1266.

GIJBEN, M. 2012. The lightning climatology of South Africa. *South African Journal of Science*108:44–53.

HAAS, D., NIPKOW, M., FIEDLER, G., SCHNEIDER, R., HAAS, W. & SCHÜRENBERG, B. 2005. Protecting birds from powerlines. *Nature and Environment* 140:1–44.

HALL, K. L. 2012. *Out of sight, out of mind: an updated study on the undergrounding of overhead power lines*. Edison Electric Institute, Washington, D.C., USA.

HARRISON, J. A., ALLAN, D. G. & VAN HENSBERGEN, H. J. 1994. Automated habitat annotation of bird species lists - an aid in environmental consultancy. *Ostrich* 65(3&4):316–328.

HARRISON, J. A., ALLAN, D. G., UNDERHILL, L. G., HERREMANS, M., TREE, A. J., PARKER, V. & BROWN, C. J. (eds.) 1997a. *The atlas of southern African birds, Vol.~1: Non-passerines*. BirdLife South Africa, Johannesburg.

HARRISON, J. A., ALLAN, D. G., UNDERHILL, L. G., HERREMANS, M., TREE, A. J., PARKER, V. & BROWN, C. J. (eds.) 1997b. *The atlas of southern African birds, Vol.~2: Passerines*. BirdLife South Africa, Johannesburg.

HERNANDEZ, R. R., EASTER, S. B., MURPHY-MARISCAL, M. L., MAESTRE, F. T., TAVASSOLI, M., ALLEN, E. B., BARROWS, C. W., BELNAP, J., OCHOA-HUESO, R., RAVI, S. & ALLEN, M. F. 2014. Environmental impacts of utility-scale solar energy. *Renewable and Sustainable Energy Reviews* 29:766–779.

HOCKEY, P. A. R., DEAN, W. R. J. & RYAN, P. G. (eds.) 2005. *Roberts - Birds of southern Africa*, 7

HUNTING, K. 2002. A roadmap for PIER research on avian collisions with power lines in California. Prepared for the California Energy Commission, Public Interest Energy Research Program. Report No. P500-02-071F.

JANSS, G. F. E. 2000. Avian mortality from power lines: a morphologic approach of a species-specific mortality. *Biological Conservation* 95(3):353–359.

JANSS, G. F. E. & FERRER, M. 1998. Rate of bird collision with power lines: effects of conductor-marking and static wire-marking. *Journal of Field Ornithology* 69(1):8–17.

JENKINS, A. 2008. WEIG visits the roof of Africa surveying power lines for vulture casualties in the Lesotho Highlands. Available athttp://www.ewt.org.za/programmes/WEP/Newsletters/Wildlife%20WATTch%20Dec%202008.pdf [accessed on 2 November 2013].

JENKINS, A. & SMALLIE, J. 2009. Terminal velocity. End of the line for Ludwig's Bustard? *Africa Birds and Birding* 14(2):34–39.

JENKINS, A. R., SMALLIE, J. J. & DIAMOND, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. *Bird Conservation International* 20:263–278.

KAGAN, R. A., VINER, T. C., TRAIL, P. W. & ESPINOZA, E. O. 2014. Avian mortality at solar energy facilities in southern California: a preliminary analysis, National Fish and Wildlife Forensics Laboratory.

KRÜGER, S. C., SIMMONS, R. E. & AMAR, A. 2015. Anthropogenic activities influence the abandonment of Bearded Vulture (*Gypaetus barbatus*) territories in southern Africa. *The Condor* 117:94–107.

KRUGER, T. L. 2010. Long term prospects for the persistence of breeding Verreaux's Eagles (*Aquila verreauxii*) at the Walter Sisulu National Botanical Garden, Johannesburg. Master's thesis, School of Animal, Plant and Environmental Sciences, University Of The Witwatersrand.

KUVLESKY, W. P. J., BRENNAN, L. A., MORRISON, M. L., BOYDSTON, K. K., BALLARD, B. M. & BRYANT, F. C. 2007. Wind energy development and wildlife conservation: challenges and opportunities. *Journal of Wildlife Management* 71(8):2487–2498.

LONGCORE, T. & RICH, C. 2004. Ecological light pollution. *Frontiers in Ecology and the Environment* 2(4):191–198.

LOVICH, J. E. & ENNEN, J. R. 2011. Wildlife conservation and solar energy development in the desert southwest, United States. *BioScience* 61(12):982–992.

MACHANGE, R. W. 2003. Eagles as indicators of ecosystem health: is the distribution of Martial Eagle nests in the Karoo influenced by variations in land-use and rangeland quality? Master's thesis, Percy FitzPatrick Institute of African Ornithology, University ofCape Town.

MACLEAN, G. L. 1985. *Roberts' birds of southern Africa*, 5

MARNEWICH, M. D., RETIEF, E. F., THERON, N. T., WRIGHT, D. R. & ANDERSON, T. A. 2015. *Important Bird and Biodiversity Areas of South Africa*. BirdLife South Africa, Johannesburg.

MARTIN, G. R. & SHAW, J. M. 2010. Bird collisions with power lines: Failing to see the way ahead?*Biological Conservation* 143(11):2695–2702.

MCCRARY, M. D., MCKERNAN, R. L., SCHREIBER, R. W., WAGNER, W. D. & SCIARROTTA, T. C. 1986. Avian mortality at a solar energy power plant. *Journal of Field Ornithology* 57(2):135–141.

MUCINA, L. & RUTHERFORD, M. C. (eds.) 2006. *The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19*. South African National Biodiversity Institute, Pretoria.

NAVARA, K. J. & NELSON, R. J. 2007. The dark side of light at night: physiological, epidemiological, and ecological consequences. *Journal of Pineal Research* 43(3):215–224.

OGDEN, L. J. E. 1996. *Collision course: The hazards of lighted structures and windows to migrating birds*. World Wildlife Fund Canada.

PERRY, G., BUCHANAN, B. W., FISHER, R. N., SALMON, M. & WISE, S. E. 2008. Effects of artificial night lighting on reptiles and amphibians in urban environments. Pages 239–256 in: Mitchell *et al.*(eds.). *Urban Herpetology*, Society for the Study of Amphibians and Reptiles, Salt Lake City, UT. Herpetological Conservation Number Three.

PETERS, D. 2012. Address by the Minister of Energy, Ms Dipuo Peters, MP. Sod-turning for the Solar Capital De Aar project, 10th December 2012. Available athttp://www.energy.gov.za/files/media/speeches/2012/Solar%20Capital%20Speech%2010%20December%202012.pdf[accessed on 7 May 2013].

PIECHOTA, T., VAN EE, J., BATISTA, J., STAVE, K. & JAMES, D. (eds.) 2002. *Potential environmental impacts of dust suppressants: "Avoiding another Times Beach"*. US Environmental Protection Agency. Panel Summary no. EPA/600/R-04/031.

PRINSEN, H. A. M., BOERE, G. C., PÍRES, N. & SMALLIE, J. J. 2011. Review of the conflict between migratory birds and electricity power grids in the African-Eurasian region. CMS Technical Series No. XX, AEWA Technical Series No. XX Bonn, Germany.

ROSA, B. D. S. 2010. Underground viability of alternating current with isolated XLPE cable of a 400 kV double circuit very high voltage line in the regions of Girona. Summary document outlining main issues. Available at http://www.cilma.cat/wp-content/uploads/2010/12/Sintesi_refos_C_en.pdf [accessed on 11 November 2013].

RSPB 2011. Solar power. RSPB briefing, March 2011. Available athttp://www.rspb.org.uk/Images/Solar_power_briefing_tcm9-273329.pdf [accessed on 10 April 2012].

SAVERENO, A. J., SAVERENO, L. A., BOETTCHER, R. & HAIG, S. M. 1996. Avian behavior and mortality at power lines in coastal South Carolina. *Wildlife Society Bulletin* 24(4):636–648.

SCOTT, R. E., ROBERTS, L. J. & CADBURY, C. J. 1972. Bird deaths from power lines at Dungeness. *British Birds* 65(7):273–286.

SHAW, J. M., JENKINS, A. R., RYAN, P. G. & SMALLIE, J. J. 2010. A preliminary survey of avian mortality on power lines in the Overberg, South Africa. *Ostrich* 81(2):109–113.

SHOBRAK, M. 2012. Electrocution and collision of birds with power lines in Saudi Arabia. *Zoology in the Middle East* 57:45–52.

SMALLWOOD, K. S. 2007. Estimating wind turbine-caused bird mortality. *The Journal of Wildlife Management* 71(8):2781–2791.

STEYN, P. 1982. *Birds of prey of southern Africa*. David Philip, Cape Town.

SYMES, C. T. & KRUGER, T. L. 2012. The persistence of an apex avian predator, Verreauxs' Eagle,*Aquila verreauxii*, in a rapidly urbanizing environment. *South African Journal of Wildlife Research* 42(1):45–53.

TAME TIMES 2015. The sky is the limit. Available at http://tametimes.co.za/the-sky-is-the-limit/[accessed on 20 March 2016].

TARBOTON, W. R. & ALLAN, D. G. 1984. *The status and conservation of birds of prey in the Transvaal, Vol.~3*. Transvaal Museum, Pretoria.

TARBOTON, W. R., KEMP, M. I. & KEMP, A. C. 1987. *Birds of the Transvaal*. Transvaal Museum, Pretoria.

TAYLOR, M. R. 2015. Verreauxs' Eagle *Aquila verreauxii*. Pages 206–208 in: Taylor *et al.* (eds.). *The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland*, BirdLife South Africa, Johannesburg.

TAYLOR, M. R., PEACOCK, F. & WANLESS, R. W. (eds.) 2015. *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

THE CAMPAIGN TO PROTECT RURAL ENGLAND (CPRE), CAMPAIGN FOR NATIONAL PARKS (CNP), & NATIONAL ASSOCIATION FOR AONBS (NAAONB), 2010. An independent evaluation report of the costs for underground high voltage cables in Great Britain.

THE ROYAL COMMISSION ON ENVIRONMENTAL POLLUTION 2009. *Artificial light in the environment*. The Stationery Office Limited, London.

THOMPSON, L. S. 1978. Transmission line wire strikes: mitigation through engineering design and habitat modification. Pages 27–52 in: Avery, M. L. (ed.) *Proceedings of a workshop on impacts of transmission lines on birds in flight*. . U.S. Fish and Wildlife Service, Washington, D.C., USA .

TROMBULAK, S. C. & FRISSELL, C. A. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology* 14(1):18–30.

UMEDA, S., ISHII, N., HORIGUCHI, N., MAEDA, M., YAMAGUCHI, T., TANAKA, H., NIINOBE, H., MIZUNO, T., MARUYAMA, S., IWASAKI, K., MAJIMA, H., AMANUMA, S., KAMIYAMA, H., TOKITA, M., OYA, S., SHIGETA, H. & AKASAKA, H. 2007. Underground power cable, distribution cable, overhead transmission line, industrial cable and their accessories. *Furukawa Review* 32:2–20.

UNIVERSITY OF QUEENSLAND, AUSTRALIA 2013. UQ solar photovoltaic data. Available athttp://www.uq.edu.au/solarenergy/pv-array/rainfall-other-factors [accessed on 29 May 2013].

VAN NIEKERK, D. J. 2012. Avicta treated Zea mays seed: Is South African wildlife at risk? A study commissioned by Syngenta.

VAN NIEKERK, D. J. 2013. Avifaunal impact assessment for proposed Cecilia substation and power line. A report to EnviroWorks.

VAN NIEKERK, D. J. 2015. Avifaunal impact assessment report for the proposed extension of the Bokamoso Photovoltaic Solar Energy Facility near Leeudoringstad, North West Province. A report to Environamics Environmental Consultants, xxx.

VAN ROOYEN, C. 2003. The management of wildlife interactions with overhead lines training manual. Eskom African Centre for Energy and Environment, Johannesburg.

VAN ROOYEN, C. S. & LEDGER, J. A. 1999. Birds and utility structures: developments in southern Africa. Pages 205–229 in: Ferrer, M. & Janss, G. F. E. (eds.) *Birds and Powerlines: collision, electrocution, and breeding*. . Quercus, Madrid, Spain .

VOSLOO, H. F. & VAN ROOYEN, C. 2009. Transmission bird collision prevention guideline. Available at http://www.zitholele.co.za/projects/12619%20-%20Camden/3%20Environmental%20Impact%20Assessment%20Phase/Final%20Environmental%20Impact%20Report/Appendix%20Q%20-%20Eskom%20Bird%20Collision%20Prevention%20Guideline.pdf [accessed on 8 November 2009].

WALSTON, L. J., ROLLINS, K. E., SMITH, K. P., LAGORY, K. E., SINCLAIR, K., TURCHI, C., WENDELIN, T. & SOUDER, H. 2015. A review of avian monitoring and mitigation information at existing utility-scale solar facilities. Available at http://www.evs.anl.gov/downloads/ANL-EVS_15-2.pdf [accessed on 29 October 2015].

WESTERN ECOSYSTEMS TECHNOLOGY, INC 2015. Bird and Bat Conservation Strategy (BBCS) for Genesis Solar Energy Project.

WILLIAMS, P. 2013. Installation of underground cables - LV to 132kV. UK Power Networks. Available at https://library.ukpowernetworks.co.uk/library/en/g81/Installation_and_Records/Cables/Docum

ents/ECS+02-0019+Installation+of+Underground+Cables+-+LV+to+132kV.pdf [accessed on 12 November 2013].

Table 1: Bird species expected to occur in the study area and environs (see Section 4). Each species is included in only one of five groups (A–E) with the groups arranged in descending ordered of priority. Name: Roberts' number (Maclean 1985) followed by English and scientific name based on BirdLife South Africa (2015) (E, endemic; n-E, near-endemic; RR, range restricted); Red Data status is based on Taylor *et al*. (2015); Habitat: Habitat preferences according to Harrison *et al*. (1994): AQ, Aquatic; FR, Forest; GR, Grassland; HG, Generalist; MR, Marine; RC, Montane\Rocky; SC, Scrub; WO, Woodland; REFrisk: Risk associated with the primary renewable energy structures (wind turbines/heliostats/PV panels) (see Section 4.3.1); EESrisk: Risk associated with power lines (see Section 4.3.2).

Name	**Red Data**	**Habitat**	**REFrisk**	**EESrisk**
			Disturb.	**Accident**
A. 23 RED DATA BOOK SPECIES:				
R090 Yellow-billed Stork (*Mycteria ibis*)	Endangered	AQ	**unlikely**	**unlikely**
R122 Cape Vulture (*Gyps coprotheres*) n-E	Endangered	HG	unlikely	low (c, e)
R132 Tawny Eagle (*Aquila rapax*)	Endangered	HG	unlikely	low (c, e)
R140 Martial Eagle (*Polemaetus bellicosus*)	Endangered	HG	unlikely	**Moderate (c, e)**
R165 African Marsh Harrier (*Circus ranivorus*)	Endangered	AQ	**unlikely**	**unlikely**
R168 Black Harrier (*Circus maurus*) n-E	Endangered	GR, SC	unlikely	unlikely
R209 Grey Crowned Crane (*Balearica regulorum*)	Endangered	AQ, GR	**unlikely**	**low (c, e)**
R232 Ludwig's Bustard (*Neotis ludwigii*)	Endangered	SC	low	**HIGH (c)**
R084 Black Stork (*Ciconia nigra*)	Vulnerable	AQ	**unlikely**	**low (c*, e*)**
R118 Secretarybird (*Sagittarius serpentarius*)	Vulnerable	HG	**HIGH**	**HIGH (c)**
R131 Verreauxs' Eagle (*Aquila verreauxii*)	Vulnerable	RC	**Moderate**	**Moderate (c, e)**
R172 Lanner Falcon (*Falco biarmicus*)	Vulnerable	HG	unlikely	low (c, e)
R231 Denham's Bustard (*Neotis denhami*)	Vulnerable	GR	unlikely	low (c)
R299 Burchell's Courser (*Cursorius rufus*)	Vulnerable	GR, SC	unlikely	unlikely
R096 Greater Flamingo (*Phoenicopterus roseus*)	Near-Threatened	AQ	**unlikely**	**Moderate (c)**

CONTINUED ON NEXT PAGE . . .

. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R097 Lesser Flamingo (*Phoeniconaias minor*)	Near-Threatened	AQ	**unlikely**	**Moderate (c)**
R117 Maccoa Duck (*Oxyura maccoa*)	Near-Threatened	AQ	**unlikely**	**unlikely**
R208 Blue Crane (*Anthropoides paradiseus*) n-E	Near-Threatened	GR	**HIGH**	**HIGH (c)**
R230 Kori Bustard (*Ardeotis kori*)	Near-Threatened	SC, WO	unlikely	low (c)
R235 Karoo Korhaan (*Eupodotis vigorsii*) n-E	Near-Threatened	GR, SC	**HIGH**	**Moderate (?)**
R247 Chestnut-banded Plover (*Charadrius pallidus*)	Near-Threatened	AQ, MR	**unlikely**	**unlikely**
R446 European Roller (*Coracias garrulus*)	Near-Threatened	WO	unlikely	low (c*, e*)
R721 African Rock Pipit (*Anthus crenatus*) E	Near-Threatened	RC	low	unlikely

B. 37 ADDITIONAL SPECIES POTENTIALLY NEGATIVE AFFECTED BY RENEWABLE ENERGY FACILITY

R162 Pale Chanting Goshawk (*Melierax canorus*)	Not listed	FR, SC, WO	low	**Moderate (c, e)**
R182 Greater Kestrel (*Falco rupicoloides*)	Not listed	GR, SC	**Moderate**	**Moderate (c, e)**
R190 Grey-winged Francolin (*Scleroptila afra*) E	Not listed	GR, SC	low	low (c)
R234 Blue Korhaan (*Eupodotis caerulescens*) E	Not listed	GR	**HIGH**	**HIGH (x)**
R239a Northern Black Korhaan (*Afrotis afraoides*)	Not listed	GR	**HIGH**	**HIGH (c)**
R255 Crowned Lapwing (*Vanellus coronatus*)	Not listed	GR	**HIGH**	unlikely
R297 Spotted Thick-knee (*Burhinus capensis*)	Not listed	HG	**HIGH**	unlikely
R301 Double-banded Courser (*Rhinoptilus africanus*)	Not listed	GR, SC	low	unlikely
R354 Cape Turtle Dove (*Streptopelia capicola*)	Not listed	HG	low	low (c)
R424 Speckled Mousebird (*Colius striatus*)	Not listed	WO	low	unlikely
R425 White-backed Mousebird (*Colius colius*)	Not listed	WO	low	unlikely

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R426 Red-faced Mousebird (*Urocolius indicus*)	Not listed	WO	low	unlikely
R495a Eastern clapper Lark (*Mirafra fasciolata*)	Not listed	GR	**HIGH**	unlikely
R506 Spike-heeled Lark (*Chersomanes albofasciata*)	Not listed	GR, SC	**HIGH**	unlikely
R507 Red-capped Lark (*Calandrella cinerea*)	Not listed	GR, SC	**Moderate**	**Moderate (c)**
R512 Large-billed Lark (*Galerida magnirostris*) E	Not listed	GR, SC	**HIGH**	unlikely
R516 Grey-backed Sparrow-lark (*Eremopterix verticalis*)	Not listed	GR, SC	**HIGH**	unlikely
R567 African Red-eyed Bulbul (*Pycnonotus nigricans*)	Not listed	WO	**Moderate**	unlikely
R586 Mountain Wheatear (*Oenanthe monticola*)	Not listed	RC	**Moderate**	unlikely
R587 Capped Wheatear (*Oenanthe pileata*)	Not listed	GR, SC	**Moderate**	low (c)
R589 Familiar Chat (*Cercomela familiaris*)	Not listed	HG	**Moderate**	unlikely
R591 Sickle-winged Chat (*Cercomela sinuata*) n-E	Not listed	GR, SC	**Moderate**	unlikely
R595 Ant-eating Chat (*Myrmecocichla formicivora*)	Not listed	GR, SC	**HIGH**	unlikely
R614 Karoo Scrub Robin (*Erythropygia coryphoeus*) n-E	Not listed	SC	**Moderate**	unlikely
R622 Layard's Tit-Babbler (*Sylvia layardi*)	Not listed	SC	**Moderate**	unlikely
R653 Yellow-bellied Eremomela (*Eremomela icteropygialis*)	Not listed	SC, WO	**Moderate**	unlikely
R665 Desert Cisticola (*Cisticola aridulus*)	Not listed	GR	**HIGH**	unlikely
R666 Cloud Cisticola (*Cisticola textrix*) n-E	Not listed	GR	**HIGH**	unlikely
R669 Grey-backed Cisticola (*Cisticola subruficapilla*)	Not listed	SC	**HIGH**	unlikely
R686a Karoo Prinia (*Prinia maculosa*) n-E	Not listed	SC	**HIGH**	unlikely
R688 Rufous-eared Warbler (*Malcorus pectoralis*)	Not listed	SC	**HIGH**	unlikely
R716 African Pipit (*Anthus cinnamomeus*)	Not listed	GR	**HIGH**	unlikely
R727 Cape Longclaw (*Macronyx capensis*)	Not listed	GR	**HIGH**	unlikely

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R746 Bokmakierie (*Telophorus zeylonus*)	Not listed	SC	low	unlikely
R852 African Quail-finch (*Ortygospiza fuscocrissa*)	Not listed	GR	low	unlikely
R885 Cape Bunting (*Emberiza capensis*)	Not listed	GR, RC, SC	low	unlikely
R887 Lark-like Bunting (*Emberiza impetuani*)	Not listed	SC, WO	**HIGH**	unlikely
C. 54 ADDITIONAL SPECIES POTENTIALLY NEGATIVE IMPACTED BY POWER LINES				
R006 Great Crested Grebe (*Podiceps cristatus*)	Not listed	AQ	**unlikely**	**low (x*)**
R008 Little Grebe (*Tachybaptus ruficollis*)	Not listed	AQ	**unlikely**	**low (x*)**
R055 White-breasted Cormorant (*Phalacrocorax lucidus*)	Not listed	AQ, MR	**unlikely**	**Moderate (c)**
R062 Grey Heron (*Ardea cinerea*)	Not listed	AQ, MR	**unlikely**	**low (c, e)**
R063 Black-headed Heron (*Ardea melanocephala*)	Not listed	HG	unlikely	low (c, e)
R064 Goliath Heron (*Ardea goliath*)	Not listed	AQ	**unlikely**	**low (c)**
R071 Western Cattle Egret (*Bubulcus ibis*)	Not listed	HG	unlikely	**Moderate (c, e)**
R083 White Stork (*Ciconia ciconia*)	Not listed	HG	unlikely	low (c, e)
R091 African Sacred Ibis (*Threskiornis aethiopicus*)	Not listed	HG	unlikely	**HIGH (c, e)**
R094 Hadeda Ibis (*Bostrychia hagedash*)	Not listed	HG	unlikely	low (c, e)
R095 African Spoonbill (*Platalea alba*)	Not listed	AQ	**unlikely**	**Moderate (?)**
R099 White-faced Whistling Duck (*Dendrocygna viduata*)	Not listed	AQ	**unlikely**	**Moderate (c)**
R102 Egyptian Goose (*Alopochen aegyptiaca*)	Not listed	AQ	**unlikely**	**HIGH (c, e)**
R103 South African Shelduck (*Tadorna cana*)	Not listed	AQ	**unlikely**	**HIGH (c)**
R104 Yellow-billed Duck (*Anas undulata*)	Not listed	AQ	**unlikely**	**HIGH (c)**

CONTINUED ON NEXT PAGE . . .

. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R108 Red-billed Teal (*Anas erythrorhyncha*)	Not listed	AQ	**unlikely**	**Moderate (?)**
R112 Cape Shoveler (*Anas smithii*)	Not listed	AQ	**unlikely**	**HIGH (?)**
R116 Spur-winged Goose (*Plectropterus gambensis*)	Not listed	AQ	**unlikely**	**HIGH (c, e)**
R127 Black-shouldered Kite (*Elanus caeruleus*)	Not listed	HG	unlikely	low (c, e)
R136 Booted Eagle (*Hieraaetus pennatus*)	Not listed	HG	unlikely	**Moderate (c*, e*)**
R143 Black-chested Snake Eagle (*Circaetus pectoralis*)	Not listed	HG	unlikely	low (c, e)
R148 African Fish Eagle (*Haliaeetus vocifer*)	Not listed	AQ	**unlikely**	**low (c, e)**
R149 Common (Steppe) Buzzard (*Buteo buteo*)	Not listed	HG	unlikely	low (c, e)
R152 Jackal Buzzard (*Buteo rufofuscus*) n-E	Not listed	HG	unlikely	low (c, e)
R169 African Harrier-Hawk (*Polyboroides typus*)	Not listed	HG	unlikely	low (e)
R170 Western Osprey (*Pandion haliaetus*)	Not listed	AQ	**unlikely**	**low (c*, e*)**
R171 Peregrine Falcon (*Falco peregrinus*)	Not listed	RC	unlikely	low (c*, e*)
R173 Eurasian Hobby (*Falco subbuteo*)	Not listed	HG	unlikely	low (c*, e*)
R181 Rock Kestrel (*Falco rupicolus*)	Not listed	HG	unlikely	low (c*, e*)
R183 Lesser Kestrel (*Falco naumanni*)	Not listed	GR	unlikely	low (c, e*)
R200 Common Quail (*Coturnix coturnix*)	Not listed	GR	unlikely	low (c*)
R203 Helmeted Guineafowl (*Numida meleagris*)	Not listed	HG	unlikely	low (c, e)
R226 Common Moorhen (*Gallinula chloropus*)	Not listed	AQ	**unlikely**	**low (c*)**
R228 Red-knobbed coot (*Fulica cristata*)	Not listed	AQ	**unlikely**	**low (c*)**
R258 Blacksmith Lapwing (*Vanellus armatus*)	Not listed	AQ	**unlikely**	**Moderate (c)**
R284 Ruff (*Philomachus pugnax*)	Not listed	AQ	**unlikely**	**low (c*, e*)**
R295 Black-winged Stilt (*Himantopus himantopus*)	Not listed	AQ	**unlikely**	**Moderate**

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R348 Rock Dove (*Columba livia*)	Not listed	HG	unlikely	low (c)
R349 Speckled Pigeon (*Columba guinea*)	Not listed	HG	unlikely	**Moderate (c, e)**
R355 Laughing Dove (*Streptopelia senegalensis*)	Not listed	HG	unlikely	low (c)
R356 Namaqua Dove (*Oena capensis*)	Not listed	HG	unlikely	low (c*)
R392 Western Barn Owl (*Tyto alba*)	Not listed	HG	unlikely	low (c, e)
R400 Cape Eagle-Owl (*Bubo capensis*)	Not listed	RC	unlikely	low (x)
R401 Spotted Eagle-Owl (*Bubo africanus*)	Not listed	HG	unlikely	low (c, e)
R411 Common Swift (*Apus apus*)	Not listed	HG	unlikely	**Moderate (c*)**
R480 Ground Woodpecker (*Geocolaptes olivaceus*) E	Not listed	RC	unlikely	low (c)
R518 Barn Swallow (*Hirundo rustica*)	Not listed	HG	unlikely	**Moderate (c*)**
R547 Cape Crow (*Corvus capensis*)	Not listed	HG	unlikely	low (e)
R548 Pied crow (*Corvus albus*)	Not listed	HG	unlikely	low (e)
R643 Willow Warbler (*Phylloscopus trochilus*)	Not listed	WO	unlikely	low (c*)
R689 Spotted flycatcher (*Muscicapa striata*)	Not listed	WO	unlikely	low (x*)
R733 Red-backed Shrike (*Lanius collurio*)	Not listed	WO	unlikely	low (c*)
R757 Common Starling (*Sturnus vulgaris*)	Not listed	HG	unlikely	low (c*)
R801 House Sparrow (*Passer domesticus*)	Not listed	HG	unlikely	low (c*)
D. 40 ADDITIONAL WATERBIRDS:				
R007 Black-necked Grebe (*Podiceps nigricollis*)	Not listed	AQ, MR	**unlikely**	**unlikely**
R058 Reed Cormorant (*Phalacrocorax africanus*)	Not listed	AQ	**unlikely**	**unlikely**

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R060 African Darter (*Anhinga rufa*)	Not listed	AQ	**unlikely**	**unlikely**
R066 Great Egret (*Egretta alba*)	Not listed	AQ	**unlikely**	**unlikely**
R067 Little Egret (*Egretta garzetta*)	Not listed	AQ, MR	**unlikely**	**unlikely**
R068 Yellow-billed Egret (*Egretta intermedia*)	Not listed	AQ	**unlikely**	**unlikely**
R076 Black-crowned Night Heron (*Nycticorax nycticorax*)	Not listed	AQ, MR	**unlikely**	**unlikely**
R078 Little Bittern (*Ixobrychus minutus*)	Not listed	AQ	**unlikely**	**unlikely**
R081 Hamerkop (*Scopus umbretta*)	Not listed	AQ	**unlikely**	**unlikely**
R093 Glossy Ibis (*Plegadis falcinellus*)	Not listed	AQ	**unlikely**	**unlikely**
R105 African Black Duck (*Anas sparsa*)	Not listed	AQ	**unlikely**	**unlikely**
R106 Cape Teal (*Anas capensis*)	Not listed	AQ	**unlikely**	**unlikely**
R113 Southern Pochard (*Netta erythrophthalma*)	Not listed	AQ	**unlikely**	**unlikely**
R213 Black Crake (*Amaurornis flavirostra*)	Not listed	AQ	**unlikely**	**unlikely**
R240 African Jacana (*Actophilornis africanus*)	Not listed	AQ	**unlikely**	**unlikely**
R245 Common Ringed Plover (*Charadrius hiaticula*)	Not listed	AQ, MR	**unlikely**	**unlikely**
R248 Kittlitz's Plover (*Charadrius pecuarius*)	Not listed	AQ	**unlikely**	**unlikely**
R249 Three-banded Plover (*Charadrius tricollaris*)	Not listed	AQ	**unlikely**	**unlikely**
R264 Common Sandpiper (*Actitis hypoleucos*)	Not listed	AQ, MR	**unlikely**	**unlikely**
R266 Wood Sandpiper (*Tringa glareola*)	Not listed	AQ	**unlikely**	**unlikely**
R269 Marsh Sandpiper (*Tringa stagnatilis*)	Not listed	AQ	**unlikely**	**unlikely**
R270 Common Greenshank (*Tringa nebularia*)	Not listed	AQ, MR	**unlikely**	**unlikely**
R272 Curlew Sandpiper (*Calidris ferruginea*)	Not listed	AQ, MR	**unlikely**	**unlikely**
R274 Little Stint (*Calidris minuta*)	Not listed	AQ, MR	**unlikely**	**unlikely**

CONTINUED ON NEXT PAGE . . .

. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R286 African Snipe (*Gallinago nigripennis*)	Not listed	AQ	**unlikely**	**unlikely**
R294 Pied Avocet (*Recurvirostra avosetta*)	Not listed	AQ	**unlikely**	**unlikely**
R339 White-winged Tern (*Chlidonias leucopterus*)	Not listed	AQ, GR	**unlikely**	**unlikely**
R428 Pied Kingfisher (*Ceryle rudis*)	Not listed	AQ	**unlikely**	**unlikely**
R429 Giant Kingfisher (*Megaceryle maxima*)	Not listed	AQ	**unlikely**	**unlikely**
R431 Malachite Kingfisher (*Alcedo cristata*)	Not listed	AQ	**unlikely**	**unlikely**
R520 White-throated Swallow (*Hirundo albigularis*)	Not listed	AQ	**unlikely**	**unlikely**
R533 Brown-throated Martin (*Riparia paludicola*)	Not listed	AQ	**unlikely**	**unlikely**
R631 African Reed Warbler (*Acrocephalus baeticatus*)	Not listed	AQ	**unlikely**	**unlikely**
R635 Lesser Swamp Warbler (*Acrocephalus gracilirostris*)	Not listed	AQ	**unlikely**	**unlikely**
R677 Levaillant's Cisticola (*Cisticola tinniens*)	Not listed	AQ, GR	**unlikely**	**unlikely**
R687 Namaqua Warbler (*Phragmacia substriata*) n-E	Not listed	AQ	**unlikely**	**unlikely**
R713 Cape Wagtail (*Motacilla capensis*)	Not listed	AQ	**unlikely**	**unlikely**
R824 Southern Red Bishop (*Euplectes orix*)	Not listed	AQ	**unlikely**	**unlikely**
R826 Yellow-crowned Bishop (*Euplectes afer*)	Not listed	AQ, GR	**unlikely**	**unlikely**
R846 Common Waxbill (*Estrilda astrild*)	Not listed	AQ	**unlikely**	**unlikely**
E. 106 ADDITIONAL SPECIES:				
R001 Common Ostrich (*Struthio camelus*)	Not listed	HG	unlikely	unlikely
R130 European Honey Buzzard (*Pernis apivorus*)	Not listed	WO	unlikely	unlikely
R155 Rufous-breasted Sparrowhawk (*Accipiter rufiventris*)	Not listed	HG	unlikely	unlikely

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R158 Black Sparrowhawk (*Accipiter melanoleucus*)	Not listed	FR, WO	unlikely	unlikely
R161 Gabar Goshawk (*Melierax gabar*)	Not listed	WO	unlikely	unlikely
R180 Amur Falcon (*Falco amurensis*)	Not listed	GR, WO	unlikely	unlikely
R193 Orange River Francolin (*Scleroptila gutturalis*)	Not listed	GR, WO	unlikely	unlikely
R199 Swainson's Spurfowl (*Pternistis swainsonii*)	Not listed	GR, WO	unlikely	unlikely
R252 Caspian Plover (*Charadrius asiaticus*)	Not listed	GR	unlikely	unlikely
R344 Namaqua Sandgrouse (*Pterocles namaqua*)	Not listed	SC	unlikely	unlikely
R352 Red-eyed Dove (*Streptopelia semitorquata*)	Not listed	WO	unlikely	unlikely
R377 Red-chested Cuckoo (*Cuculus solitarius*)	Not listed	FR, WO	unlikely	unlikely
R380 Great Spotted Cuckoo (*Clamator glandarius*)	Not listed	WO	unlikely	unlikely
R382 Jacobin Cuckoo (*Clamator jacobinus*)	Not listed	WO	unlikely	unlikely
R386 Diederik Cuckoo (*Chrysococcyx caprius*)	Not listed	GR, WO	unlikely	unlikely
R405 Fiery-necked Nightjar (*Caprimulgus pectoralis*)	Not listed	WO	unlikely	unlikely
R406 Rufous-cheeked Nightjar (*Caprimulgus rufigena*)	Not listed	WO	unlikely	unlikely
R412 African Black Swift (*Apus barbatus*)	Not listed	HG	unlikely	unlikely
R415 White-rumped Swift (*Apus caffer*)	Not listed	HG	unlikely	unlikely
R417 Little Swift (*Apus affinis*)	Not listed	HG	unlikely	unlikely
R418 Alpine Swift (*Tachymarptis melba*)	Not listed	HG	unlikely	unlikely
R421 African Palm Swift (*Cypsiurus parvus*)	Not listed	HG	unlikely	unlikely
R435 Brown-hooded Kingfisher (*Halcyon albiventris*)	Not listed	WO	unlikely	unlikely
R438 European Bee-eater (*Merops apiaster*)	Not listed	HG	unlikely	unlikely
R451 African Hoopoe (*Upupa africana*)	Not listed	WO	unlikely	unlikely

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R465 Acacia Pied Barbet (*Tricholaema leucomelas*)	Not listed	WO	unlikely	unlikely
R473 Crested Barbet (*Trachyphonus vaillantii*)	Not listed	WO	unlikely	unlikely
R474 Greater Honeyguide (*Indicator indicator*)	Not listed	WO	unlikely	unlikely
R476 Lesser Honeyguide (*Indicator minor*)	Not listed	WO	unlikely	unlikely
R486 Cardinal Woodpecker (*Dendropicos fuscescens*)	Not listed	WO	unlikely	unlikely
R492 Melodious Lark (*Mirafra cheniana*) n-E	Not listed	GR	unlikely	unlikely
R495b Cape Clapper Lark (*Mirafra apiata*)	Not listed	SC	unlikely	unlikely
R498 Sabota Lark (*Calendulauda sabota*)	Not listed	WO	unlikely	unlikely
R500c Eastern Long-billed Lark (*Certhilauda semitorquata*) E	Not listed	GR	unlikely	unlikely
R500d Karoo Long-billed Lark (*Certhilauda subcoronata*)	Not listed	SC	unlikely	unlikely
R502a Karoo Lark (*Calendulauda albescens*) E	Not listed	SC	unlikely	unlikely
R508 Pink-billed Lark (*Spizocorys conirostris*)	Not listed	GR	unlikely	unlikely
R523 Pearl-breasted Swallow (*Hirundo dimidiata*)	Not listed	HG	unlikely	unlikely
R526 Greater Striped Swallow (*Cecropis cucullata*)	Not listed	GR, SC	unlikely	unlikely
R528 South African Cliff Swallow (*Petrochelidon spilodera*) b-E	Not listed	GR	unlikely	unlikely
R529 Rock Martin (*Hirundo fuligula*)	Not listed	RC	unlikely	unlikely
R530 Common House Martin (*Delichon urbicum*)	Not listed	HG	unlikely	unlikely
R541 Fork-tailed Drongo (*Dicrurus adsimilis*)	Not listed	FR, WO	unlikely	unlikely
R550 White-necked Raven (*Corvus albicollis*)	Not listed	RC	unlikely	unlikely
R551 Grey Tit (*Parus afer*) n-E	Not listed	SC	unlikely	unlikely
R552 Ashy Tit (*Parus cinerascens*)	Not listed	WO	unlikely	unlikely
R557 Grey Penduline-Tit (*Anthoscopus minutus*)	Not listed	SC, WO	unlikely	unlikely

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R566 Cape Bulbul (*Pycnonotus capensis*) E	Not listed	SC	unlikely	unlikely
R572 Sombre Greenbul (*Andropadus importunus*)	Not listed	FR, WO	unlikely	unlikely
R577a Karoo Thrush (*Turdus smithi*) n-E	Not listed	WO	unlikely	unlikely
R577b Olive Thrush (*Turdus olivaceus*)	Not listed	FR, WO	unlikely	unlikely
R581 Cape Rock Thrush (*Monticola rupestris*) n-E	Not listed	RC	unlikely	unlikely
R582 Sentinel Rock Thrush (*Monticola explorator*) E	Not listed	GR, RC, SC	unlikely	unlikely
R583 Short-toed Rock Thrush (*Monticola brevipes*)	Not listed	RC	unlikely	unlikely
R590 Tractrac Chat (*Cercomela tractrac*)	Not listed	SC	unlikely	unlikely
R592 Karoo Chat (*Cercomela schlegelii*)	Not listed	SC	unlikely	unlikely
R596 African StoneChat (*Saxicola torquatus*)	Not listed	GR, SC	unlikely	unlikely
R601 Cape Robin-Chat (*Cossypha caffra*)	Not listed	FR, SC, WO	unlikely	unlikely
R621 Chestnut-vented Tit-Babbler (*Sylvia subcaerulea*)	Not listed	SC, WO	unlikely	unlikely
R645 Bar-throated Apalis (*Apalis thoracica*)	Not listed	FR, SC, WO	unlikely	unlikely
R651 Long-billed crombec (*Sylvietta rufescens*)	Not listed	SC, WO	unlikely	unlikely
R654 Karoo Eremomela (*Eremomela gregalis*) n-E	Not listed	SC	unlikely	unlikely
R660 Cinnamon-breasted Warbler (*Euryptila subcinnamomea*) n-E	Not listed	RC, SC	unlikely	unlikely
R664 Zitting Cisticola (*Cisticola juncidis*)	Not listed	GR	unlikely	unlikely
R681 Neddicky (*Cisticola fulvicapilla*)	Not listed	SC	unlikely	unlikely
R685 Black-chested Prinia (*Prinia flavicans*)	Not listed	SC, WO	unlikely	unlikely
R697 Chat Flycatcher (*Bradornis infuscatus*)	Not listed	SC, WO	unlikely	unlikely
R698 Fiscal Flycatcher (*Sigelus silens*) n-E	Not listed	WO	unlikely	unlikely
R703 Pririt Batis (*Batis pririt*)	Not listed	WO	unlikely	unlikely

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R706 Fairy Flycatcher (*Stenostira scita*) n-E	Not listed	SC, WO	unlikely	unlikely
R710 African Paradise Flycatcher (*Terpsiphone viridis*)	Not listed	FR, WO	unlikely	unlikely
R717 Long-billed Pipit (*Anthus similis*)	Not listed	RC	unlikely	unlikely
R718 Plain-backed Pipit (*Anthus leucophrys*)	Not listed	GR	unlikely	unlikely
R719 Buffy Pipit (*Anthus vaalensis*)	Not listed	GR	unlikely	unlikely
R732 Southern (Common) Fiscal (*Lanius collaris*)	Not listed	HG	unlikely	unlikely
R736 Southern Boubou (*Laniarius ferrugineus*)	Not listed	FR, WO	unlikely	unlikely
R742 Southern Tchagra (*Tchagra tchagra*) E	Not listed	FR, SC, WO	unlikely	unlikely
R759 Pied Starling (*Lamprotornis bicolor*) E	Not listed	HG	unlikely	unlikely
R760 Wattled Starling (*Creatophora cinerea*)	Not listed	HG	unlikely	unlikely
R764 Cape Glossy Starling (*Lamprotornis nitens*)	Not listed	WO	unlikely	unlikely
R769 Red-winged Starling (*Onychognathus morio*)	Not listed	RC	unlikely	unlikely
R770 Pale-winged Starling (*Onychognathus nabouroup*)	Not listed	RC	unlikely	unlikely
R775 Malachite Sunbird (*Nectarinia famosa*)	Not listed	SC	unlikely	unlikely
R783 Southern Double-collared Sunbird (*Cinnyris chalybeus*) n-E	Not listed	FR, SC	unlikely	unlikely
R788 Dusky Sunbird (*Cinnyris fuscus*)	Not listed	SC, WO	unlikely	unlikely
R792 Amethyst Sunbird (*Chalcomitra amethystina*)	Not listed	FR, WO	unlikely	unlikely
R796a Orange River White-eye (*Zosterops pallidus*)	Not listed	WO	unlikely	unlikely
R796b Cape White-eye (*Zosterops virens*) n-E	Not listed	FR, SC, WO	unlikely	unlikely
R799 White-browed Sparrow-Weaver (*Plocepasser mahali*)	Not listed	WO	unlikely	unlikely
R803 Cape Sparrow (*Passer melanurus*)	Not listed	HG	unlikely	unlikely
R804a Southern Grey-headed Sparrow (*Passer diffusus*)	Not listed	WO	unlikely	unlikely

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. . . Table 1 continued.

Name	Red Data	Habitat	REFrisk	EESrisk
			Disturb.	Accident
R813 Cape Weaver (*Ploceus capensis*) n-E	Not listed	GR, WO	unlikely	unlikely
R814 Southern Masked Weaver (*Ploceus velatus*)	Not listed	HG	unlikely	unlikely
R821 Red-billed Quelea (*Quelea quelea*)	Not listed	HG	unlikely	unlikely
R856 Red-headed Finch (*Amadina erythrocephala*)	Not listed	GR, SC, WO	unlikely	unlikely
R860 Pin-tailed Whydah (*Vidua macroura*)	Not listed	HG	unlikely	unlikely
R869 Yellow-fronted Canary (*Crithagra mozambica*)	Not listed	WO	unlikely	unlikely
R870 Black-throated Canary (*Crithagra atrogularis*)	Not listed	WO	unlikely	unlikely
R872 Cape Canary (*Serinus canicollis*)	Not listed	HG	unlikely	unlikely
R876 Black-headed Canary (*Serinus alario*) n-E	Not listed	SC	unlikely	unlikely
R877 Brimstone Canary (*Crithagra sulphurata*)	Not listed	HG	unlikely	unlikely
R878 Yellow Canary (*Crithagra flaviventris*)	Not listed	GR, SC	unlikely	unlikely
R879 White-throated Canary (*Crithagra albogularis*)	Not listed	SC	unlikely	unlikely
R881 Streaky-headed Seedeater (*Crithagra gularis*)	Not listed	SC	unlikely	unlikely
R884 Golden-breasted Bunting (*Emberiza flaviventris*)	Not listed	WO	unlikely	unlikely
R886 Cinnamon-breasted Bunting (*Emberiza tahapisi*)	Not listed	RC	unlikely	unlikely

Table 2. Total number of bird species recorded in the 3124BB QDGC and in the eight surrounding QDGCs but not in 3124BB (8QDGC). Percentages in brackets indicate the proportion of species where 3124BB is on or close to the edge of the species distribution.

Location	SABAP1&2	SABAP2 only	SABAP1 only	TOTAL
3124BB	106 (6.6%)	55 (41.8%)	14 (35.7%)	175 (20.0%)
8QDGC	34 (82.4%)	40 (97.5%)	11 (100%)	85 (91.8%)
SEC9Q	140(25.0%)	95 (65.3%)	25 (64.0%)	260 (43.5%)

Table 3. Relative completeness of the SABAP12 dataset. Numbers represent the number of bird species recorded. The 'Shared' column indicates the number of species recorded during the December 2015 fieldwork and which have also been recorded earlier during SABAP1/2.

Pentad/QDGC	Fieldwork		SABAP2	Total
	Unique	Shared	Unique	
A) SABAP 2				
3105_2450	47	60	12	119
3105_2455	90	3	1	94
3110_2450	22	55	27	104
3110_2455	32	79	34	145
All 4 pentads	33	116	17	166
3124BB	30	119	20	169
B) SABAP12				
3124BB	23	126	27	176

Table 4. Impact table assessing the significance of the impact of the proposed ptCSP development near Noupoort on birds during the construction phase.

Impacts: ptCSP construction phase:

Destruction of habitat and nests, and displacement of birds during the construction of roads and the ptCSP structures. Roads can also cause erosion.

Issue	Nature of impact	Extent of impact	No-Go Areas
Disturbance and displacement of birds and destruction of nests	Birds will experience habitat loss.	Local	Drainage lines & wetlands associated with the eastern and western Valley-Bottom Wetlands of the Noupoortspruit (see Figure 3)

Description of expected significance of impact:

If the No-Go and High sensitive areas are effectively avoided by the proposed construction activities, its impact on the five breeding resident Red Data species are predicted to be negligible. However, intrusion of the construction activities into these areas are likely to increase the negative impact risks for these species. In such cases the impact may entail temporary disturbance, temporary or permanent displacement, destruction of nests and or failed breeding attempts. The only mitigation then would be to schedule construction in these areas to take place during the non-breeding season of the species involved.

Non-threatened breeding resident bird species occurring inside and outside the No-Go and High sensitive areas are susceptible to impacts similar to those indicated above. However, regardless of the location of the proposed development it is unavoidable that some of these birds will be negatively impacted, particularly when the construction period overlaps with their breeding season. One possible mitigation strategy would be to schedule construction activities to occur outside the breeding season, but since these non-threatened birds are of low conservation concern, and because construction activities is likely to take place over a continuous and extended period of time, it is unlikely to be a feasible strategy.

Gaps in knowledge & recommendations for further study:

The site survey during December 2015 coincided with a widespread drought and all the major wetlands in WLS1 were dry. Subsequent rainfall inundated these wetlands and incidental observation during the February 2016 site survey indicated that they attract many birds. - From an impact assessment perspective a survey when the wetland areas are inundated will be an important time of the annual cycle to monitor. It will also be important to do observation on the birds of the area when grass is prominent. Therefore, assuming a normal rainfall pattern, the next survey will be undertaken in the second quarter of 2016 while the wetlands are still inundated and when grasses will be more prominent. This will be the final survey required for the pre-construction monitoring programme

Table 5. Impact table assessing the significance of the impact of the proposed ptCSP development near Noupoort on birds during the operational phase: solar fields and associated infrastructure.

Impacts: ptCSP operational phase The following impacts are identified as potential major impacts associated with the operation of the proposed Noupoort CSP Project and which will be assessed further during the EIA phase. » Permanent alteration of habitat within the CSP trough footprint » Collision with the CSP troughs and or perimeter fence.			
Issue	**Nature of impact**	**Extent of impact**	**No-Go Areas**
Permanent alteration of habitat within the CSP trough footprint	In order for solar energy facilities to be commercially viable, they require large tracts of land (~900ha). It can therefore be assumed that some habitat will be lost during the establishment of the facility and its associated infrastructure (including clearing for access roads and power lines). Habitat loss reduces the carrying capacity of the local area.	Confined to the solar field footprint area.	Drainage lines & wetlands associated with the eastern and western Valley-Bottom Wetlands of the Noupoortspruit and the south-western No-Go and High sensitive areas (see Figure 3).
Birds colliding with ptCSP infrastructure	Birds colliding with project infrastructure.	Confined to the solar field footprint area.	Drainage lines & wetlands associated with the eastern and western Valley-Bottom Wetlands of the Noupoortspruit and the south-western No-Go and High sensitive areas (see Figure 3)
Description of expected significance of impact: The potential impacts are expected to be negative and probable. Impacts during the operation			

phase will be long term. Reversibility of impacts is low, but there is no irreplaceable loss of resources associated with the potential impact. Possible mitigation measures will be investigated during the EIA phase.

Gaps in knowledge & recommendations for further study

The Avifauna Study during the EIA Phase will include the development of a detailed sensitivity map indicating the utilisation of the area by species of concern and the presence of relevant sensitive habitat features.

Table 6. Impact table assessing the significance of the impact of the proposed ptCSP development near Noupoort on birds during the operational phase: power lines.

Impacts: Power lines

It is not yet possible to evaluate the risks involved because the alignment of the new power line is not yet known. Potential major impacts include collisions with power lines and electrocution.

Issue	**Nature of impact**	**Extent of impact**	**No-Go Areas**
Birds colliding with power line and/or electrocution	Fatal interactions involving birds and power line infrastructure include cases where birds collide with the power lines and/or when they cause a short circuit on electricity infrastructure."	Local	Drainage lines & wetlands associated with the eastern and western Valley-Bottom Wetlands of the Noupoortspruit (see Figure 3)

Description of expected significance of impact:

The potential impacts are expected to be negative and probable. Impacts during the operation phase will be long term. Reversibility of impacts is low, but there is no irreplaceable loss of resources associated with the potential impact. Any power line crossing wetland systems is highly likely to present a significant collision risk to birds such as the Blue Crane *Anthropoides paradiseus*. Possible mitigation measures will be investigated during the EIA phase.

Gaps in knowledge & recommendations for further study:

The alignment of the new power line is not yet known. The following activities will be included as part of the Avifauna Study during the EIA Phase:

» Second field survey in the wet season.
» A detailed sensitivity map will be produced and will include mapping and incorporation of any sensitive features that may occur on site.
» The presence of species of concern will be evaluated.

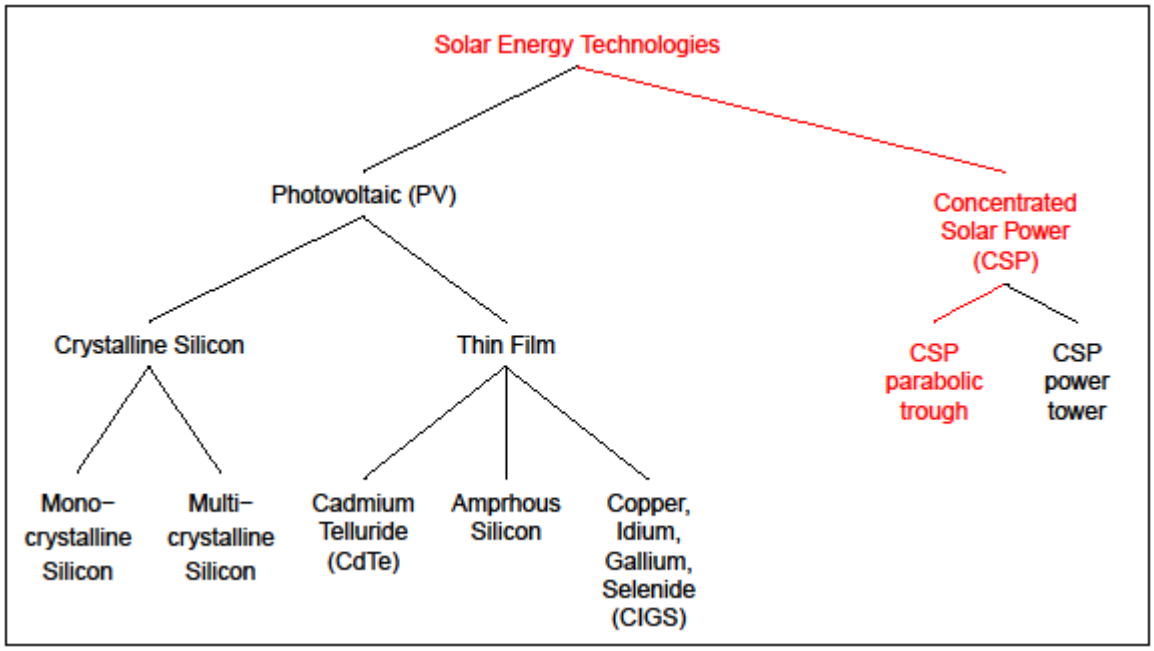

Figure 1: The most widely adopted solar energy technologies (First Solar 2011; Hernandez *et al*. 2014).

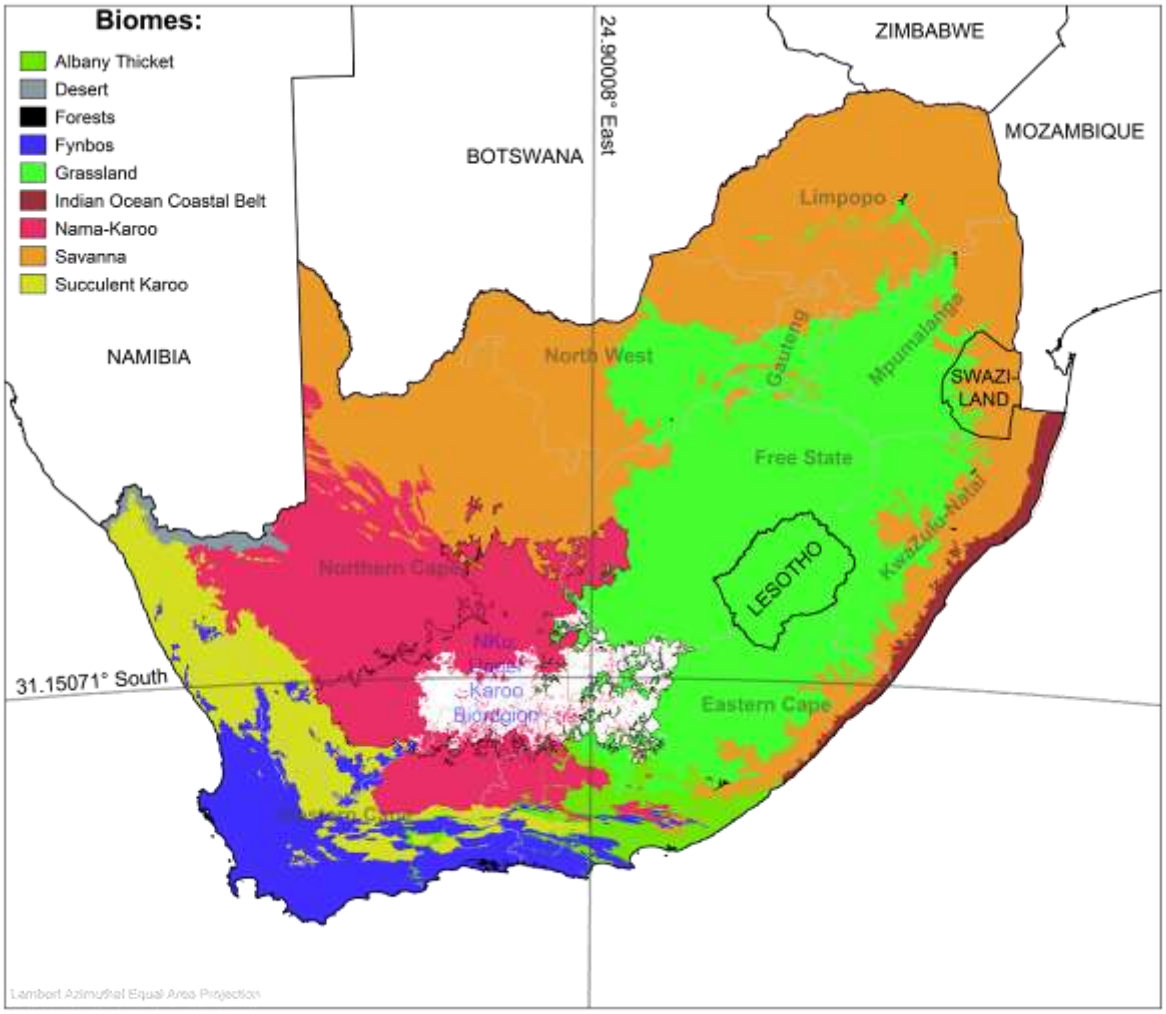

Figure 2: Location of the proposed ptCSP facility near Noupoort, Northern Cape Province, in relation to the South African biomes. White areas within the Upper Karoo Bioregion (NKu; Delineated) represent the distribution of the Eastern Upper Karoo (NKu 4) vegetation unit. The proposed ptCSP facility is located at the intersection of the pair of latitudinal and longitudinal lines. The red block indicates the extent of the SAC9Q-block enlarged in Figure 11. Vegetation data from Mucina & Rutherford (2006).

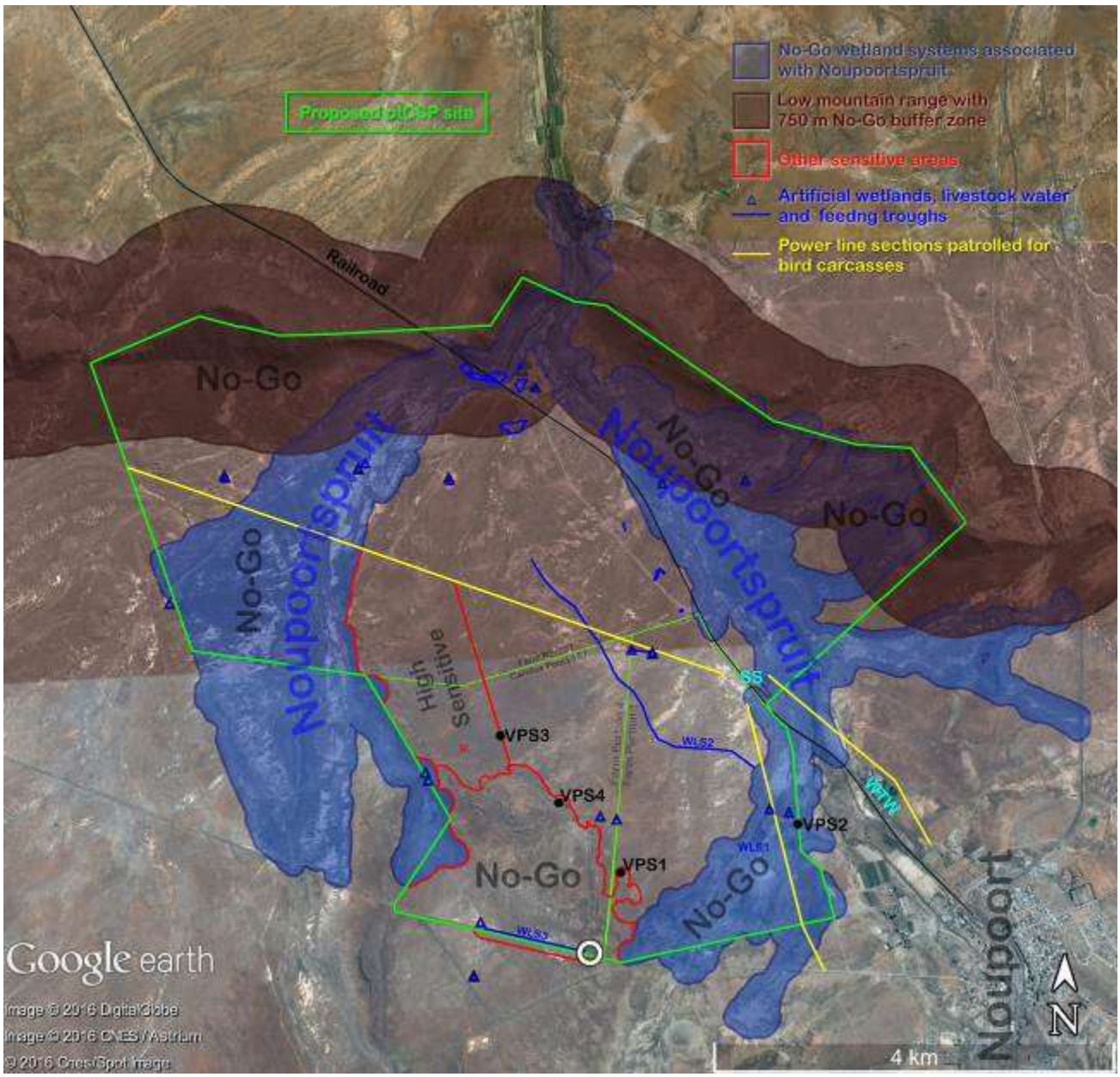

Figure 3: Avifaunal sensitivity map of the proposed ptCSP site (demarcated by the green line) located north-west of Noupoort, Northern Cape Province. The site consists of portions 1 (east) & 4 (west) of the farm Carolus Poort 167 in the south and the much larger Remaining Extent of Farm 207 in the north. The white circle near the southern border of the site and the eastern end of WLS3 indicates the location of a Secretarybird R118 nesting tree (see also Figure 9) while the red R in the high sensitive zone further north indicates the location of trees they use for roosting. VPS, Vantage Point Survey stations; WLS, wetland system; WTW, Noupoort WTW; SS, Newgate sub-station. See also the legend at the top.

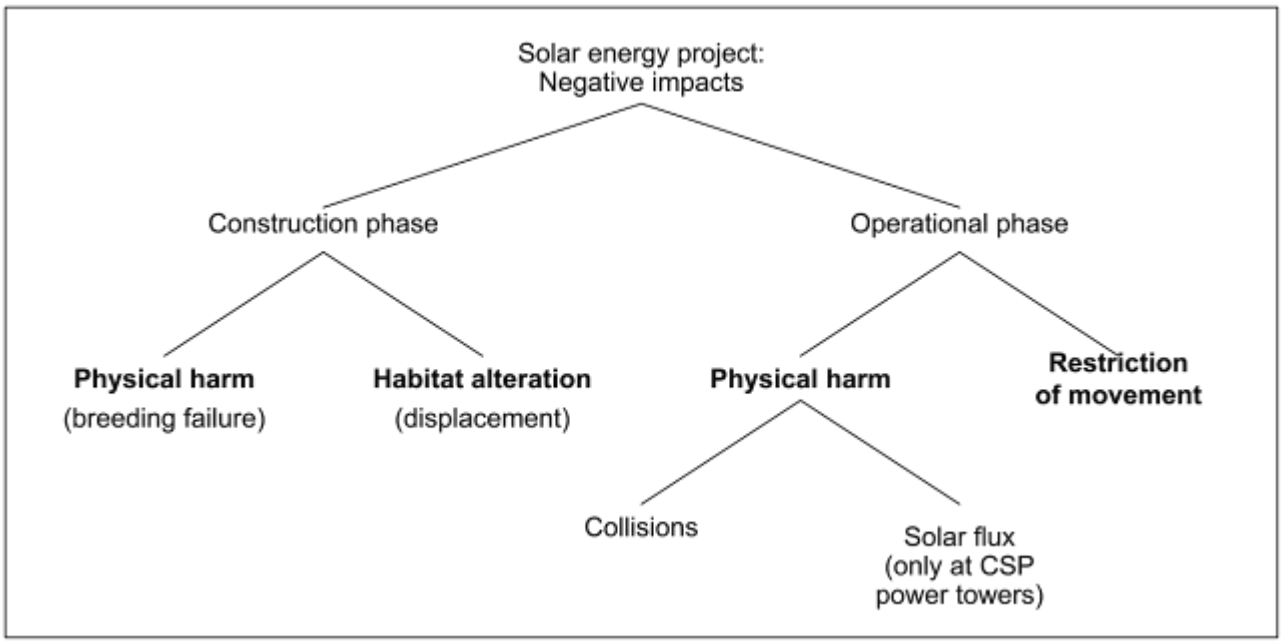

Figure 4 Summary of impact categories associated with solar energy projects. All these impacts are relevant to all utility scale solar technology types (see Figure 1), except solar-flux-related incidents which have only been observed at Concentrated Solar Power (CSP) power towers (Walston *et al*. 2015).

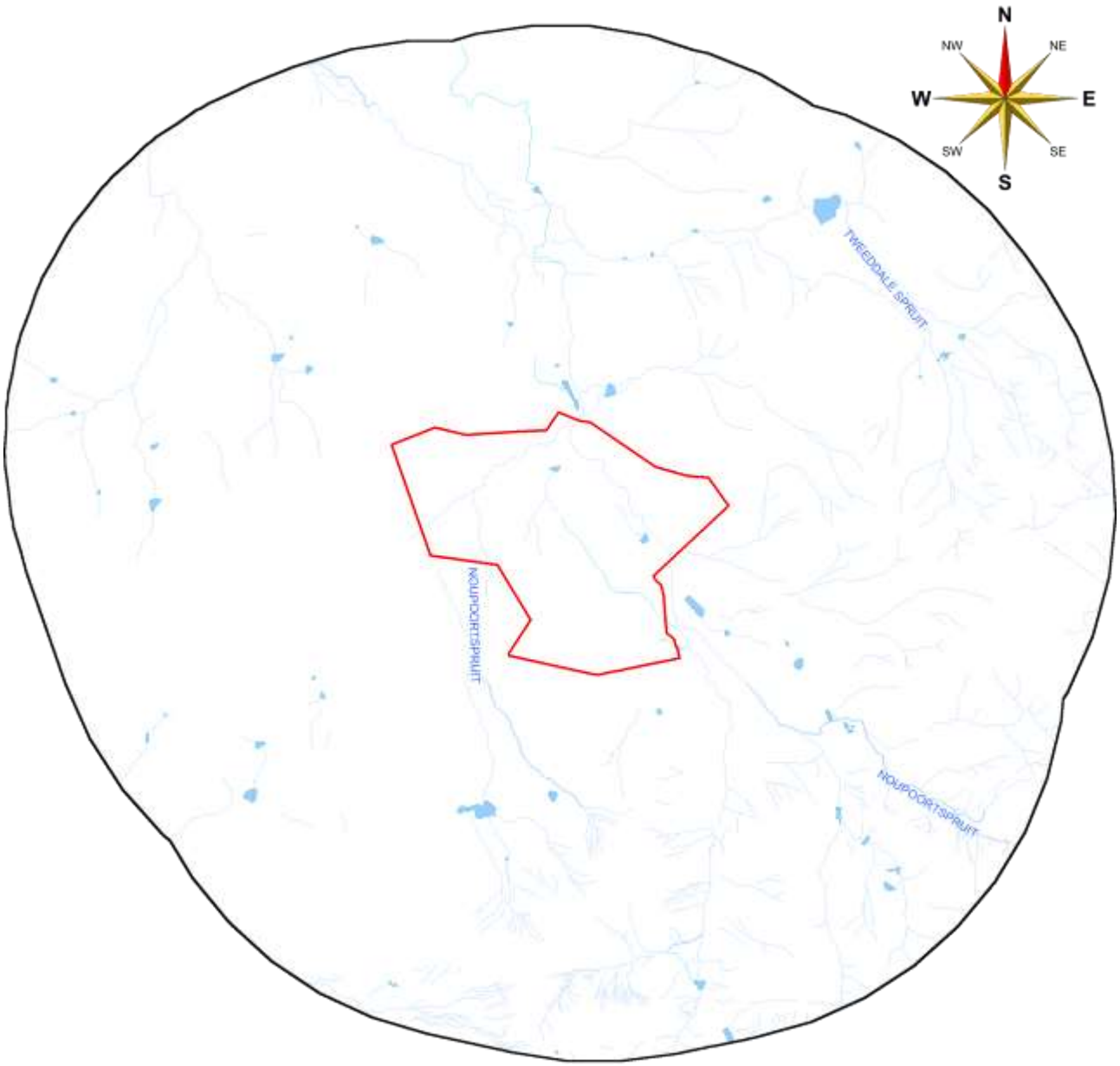

Figure 5: Wetland systems within 10 km (black outline) from the proposed ptCSP site (red outline). Most of these systems are ephemeral. Wetland outlines from the PlanetGIS SA-topo50 map (version 19 September 2014; www.planetgis.net).

A) Dwarf shrubland. The Newgate substation (SS) is visible in the distance.

B) Grassland with rocky outcrop in the background. Note also the four Blue Cranes R208 in the foreground.

Figure 6: Habitats found in the study area. See also Figure 8.

A) Western branch with typical Eastern Upper Karoo habitat.

B) Eastern branch with tall bushes.

Figure 7: The two major branches of Noupoortspruit close to their confluence. Both pictures were taken from different points along the northern mountain range.

Figure 8: Examples of the habitat components in WLS1 (see also Figure 3).

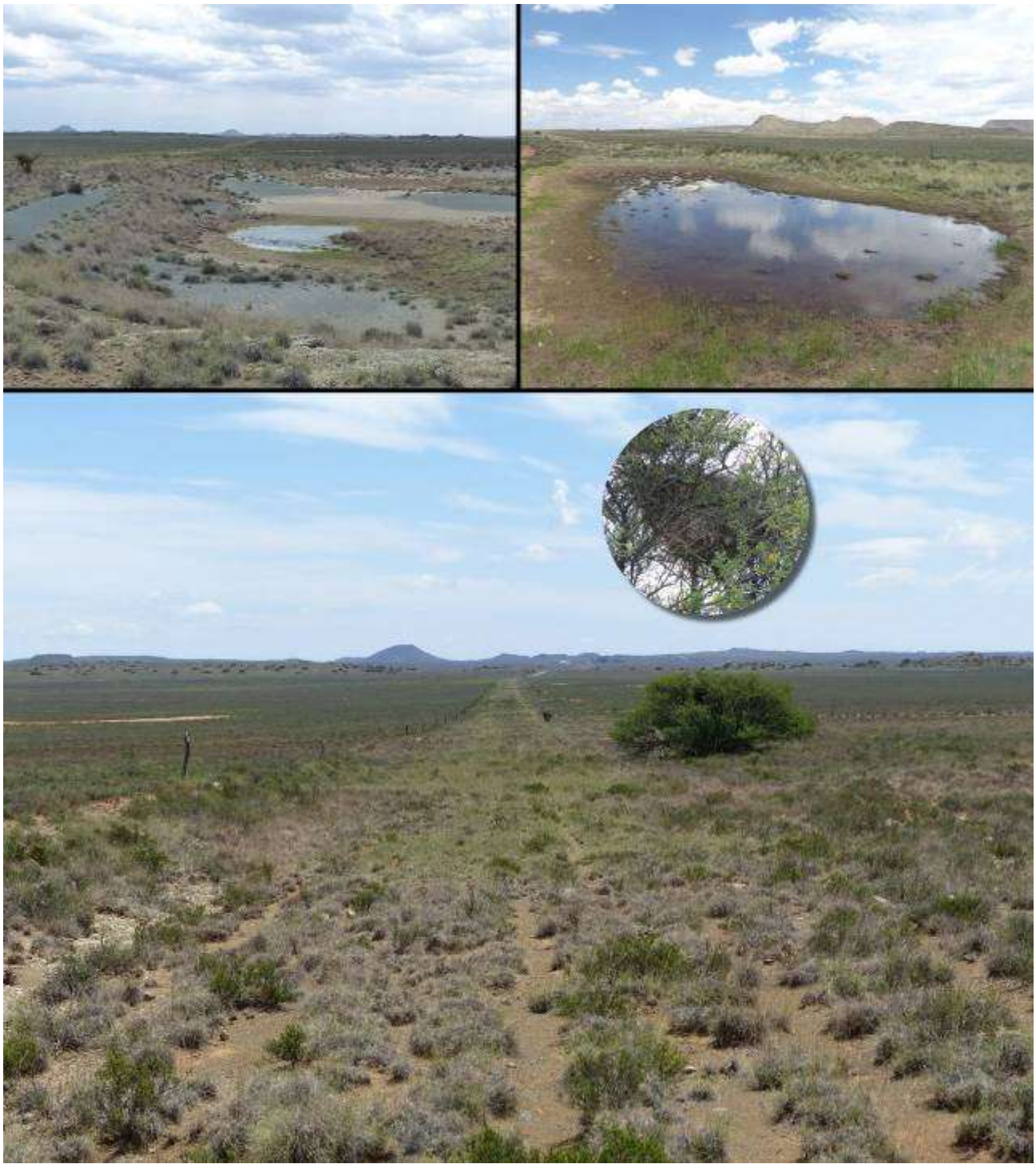

Figure 9: The southern border of Portion 4 of the farm Carolus Poort 167 was once a road. Currently there is no fence and the enclosure extends further south (left) to a gravel road. The two picture at the top shows examples of wetlands occurring along its northern (right-hand) edge. The inset in the bottom picture shows the Secretarybird R118 nest located in the tree. See also Figure 3.

Figure 10: Small wetland, water and livestock feeding troughs in the north of the proposed ptCSP footprint area (see Figure 3). The red 'x' in the bottom picture highlights the location of the dam seen in the top picture.

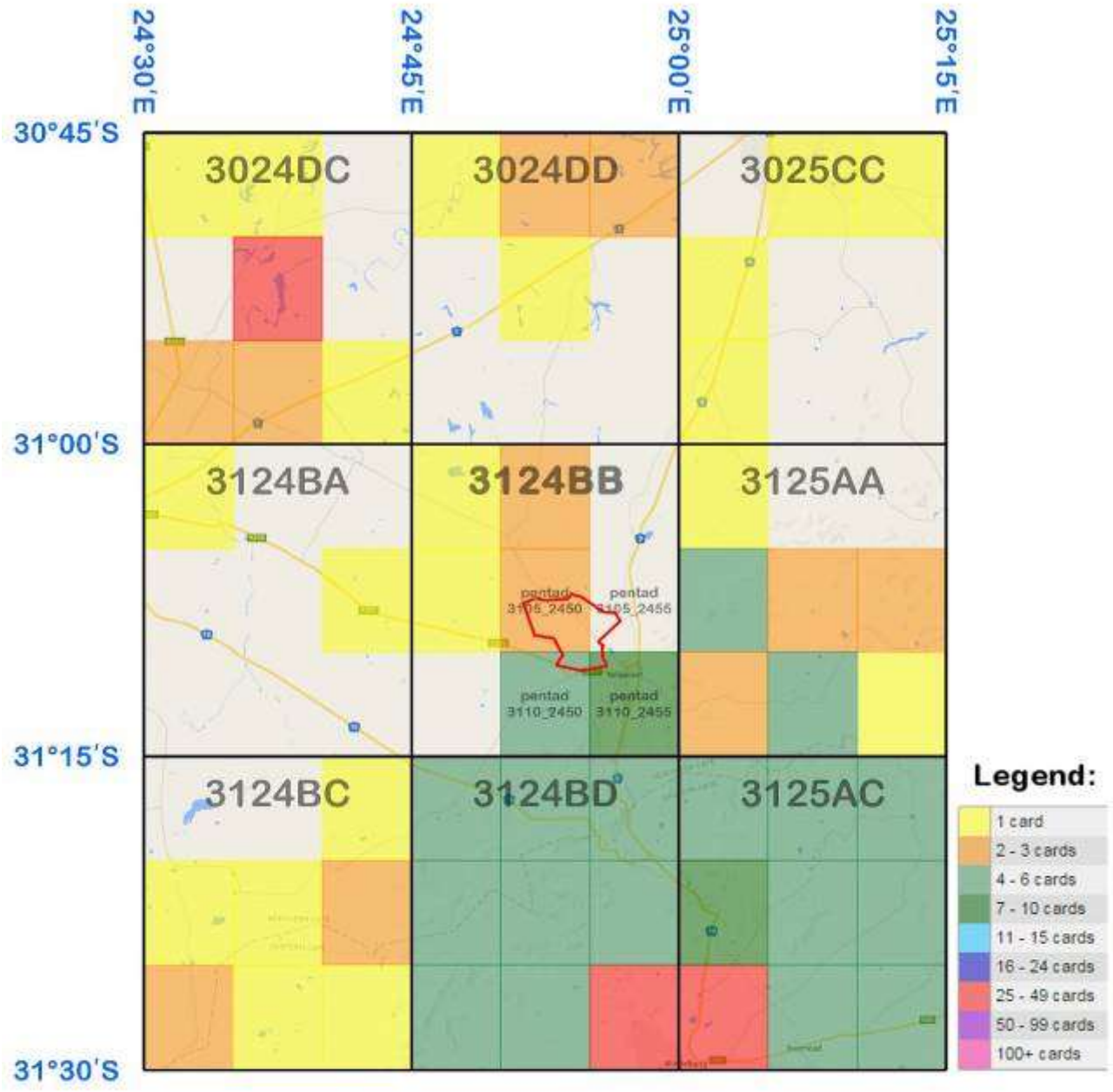

Figure 11: SABAP2 coverage of the nine quarter degree grid cells (SAC9Q-block) centred on 3124BB as on 16 March 2016 (http://sabap2.adu.org.za/coverage.php). Each coloured block represents a pentad, i.e. a 5' latitude by 5' longitude block, with the colours of each indicating the number full protocol cards submitted for it to date (see legend bottom-right). The small red delineated area near the centre straddling the four indicated pentads signifies the borders of the three farm portions on which the proposed ptCSP development is planned.

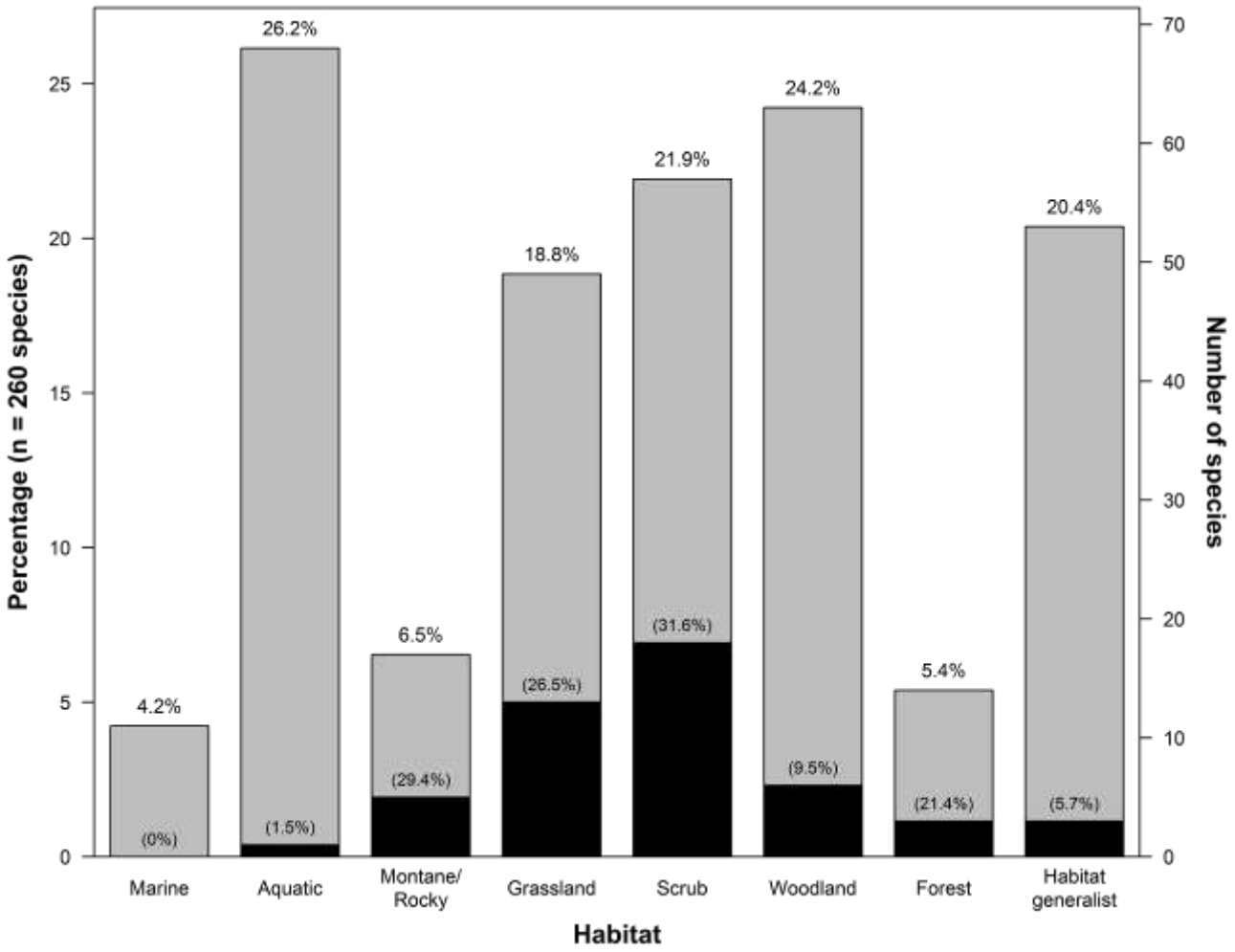

Figure 12: Habitat preferences of bird species occurring in the SAC9Q-block. The black part of each bar indicates species which are endemic or near-endemic with the percentage that they constitute of each habitat indicated in brackets. Note that species which are not indicator species may be associated with more than one habitat type (see page 17), hence the percentages given above do not add up to 100%. Data from Table 1.

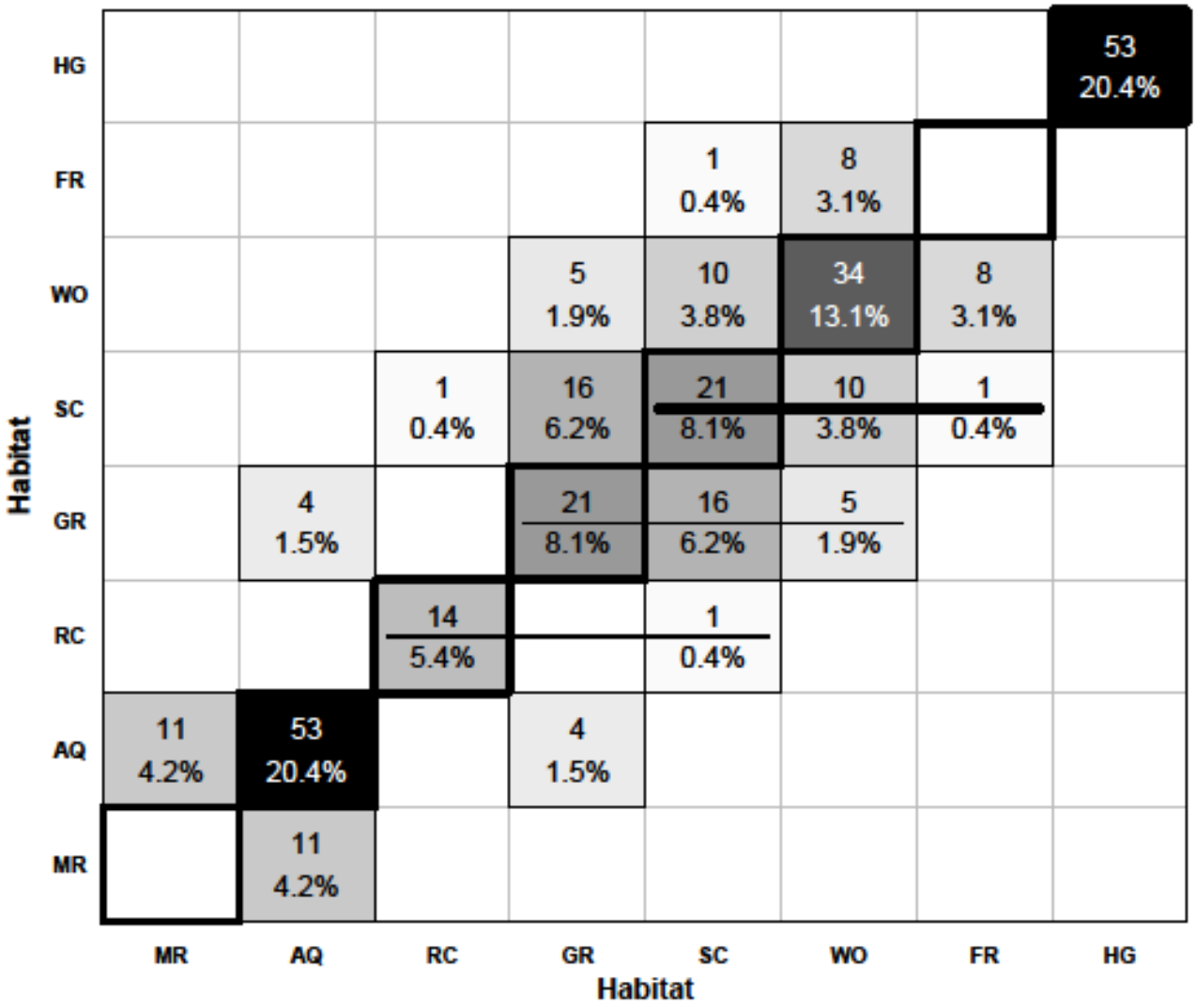

Figure 13: Habitat preference combinations of all species recorded in the SAC9Q-block. Numbers represent species totals while percentages indicate the proportion of all species (n = 260). The three horizontal lines represent from top to bottom five, one and two species associated with three habitats. Shading of each block is relative to the combination with the highest proportion (Aquatic).

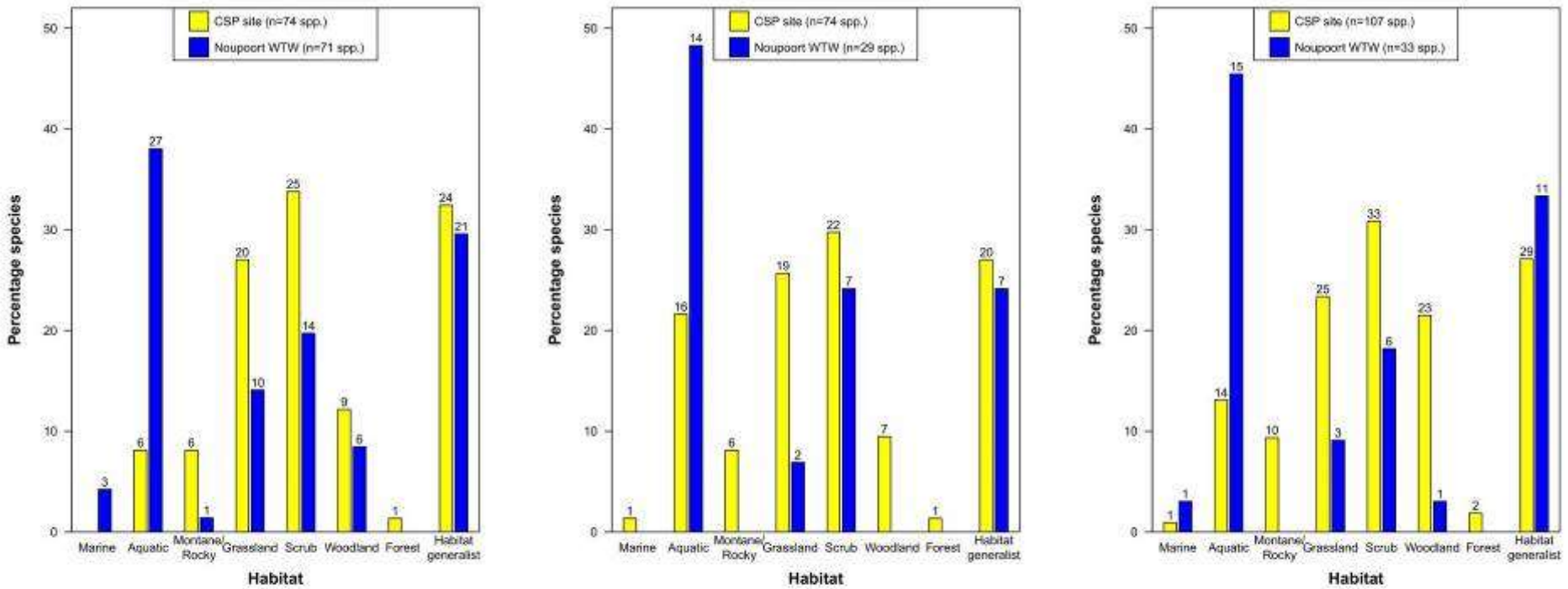

Figure 14: Habitat preference of bird species recorded in the proposed ptCSP site and at the Noupoort WTW. Whereas the WTW was visited during all days during the December 2015, it was visit only once each during the February and March site visits. The number above each bar represents the actual number of species recorded in each case.

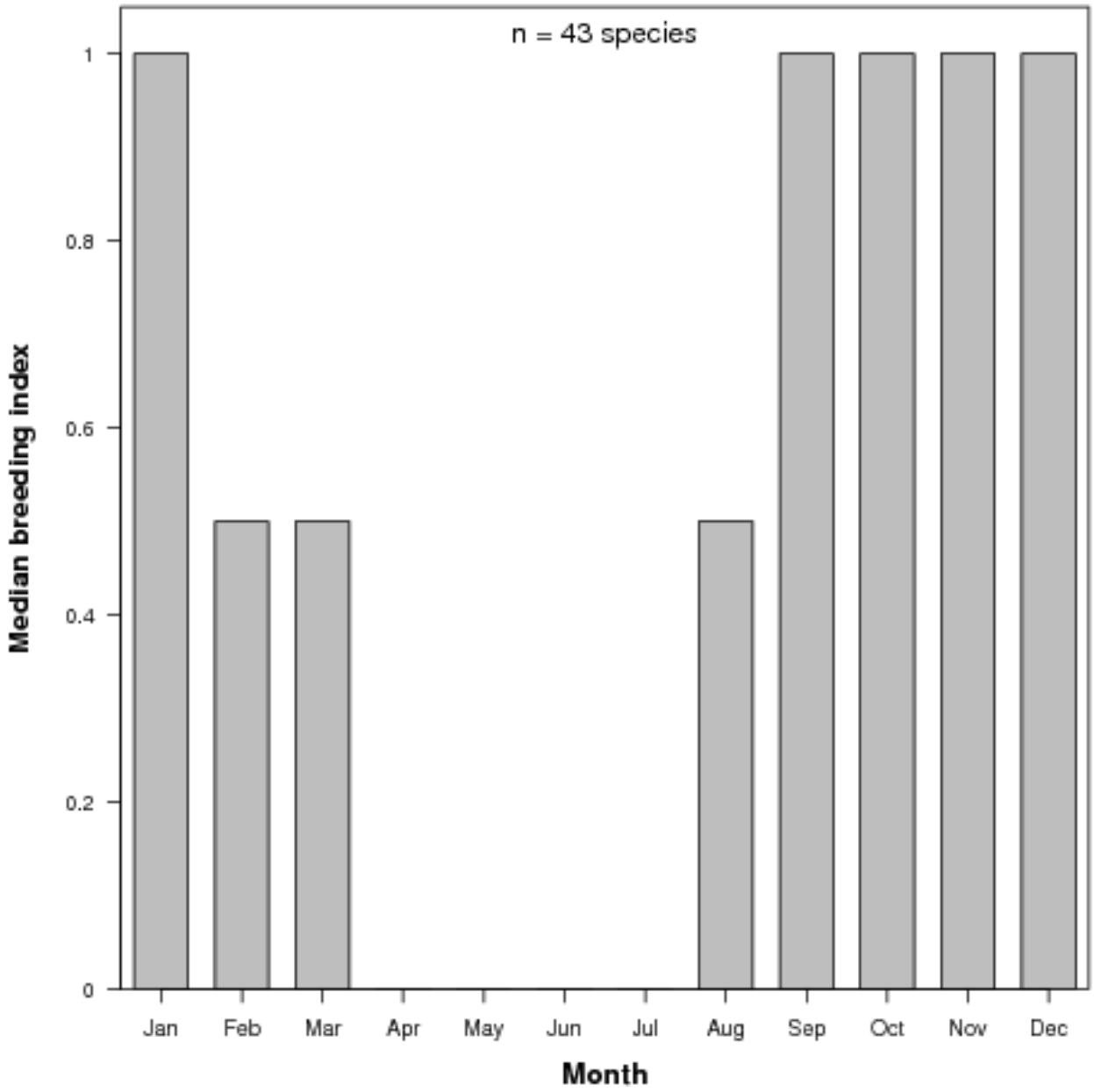

Figure 15: The monthly median breeding index. See Section 4.3.1.

Figure 16: Example of bird flight diverters employed on the earth wires of a power line.

APPENDIX A: Curriculum Vitae: Dr. D. J. van Niekerk

GENERAL

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TERTIARY QUALIFICATIONS

» B. Sc. (Biochemistry and Zoology). University of the Free State (1994)

» B. Sc. Honours in Zoology. University of the Free State (1995)

» M. Sc. in Zoology with distinction. University of the Free State (2000)

» Ph.D. in Zoology. University of the Free State (2009)

Additional courses:

» Taxidermy course. National Museum, Bloemfontein. June 1988.

» EIA, Centre for Environmental Management, University of the Free State, January 2006

WORK EXPERIENCE

Savannah Environmental	Avifauna specialist	Since 2015
Environamics Environmental Consultants	Avifauna specialist	2015
Tlokoeng Valley Biodiversity Conservation Project (Lesotho)	Project manager for the biological component	Since 2012
Nare Sereto CC	Avifauna specialist	Since 2012
Enviroworks	Avifauna specialist	Since 2009
Gold Fields Limited (Beatrix mine)	Avifauna specialist	2008
Syngenta	Trainer of personnel in Brazil for conducting risk assessment studies	2010
	Project manager for risk assessment studies	2006–2007; 2010–2011
Conserving Mountain Biodiversity in Southern Lesotho (UNDP project)	Project manager for bird component	2003-2004
Lesotho Highlands Development Authority	Project manager for bird component of monitoring and	2002-2003

	faunal rescue at Mohale Dam	
University of the Free State	Research associate Temporary lecturer Laboratory assistant	2010-2012 2006-2007 1995-2005 & 2008-2009

Specialist reports:

» Van Niekerk, D.J. 2002. Birds. In: Biological Resource Monitoring Contract LHDA 1053: Annual Report 2001/2002 (ed. C. Mokuku). NUL-CONSULS, Maseru, Lesotho.

» Van Niekerk, D.J. 2003. Birds. In: Contract LHDA 1053: Biological Resource Monitoring. Final report. NUL-CONSULS, Maseru, Lesotho.

» Van Niekerk, D.J. 2003. Faunal Rescue at Mohale Dam: December 2003 report on birds. NUL-CONSULS, Maseru, Lesotho.

» Van Niekerk, D.J. 2004. CMBSL bird report for the period November 2003. Report to the UNDP funded Conserving Mountain Biodiversity in Southern Lesotho Project.

» Van Niekerk, D.J. 2004. CMBSL bird report (May 2004 draft). Report to the UNDP funded Conserving Mountain Biodiversity in Southern Lesotho Project.

» Van Niekerk, D.J. 2007. The risk of wildlife consuming planted *Zea mays* seeds: A South African perspective. A study commissioned by Syngenta.

» Van Niekerk, D.J. 2008. Beatrix, Birds and BAD cyanides: First assessment for the International Cyanide Management Code Operations Principle.

» Van Niekerk, D.J. 2009. The impact of development in the Vaalbank Spruit section of Erfenis Dam on birds. Report to Enviroworks CC.

» Van Niekerk, D.J. 2009. Potential impact of proposed new 66 kV powerline in the Buffeljags area on birds. Report to Enviroworks CC.

» Van Niekerk, D.J. 2010. Potential impact of proposed installation of 2 x 20 MVA 88/11 kV transformers at the new Barcelona substation on birds. Report to Enviroworks CC.

» Van Niekerk, D.J. 2010. Potential impact of proposed 132kV inter-connector line at Thabong on birds. Report to Enviroworks CC.

» Van Niekerk, D.J. 2010. Animals on recently planted corn (Zea mays) fields in Brazil: An abridged report on the September 2010 survey. Report to Syngenta.

» Van Niekerk, D.J. 2011. Potential impact of the proposed 132 kV double circuit powerline at Botshabelo on birds. Report to Enviroworks CC.

» Van Niekerk, D.J. 2012. Avicta treated *Zea mays* seed: Is South African wildlife at risk? A study commissioned by Syngenta.

» Van Niekerk, D.J. 2012. Potential impact of the proposed 132 kV double circuit powerline at Botshabelo on birds: November 2012 update. Report to Enviroworks CC.

» Van Niekerk, D.J. 2012. Potential impact of the proposed SolFocus concentrator photovoltaics near Prieska, Northern Cape, on birds. Report to Nare Sereto CC.

» Van Niekerk, D.J. 2013. Potential impact of the proposed 75 MW First Solar CdTe photovoltaics development near Prieska, Northern Cape, on birds. Report to Nare Sereto CC.

» Van Niekerk, D.J. 2013. Avifaunal impact assessment for proposed Cecilia substation and power line. Report to Enviroworks CC.

» Van Niekerk, D.J. 2015. The status of birds in Tlokoeng Valley, northern Lesotho: July 2012 -- June 2014. A report to the Environmental & Sustainability Education Network of Lesotho.

» Van Niekerk, D.J. 2015. Desktop Avifaunal Assessment for the proposed Harvard to Noordstad power line, Bloemfontein. Report to Enviroworks CC.

» Van Niekerk, D.J. 2015. Avifaunal Impact Assessment report for the proposed extension of the Bokamoso Photovoltaic Solar Energy Facility near Leeudoringstad, North West Province. Report to Environamics Environmental Consultants.

» Van Niekerk, D. J. 2016. Feasibility study for the proposed construction of the Semonkong Wind Farm in Lesotho: Avifauna. Report to Savannah Environmental.

» Van Niekerk, D. J. 2016. Environmental Impact Assessment for the proposed construction of the 150 MW Sol Invictus 1 photovoltaic facility near Aggeneis in the Northern Cape Province: Avifauna. Report to Savannah Environmental.

» Van Niekerk, D. J. 2016. Environmental Impact Assessment for the proposed construction of the 150 MW Sol Invictus 2 photovoltaic facility near Aggeneis in the Northern Cape Province: Avifauna. Report to Savannah Environmental.

» Van Niekerk, D. J. 2016. Environmental Impact Assessment for the proposed construction of the 150 MW Sol Invictus 3 photovoltaic facility near Aggeneis in the Northern Cape Province: Avifauna. Report to Savannah Environmental.

» Van Niekerk, D. J. 2016. Environmental Impact Assessment for the proposed construction of the 150 MW Sol Invictus 4 photovoltaic facility near Aggeneis in the Northern Cape Province: Avifauna. Report to Savannah Environmental.

CONFERENCE CONTRIBUTIONS

» Van Niekerk, D.J. & Kok, O.B. 1995. Daaglikse aktiwiteite van die Vlaktelewerik *Chersomanes albofasciata*. Oral presentation during S.A. Academy Symposium, Section Biology, at Stellenbosch.

» Colahan, B.D. & Van Niekerk, D.J. 2008. The Lesser Kestrel at communal roosts in the Free State, South Africa --- a coordinated survey. 12th Pan-African Ornithological Congress, South Africa, 7--12 September 2008.

» Van Niekerk, D.J. 2008. The activity patterns of birds in the central Free State, South Africa. 12th Pan-African Ornithological Congress, South Africa, 7--12 September 2008.

SCIENTIFIC ARTICLES IN INTERNATIONALLY ACCREDITED JOURNALS

» De Swardt, D. H. & Van Niekerk, D. J. (1996). An annotated checklist of the birds of Qwa-Qwa National Park. *Koedoe* 39(1):89--106.

» Belozerov, V. N., Van Niekerk, D. J. & Butler, H. J. B. (2003). Population structure of *Argas arboreus* (Acari: Argasidae) ticks associated with seasonally abandoned mixed heronries, dominated by Cattle Egrets (Bubulcus ibis), in South Africa. *Onderstepoort Journal of Veterinary Research* 70:325--330.

» Van Niekerk, D. J., Fourie, L. J. & Horak, I. G. 2006. Birds as hosts of immature ixodid ticks in Free State Province, South Africa. *Onderstepoort Journal of Veterinary Research* 73:123--130.

SCIENTIFIC ARTICLES IN NON-ACCREDITED JOURNALS

» Van Niekerk, D. J. 1994. The Turnstone *Arenaria interpres* in the Orange Free State. *Mirafra* 11(1):23--24.

» Van Niekerk, D. J. 1994. Moult in immature male Lesser Kestrels *Falco naumanni*. *Mirafra* 11(2):30--31.

» Van Niekerk, D. J. 1996. Albino Pied Starling *Spreo bicolor* (Sturnidae) with some notes on albinism in the Motacillidae. *Mirafra* 13(1):9--10.

» Van Niekerk, D. J. 1996. The status and distribution of the Blackbreasted Snake Eagle *Circaetus pectoralis* (Smith) in the Orange Free State, South Africa, with some notes on movements in the rest of southern Africa. *Mirafra* 13(2):32--49.

» Kok. O. B., Haddad, C. R., Van Niekerk, D. J., Butler, H. J. B. & Nawaz, M. A. 2005. Invertebrates as a potential food source of brown bears on the Deosai Plateau, Northern Pakistan. *Pakistan Journal of Biological Sciences* 8(1):13--19.

» Van Niekerk, D. J. 2005. Nocturnal behaviour of diurnal birds when disturbed. *Afring News* 34(2):85-87