COPPERTON WIND ENERGY FACILITY

BIRD IMPACT ASSESSMENT

EXECUTIVE SUMMARY

This study contains a review of the relevant literature on the impacts on avifauna of wind farms and their associated electrical infrastructure, and identifies potential impacts of the proposed 145 MW, 58 turbine Copperton Wind Energy Facility on the avifauna of the Copperton area. The expected impacts are: habitat destruction by the construction of the facility itself and its associated power lines or substation/s, disturbance by construction and maintenance activities and possibly by the operation of the facility, and possible displacement or disturbance of sensitive species, and mortality caused by collision with the wind turbine blades, collision with the power line network associated with the wind farm, and electrocution on the required power line and substation infrastructure.

The impact zone of the proposed wind farm features fairly uniform grassy Karoo shrubland, Over 200 bird species, including 15 red-listed species, 66 endemics, and five red-listed endemics may occur in the broader area.The birds of greatest potential relevance and importance in terms of the possible impacts of the wind farm are likely to be (i) large terrestrial birds foraging on or commuting over the development area – particularly including Ludwig's Bustard *Neotis ludwigii*, Kori Bustard *Ardeotis kori*, Northern Black Korhaan *Afrotis afraoides*, and Karoo Korhaan *Eupodotis vigorsii*, (ii) raptors foraging and/or nesting in the area – particularly including Martial Eagle *Polemaetus bellicosus*, Tawny Eagle *Aquila rapax*, Lanner Falcon *Falco biarmicus*, and Secretarybird *Sagittarius serpentarius*, and (iii) a suite of endemic passerines – particularly including Red Lark *Calendulauda burra* and Sclater's Lark *Spizocorys sclateri*.

The extent to which these birds may be affected by the proposed wind farm is not yet clear, and will depend on the extent to which the proposed development area is used as a foraging site and/or as a flight path by local raptors and large terrestrial birds. An outline is provided for a comprehensive programme to establish greater clarity on these issues in order to inform the final layout and mitigation strategy of the project should it be approved, and to fully monitor the actual impacts of the wind farm on the broader avifauna of the area, from pre-construction and into the operational phase. Adherence to this monitoring scheme, and strict compliance with mitigation stipulations arising from this monitoring, will be required in order for the proposed development to proceed sustainably.

CONTENTS

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

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File Reference Number:	
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Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

Copperton Wind Energy Facility: Avian Impact Assessment

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4.2 The specialist appointed in terms of the Regulations:

I, Andrew Jenkins , declare that -

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.
-

Signature of the specialist:

AVISENSE Consulting cc

Name of company (if applicable):

21 October 2011

Date:

1. INTRODUCTION

Plan 8 (Pty) Ltd is planning to construct a wind farm (project name 'Copperton Wind Energy Facility), just north-east of the town of Copperton, in the Northern Cape Province, South Africa. Aurecon South Africa (Pty) Ltd was appointed to do the Environmental Impact Assessment (EIA) study for this project, and subsequently sub-contracted Dr Andrew Jenkins (*AVISENSE* Consulting cc) to conduct the specialist avifaunal assessment. Dr Jenkins is an experienced ornithologist, with over 20 years experience in avian research and impact assessment work. He has been involved in many power line and wind farm EIA and Environmental Management Programme (EMP) studies in South Africa, and also does research on raptors, bustards and cranes in various parts of the country.

2. DEVELOPMENT PROPOSAL

The proposed Copperton Wind Energy Facility will be located on portions 4 and 7 of Farm No. 103 – Struisbult, about 5 km north-east of the settlement of Copperton, Northern Cape Province, South Africa (Fig. 2.1). The facility will be spread over an inclusive development area of about 70 km^2, and will include up to 56 x 2.5 MW wind turbines, with a generation capacity of 140 MW, and will be constructed. Each of the turbines will stand 91-100 m high at hub-height, with a rotor diameter of 100-116 m. The facility will include an on-site substation, and will link in to the national power grid either by means of a new, 6.5 km 132 kV line linking the facility to the existing Eskom Cuprum substation at the old Copperton mining site or onsite to the existing grid.

3. SCOPE

The terms of reference for the specialist were to:

- Undertake the requisite field work to directly assess the habitats present within the inclusive impact zone, and to determine the *in situ* avifauna and identify any significant bird flight corridors present in the area;
- Integrate the on-site information with bird atlas (SABAP 1 & 2) and any other relevant bird data available for the general area to develop an inclusive, annotated list of the avifauna expected to occur on the site;
- Highlight Red Data species, endemic, restricted-range or other species of particular concern which may be present in the study area, and;
- Identify, describe and assess potential direct and indirect and cumulative impacts resulting from the proposed development both on the footprint and the immediate surrounding area during construction and operation, and recommend mitigation measures to reduce or eliminate potential negative impacts on avifauna and improve positive impacts.

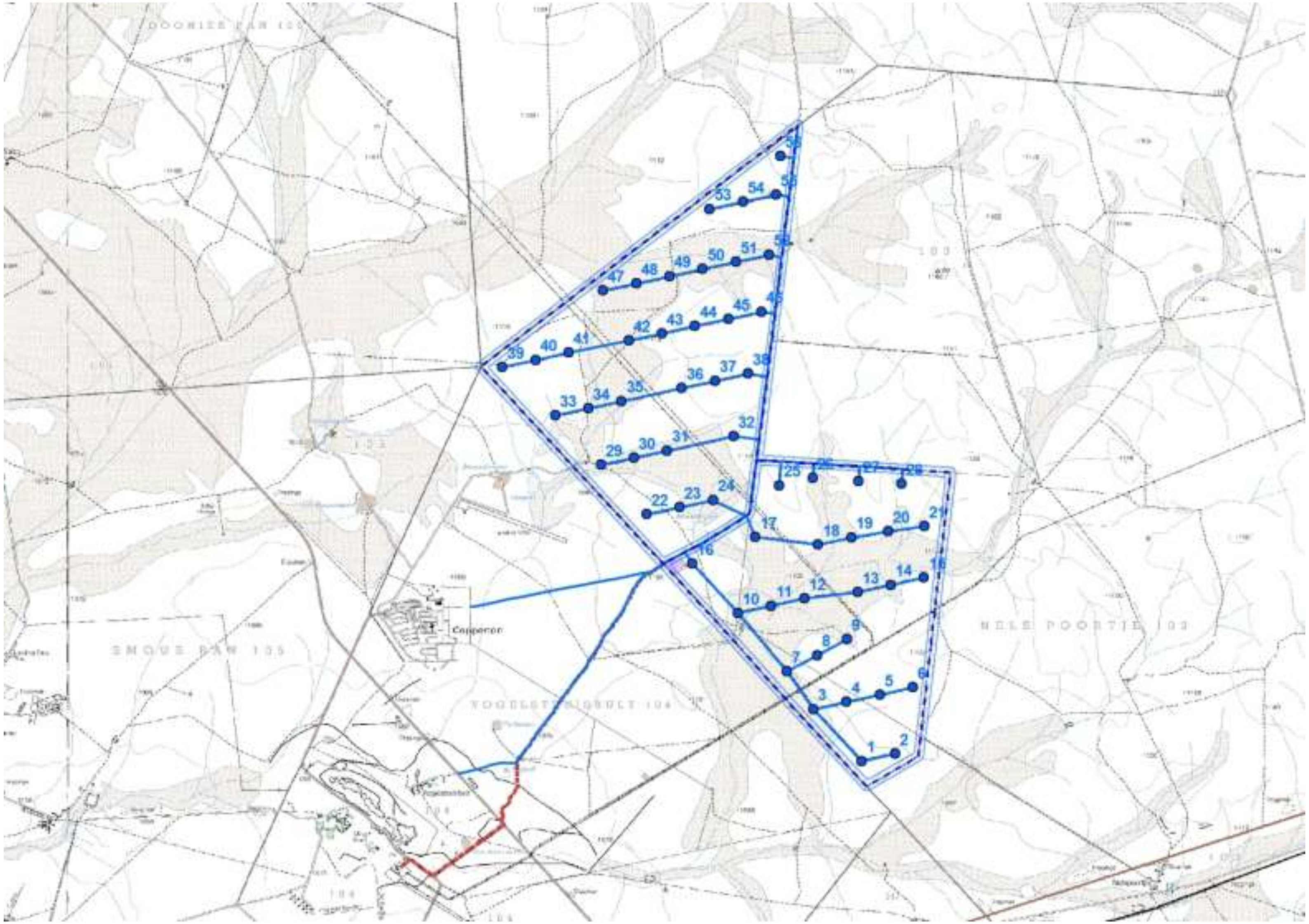

Figure 2.1 *Location and layout of the proposed Copperton Wind Energy Facility.*

4. METHODS

The study was done in three stages – preparation (literature review of bird:wind farm interactions and bird species and avian habitats likely to occur in the study area), site visit (on-site assessment of the avifauna and habitats present) and impact assessment (determination of the nature of likely impacts of the development, with recommendations on mitigation).

4.1 PREPARATION

This initial, desktop component comprised:

(i) A review of available published and unpublished literature pertaining to bird interactions with wind farms and associated power infrastructure, summarizing the issues involved and the current level of knowledge in this field.

(ii) The compilation of an inclusive, annotated list of the avifauna likely to occur within the impact zone of the proposed wind farm, using a combination of the existing distributional data (listed below) and previous experience of the avian habitats and avifauna of the general area.

(iii) The compilation of a short-list of priority bird species (defined in terms of conservation status and endemism) which could be impacted by the proposed wind farm. These species were subsequently considered as adequate surrogates for the local avifauna generally, and mitigation of impacts on these species was considered likely to accommodate any less important bird populations that may also potentially be affected.

4.2 SITE VISIT

The proposed development area was visited on October 13-14 2011 in order to:

(i) Ground-truth predicted habitats and birds present, mainly by visiting as much of the inclusive area of the proposed development as possible, with an emphasis on sampling the avifauna in all of the primary habitats available. An attempt was made to survey the cliff-nesting raptors resident on the escarpment cliffs immediately to the north-west of the development site (using accepted survey protocols – Malan 2009), as these birds may be particularly vulnerable to impact by the proposed development.

(ii) Compile SABAP 2 atlas cards for all the pentads visited.

(iii) Search for large terrestrial species, raptors and endemic passerines within the study area to determine the relative importance and on-site distribution of local populations of these key taxa.

(iv) Estimate the extent and direction of possible movements of birds within/through the anticipated impact zone of the wind farm.

4.3 IMPACT ASSESSMENT

With the site information secured, the final assessment of impacts included:

(i) The production of an avian impacts matrix for the proposed development.

(ii) Identification of no-go zones and/or the least sensitive/lowest risk areas to locate wind turbines and solar panels within the broader study area.

(iii) Recommendations on mitigation where necessary.

(iv) A comprehensive, long-term programme for monitoring actual impacts from pre- to post-construction phases of the development, and improving our understanding of the long-term effects of wind energy developments on South African avifauna.

4.4 DATA SOURCES USED

The following published and unpublished data sources were used:

(i) Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al.* 1997) were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php) for the SABAP 1 quarter-degree squares covering the proposed wind energy facility and its associated infrastructure (2922CD Volstruisbult – eight cards submitted over the atlas period, 97 species recorded - note that the SABAP 1 data are now >15 years old), and for the relevant SABAP 2 pentads (2950_2220 and 2955_2220 – one card submitted so far for this area combined). A composite list of species likely to occur in the impact zone of the wind farm was drawn up as a combination of these data and the information sources listed below, refined by a more specific assessment of the actual habitats affected and general knowledge of birds in the region (Appendix 1).

(ii) The conservation status and endemism of all species considered likely to occur in the area was determined from the national Red-list for birds (Barnes 2000), informed by a more recent revision for raptors (Jenkins 2009), the most recent iteration of the global list of threatened species (http://www.iucnredlist.org), and the most up to date and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).

(iii) Coordinated Avifaunal Roadcount (CAR) data for large terrestrial birds and Black Harrier, and Coordinated Wetland Avifaunal Count (CWAC) data for wetland species (both available from the Animal Demography Unit, UCT - http://adu.org.za/), and relevant published references (Taylor *et al.* 1999, Young *et al.* 2003).

(iv) Information on nesting raptors on the nearby Eskom 400 kV transmission lines from the Eskom Electric Eagle Project (Jenkins *et al.* 2007).

(v) EIA reports and any subsequent monitoring reports on the potential impacts on birds of other proposed and/or constructed and operational wind energy facilities in South Africa (e.g. van Rooyen 2001, Küyler 2004, Jenkins 2001, 2003, 2008a, 2009).

5. ENVIRONMENTAL IMPACTS OF WIND ENERGY FACILITIES

5.1 INTERACTIONS BETWEEN WIND ENERGY FACILITIES AND BIRDS

Recent literature reviews (www.nrel.gov), Kingsley & Whittam 2005, Drewitt & Langston 2006, Kuvlevsky *et al.* 2007, Stewart *et al.* 2007, Drewitt & Langston 2008, Krijgsveld *et al.* 2009, Sovacool 2009) are essential summaries and sources of information in this field. While the number of comprehensive, longer-term analyses of the effects of wind energy facilities on birds is increasing, and the body of empirical data describing these effects is rapidly growing, scientific research in this field is still in its infancy (Madders & Whitfield 2006, Stewart *et al.* 2007), and much of the available information originates from short-term, unpublished, descriptive studies, most of which have been carried out in the United States, and more recently across western Europe, where wind power generation is a more established and developed industry.

Concern about the impacts of wind facilities on birds first arose in the 1980s when numerous raptor mortalities were detected at facilities at Altamont Pass Wind Resource Area (California, USA) and Tarifa (southern Spain). More recently, there has been additional concern about the degree to which birds avoid or are excluded from the areas occupied by wind energy facilities – either because of the visible action of the turbine blades or because of the noise they generate - and hence suffer a loss of habitat (Larsen & Guillemette 2007, Stewart *et al.* 2007, Devereaux *et al.* 2008. Pearce-Higgins *et al.* 2009). With a few important exceptions, most studies completed to date suggest low absolute numbers of bird fatalities at wind energy facilities (Kingsley & Whittam 2005), and low casualty rates relative to other existing sources of anthropogenic avian mortality on a per structure basis (Crockford 1992, Colson & associates 1995, Gill *et al.* 1996, and Erickson *et al*. 2001).

5.1.1. Collisions with turbines

Collision rates

As more monitoring has been conducted at a growing number of sites, some generic standards and common units have been established, with bird collisions with turbine blades generally measured in mortalities/turbine/year, mortalities/Mega-Watt/year, or mortalities /Giga-Watt Hour (Smallwood & Thelander 2008, Sovacool 2009). Wherever possible, measured collision rates should allow for (i) casualty remains which are not detected by observers (searcher efficiency - Newton & Little 2009), and (ii) casualties which are removed by scavengers before detection, and the rate at which this occurs (scavenger removal rate). Also, although collision rates may appear relatively low in many instances, cumulative effects over time, especially when applied to large, long lived, slow reproducing and/or threatened species (many of which are collision-prone), may be of considerable conservation significance.

The National Wind Co-ordinating Committee (2004) estimates that 2.3 birds are killed per turbine per year in the US outside of California – correcting for searcher efficiency and scavenger rates. However, this index ranges from as low as 0.63 mortalities/turbine/year in Oregon, to as high as 10 mortalities/turbine/year in

Tennessee (NWCC 2004), illustrating the wide variance in mortality rates between sites. Curry & Kerlinger (2000) found that only 13% of the >5000 turbines at Altamont Pass, California were responsible for all Golden Eagle *Aquila chrysaetos* and Red-tailed Hawk *Buteo jamaicensis* collisions, but the most recent aggregate casualty estimates for Altamont run to >1000 raptor mortalities/year, and nearly 3000 mortalities/year overall (Smallwood & Thelander 2008), including >60 Golden Eagles, and at a mean rate of about 2-4 mortalities/MW/year.

At the Tarifa and Navarre wind energy facilities on the Straits of Gibraltar, southern Spain, about 0.04-0.08 birds are killed per turbine/year (Janss 2000a, de Lucas *et al.* 2008), with relatively high collision rates for threatened raptors such as Griffon Vulture *Gyps fulvus*, of particular concern (Table 1). At the same sites, collisions have also been found to be non-randomly distributed between turbines, with >50% of the vulture casualties recorded at Tarifa being killed by only 15% of the turbine array at the facility (Acha 1997). Collision rates from other European sites are equally variable, with certain locations sporadically problematic (Everaert 2003, Newton & Little 2009, Table 1).

To date, only eight wind turbines have been constructed in South Africa at two pilot wind energy facilities at Klipheuwel and Darling in the Western Cape (van Rooyen 2001, Jenkins 2001, 2003) and, more recently, in the first phase of a bigger development at Coega in the Eastern Cape. An avian mortality monitoring program was established at the Klipheuwel facility once the turbines were operational, involving regular site visits to monitor both bird traffic through the area and detect bird mortalities (Küyler 2004). This study found that (i) 9-57% of the birds recorded per observation period within 500m of the turbines were flying at blade height, and (ii) 0-32% of birds sighted were flying either between the turbines or within the arc of the rotors of the outermost turbines. Five bird carcasses were found on the three-turbine site during the 8-month monitoring period, of which two, a Horus Swift *Apus horus* and a Large-billed Lark *Galerida magnirostris*, were thought to have been killed by collision with turbine blades, indicating a net collision rate for birds of about 1.00 mortality/turbine/year.

It is important to note here that simple estimates of aggregate collision rates for birds are not an adequate expression of biodiversity impact. Rather, consideration must be given to the conservation status of the species affected or potentially affected, and the possibility that even relatively low collision rates for some threatened birds may not be sustainable in the long term.

Causes of collision

Multiple factors influence the number of birds killed at wind energy facilities. These can be classified into three broad groupings: (i) avian variables, (ii) location variables, and (iii) facility-related variables. Although only one study has so far shown a direct relationship between the abundance of birds in an area and the number of collisions (Everaert 2003), it would seem logical to assume that the more birds there are flying through an array of turbines, the higher the chances of a collision occurring. The nature of the birds present in the area is also very important as some species are more vulnerable to collision with turbines than others, and feature disproportionately frequently in collision surveys (Drewitt & Langston 2006, 2008, de Lucas *et al.* 2008).

Species-specific variation in behaviour, from general levels of activity to particular foraging or commuting strategies, also affect susceptibility to collision (Barrios & Rodríguez 2004, Smallwood *et al.* 2009). There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk.

Landscape features can potentially channel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Ridges and steep slopes are important factors in determining the extent to which an area is used by gliding and soaring birds (Barrios & Rodríguez 2004). High densities of prey will attract raptors, increasing the time spent hunting, and as a result reducing the time spent being observant. Poor weather affects visibility. Birds fly lower during strong headwinds (Hanowski & Hawrot 2000, Richardson 2000), so when the turbines are functioning at their maximum speed, birds are likely to be flying at their lowest height, exponentially increasing collision risk (Drewitt & Langston 2006, 2008).

All other variables being equal, larger wind energy facilities, with more turbines, are more likely to incur significant numbers of bird casualties, simply because they present greater aggregate risk (Kingsley & Whittam 2005). Also, turbine size may be proportional to collision risk, with taller turbines associated with higher mortality rates in some instances (e.g. de Lucas *et al.* 2009, but see Howell 1995, Erickson *et al.* 1999, Barclay *et al.* 2007), although with newer technology, fewer, larger turbines are needed to generate equivalent or even greater quantities of power, possibly resulting in fewer collisions per Megawatt of power produced (Erickson *et al.* 1999). Certain turbine tower structures, and particularly the old-fashioned lattice designs, present many potential perches for birds, increasing the likelihood of collisions occurring as birds land at or leave these perch or roost sites. This generally is not a problem associated with more modern, tubular tower designs (Drewitt & Langston 2006, 2008), such as those proposed for this project.

Illumination of turbines and other infrastructure is often associated with increased collision risk (Winkelman 1995, Erickson *et al.* 2001), either because birds moving long distances at night do so by celestial navigation, and may confuse lights for stars (Kemper 1964), or because lights attract insects, which in turn attract birds. Changing constant lighting to intermittent lighting has been shown to reduce nocturnal collision rates (Richardson 2000, APLIC 1994, Jaroslow 1979, Weir 1976) and changing flood-lighting from white to red can reduce mortality rates by up to 80% (Weir 1976). A recent study found no significant difference in nocturnal collision rates by small passerines at unlit turbines *vs* turbines with regulation aviation safety lighting (small, flashing red lights) (Kerlinger *et al.* 2010).

Spacing between turbines at a wind facility can have an effect on the number of collisions. Some authors have suggested that paths should be left between turbines to allow free passage through the turbine strings (Drewitt & Langston 2006, Kuvlevsky *et al.* 2007, Drewitt & Langston 2008). This approach tallies well with wind energy generation principles, which require relatively large spaces between turbines in order to avoid wake and turbulence effects. An alternative perspective suggests that all attempts by birds to fly through wind energy facilities, rather than over or around them, should be discouraged to minimise collision risk (Drewitt & Langston

2006, Kuvlevsky *et al.* 2007, Drewitt & Langston 2008). This approach effectively renders the entire footprint of the facility as lost habitat (see below).

Collision prone birds

Collision prone birds are generally either (i) large species and/or species with high ratios of body weight to wing surface area (wing loading), which confers low maneuverability (cranes, bustards, vultures, gamebirds, waterfowl, falcons), (ii) species which fly at high speeds (gamebirds, pigeons and sandgrouse, swifts, falcons), (iii) species which are distracted in flight - predators or species with aerial displays (many raptors, aerial insectivores, some open country passerines), (iv) species which habitually fly in low light conditions, and (v) species with narrow fields of forward binocular vision (Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010, Noguera *et al.* 2010). These traits confer high levels of *susceptibility*, which may be compounded by high levels of *exposure* to man-made obstacles such as overhead power lines and wind turbine areas (Jenkins *et al.* 2010). Exposure is greatest in (i) very aerial species, (ii) species inclined to make regular and/or long distance movements (migrants, any species with widely separated resource areas - food, water, roost and nest sites), (iii) species that regularly fly in flocks (increasing the chances of incurring multiple fatalities in a single collision incident).

Soaring species may be particularly prone to colliding with wind turbines where the latter are placed along ridges to exploit the same updrafts favoured by such birds - vultures, storks, cranes, and most raptors - for cross-country flying (Erickson et al. 2001, Kerlinger & Dowdell 2003, Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010, Noguera *et al.* 2010). Large soaring birds – for example, many raptors and storks - depend heavily on external sources of energy for sustainable flight (Pennycuick 1989). In terrestrial situations, this generally requires that they locate and exploit pockets or waves of rising air, either in the form of bubbles of vertically rising, differentially heated air – thermal soaring - or in the form of wind forced up over rises in the landscape, creating waves of rising turbulence – slope soaring.

Certain species are morphologically specialised for flying in open landscapes with high relief and strong prevailing winds, and are particularly dependent on slope soaring opportunities for efficient aerial foraging and travel. South African examples might include Bearded *Gypaetus barbatus* and Cape Vulture *Gyps coprotheres*, Verreaux's Eagle *Aquila verreauxii*, Jackal Buzzard *Buteo rufofuscus*, Rock Kestrel *Falco rupicolus*, Peregrine Falcon *Falco peregrinus*, Lanner Falcon *Falco biarmicus* and Black Stork *Ciconia nigra* and, to a lesser extent, most other open-country raptors. Such species are potentially threatened by wind energy developments where turbines are situated to exploit the wind shear created by hills and ridge-lines. In these situations, birds and industry are competing for the same wind resource, and the risk that slope soaring birds will collide with the turbine blades, or else be prevented from using foraging habitat critical for their survival, is greatly increased. Evidence of these effects has been obtained from several operational wind energy facilities in other parts of the world – for example relatively high mortality rates of large eagles, buzzards and kestrels at Altamont Pass, California (>1100 raptors killed annually or 1.9 raptor casualties/MW/year, Smallwood & Thelander 2008), and of vultures and kestrels at Tarifa, Spain (0.15-0.19 casualties/turbine/year, Barrios &

Rodríguez 2004, de Lucas *et al.* 2008, Table 1), and displacement of raptors generally in southern Spain (Farfán *et al.* 2009) and of large eagles in Scotland (Walker *et al.* 2005) – and one study has shown that the additive impact of wind farm mortality on an already threatened raptor (Egyptian Vulture *Neophron percnopterus*) could theoretically cause its localised extinction (Carrete *et al.* 2009).

Mitigating collision risk

The only direct way to reduce the risk of birds colliding with turbine blades is to make the blades more conspicuous and hence easier to avoid. Blade conspicuousness is compromised by a phenomenon known as 'motion smear' or retinal blur, in which rapidly moving objects become less visible the closer they are to the eye (McIsaac 2001, Hodos 2002). The retinal image can only be processed up to a certain speed, after which the image cannot be perceived. This effect is magnified in low light conditions, so that even slow blade rotation can be difficult for birds to see.

Laboratory-based studies of visual acuity in raptors have determined that (i) visual acuity appears superior when objects are viewed at a distance, suggesting that the birds may view nearby objects with one visual field and objects further away with another, (ii) moderate motion of the visual stimulus significantly influences acuity, and kestrels may be unable to resolve all portions of an object such as a rotating turbine blade because of motion smear, especially under low contrast or dim lighting conditions, (iii) this deficiency can be addressed by patterning the blade surface in a way which maximises the time between successive stimulations of the same retinal region, and (v) the easiest, cheapest and most visible blade pattern for this purpose, effective across the widest variety of backgrounds, is a single black blade in an array of white blades (McIsaac 2001, Hodos 2002). Hence blade marking may be an important means to reduce collision rates by making the rotating turbine blades as conspicuous as possible under the least favourable visual conditions, particularly at facilities where raptors are known or likely to be frequent collision casualties.

Even if the turbine rotors are marked in this way, many species may still be susceptible to colliding with them, especially during strong winds (when the rotor speed is high and birds tend to fly low and with less control) and when visibility is poor (at night or in thick mist). All other collision mitigation options operate indirectly, by reducing the frequency with which collision prone species are exposed to collision risk. This is achieved mainly by (i) siting farms and individual turbines away from areas of high avifaunal density or aggregation, regular commute routes or hazardous flight behavior, (ii) using low risk turbine designs and configurations, which discourage birds from perching on turbine towers or blades, and allow sufficient space for commuting birds to fly safely through the turbine strings, and (iii) carefully monitoring collision incidence, and being prepared to shut-down problem turbines at particular times or under particular conditions.

Table 5.1. Results of recent published studies of the effects of wind energy facilities on local avifauna.

Location	*n* wind farm/s assessed	Turbine hub height (m)	*n* turbines	Habitat	Bird groups assessed	Evidence of displacement?	Collision rate (birds/turbine/year)	Reference
Tarifa, Southern Spain	2	18-36	66-190	Hilly woodland	Raptors	N/A	Raptors = 0.27, Griffon Vultures = 0.12	Barrios & Rodríguez 2004
Tarifa, Southern Spain	2	28-36	66-190	Hilly woodland	Raptors	N/A	0.04-0.07, mostly Griffon Vultures	de Lucas *et al.* 2008
East Anglia, UK	2	60	8	Croplands	Gamebirds, corvids, larks and see-eaters	Minimal, only gamebirds significantly affected	N/A	Devereaux *et al.* 2008
Altamont Pass, California	1	14-43	5400	Hilly grassland	Various	N/A	4.67 , raptors = 1.94	Smallwood & Thelander 2008
Southern Spain	1	44	16	Hilly woodland	Various	Yes, >75% reduction in raptor sightings	0.03	Farfán *et al.* 2009
Netherlands	3	67-78	7-10	Farmland	Various	N/A	27.0-39.0	Krijgsveld *et al.* 2009
Northumberland, UK	1	30	9	Coastal	Seabirds	N/A	16.5-21.5, mostly large gulls	Newton & Little 2009
N England & Scotland	12	30-70	14-42	Moorland	Gamebirds, shorebirds, raptors, passerines	Yes, 53% reduction in Hen Harrier *Circus cyaneus* sightings, other species also decreased	N/A	Pearce-Higgins *et al.* 2009

Effective mitigation can only be achieved with a commitment to rigorous pre- and post-construction monitoring (see below), ideally using a combination of occasional, direct observation of birds commuting or foraging through and around the renewable energy facility, coupled with constant, remote tracking of avian traffic using specialised radar equipment (e.g. see http://www.detect-inc.com/wind.html). Such systems can be programmed to set the relevant turbines to idle as birds enter a pre-determined danger zone around the turbine array, and to re-engage those turbines once the birds have safely passed. Note that (i) each radar installation of this type has a maximum effective range of 10-15 km depending on topography, (ii) that maximum efficacy on any one site can only be achieved through trial and error, and a considerable amount of specialized analysis and software refinement, and (iii) that radar deployment is an expensive exercise, with each unit retailing at about ZAR 2.5-4.2 m.

5.1.2 Habitat loss – destruction, disturbance and displacement

Although the final, destructive footprint of most facilities of this nature is likely to be relatively small, the construction phase of development inevitably incurs quite extensive temporary damage or permanent destruction of habitat, which may be of lasting significance in cases where renewable energy facility sites coincide with critical areas for restricted range, endemic and/or threatened species. Similarly, construction, and to a lesser extent ongoing maintenance activities, are likely to cause some disturbance of birds in the general surrounds, and especially of shy and/or ground-nesting species resident in the area. Mitigation of such effects requires that generic best-practice principles be rigorously applied - sites are selected to avoid the destruction of key habitats, and construction and final footprints, as well as sources of disturbance of key species, must be kept to an absolute minimum. Some studies have shown significant decreases in the numbers of certain birds in areas where wind energy facilities are operational as a direct result of avoidance of the noise or movement of the turbines (e.g. Larsen & Guillemette 2007, Farfán *et al.* 2009, Table 1), while others have shown decreases which may be attributed to a combination of collision casualties and avoidance or exclusion from the impact zone of the facility in question (Stewart *et al.* 2007). Such displacement effects are probably more relevant in situations where wind energy facilities are built in natural habitat (Pearce-Higgins *et al.* 2009, Madders & Whitfield 2006) than in more modified environments such as farmland (Devereaux *et al.* 2008), where the affected avifauna already have a degree of habituation to and tolerance of anthropogenic environmental change. Either way, displacement effects on birds by wind energy facilities are highly species-specific in operation.

5.2. Impacts of associated infrastructure

Infrastructure commonly associated with wind energy facilities may also have detrimental effects on birds. The construction and maintenance of substations, and roadways causes both temporary and permanent habitat destruction and disturbance, and overhead power lines substations and other live ancillary infrastructure may pose an electrocution risk to certain species (Van Rooyen 2004a, Lehman *et al.* 2007, Jenkins *et al.* 2010).

5.2.1. Construction and maintenance of power lines and substations

Some habitat destruction and alteration inevitably takes place during the construction of power lines, substations and associated roadways. Also, power line service roads or servitudes have to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, and to prevent vegetation from intruding into the legally prescribed clearance gaps between the ground and the conductors. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude, and retention of cleared servitudes can have the effect of altering bird community structure along the length of any given power line (e.g. King & Byers 2002).

5.2.2 Collision with power lines

Power lines pose at least an equally significant collision risk to wind turbines, probably affecting the same suite of collision prone species (Bevanger 1994, 1995, 1998, Janss 2000b, Anderson 2001, van Rooyen 2004a, Drewitt & Langston 2008, Jenkins *et al.* 2010). Mitigation of this risk involves the informed selection of low impact alignments for new power lines relative to movements and concentrations of high risk species, and the use of either static or dynamic marking devices to make the lines, and in particular the earthwires, more conspicuous. While various marking devices have been used globally, many remain largely untested in terms of their efficacy in reducing collision incidence, and those that have been fully assessed (both static and dynamic devices) have all been found to be only partially effective, and markedly less so for certain species (e.g. bustards) (Drewitt & Langston 2008, Jenkins *et al.* 2010).

5.2.3. Electrocution on power infrastructure

Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004b, Lehman *et al.* 2007). Electrocution risk is strongly influenced by the voltage and design of the hardware installed (generally occurring on lower voltage infrastructure where air gaps are relatively small), and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energised components. Mitigation of electrocution risk involves the use of bird-safe structures (ideally with critical air gaps >2 m), the physical exclusion of birds from high risk areas of live infrastructure, and comprehensive insulation of such areas (van Rooyen 2004b, Lehman *et al.* 2007).

6. THE AFFECTED ENVIRONMENT

6.1 THE NATURAL ENVIRONMENT

The study area is located in the Bushmanland Bioregion of the Nama Karoo Biome (Mucina & Rutherford 2006). The natural vegetation of the study area is dominated by Bushmanland Basin Shrubland – irregular plains with dwarf shrubland, with low, drought resistant shrubs and grassland, and sporadic, rain-driven outbreaks of annuals (Mucina & Rutherford 2006). Altitude on the site varies very little (1102-1140 metres above sea level).The area receives about 80 mm of rain per annum, most of which falls in autumn (February-March). Temperatures range from a mean winter minimum of about 2ºC, to a mean summer maximum of about 32ºC.

6.2 THE ALTERED ENVIRONMENT

The area is presently used mainly for small stock (sheep, goats) farming. There are no formal dwellings within the development area, and a scattering of reservoirs supplied by wind pumps. The R357 roadway runs to the south of the development area, while the settlement of Copperton and infrastructure of the now disused Copperton mine lie to the south-west. There is a network of gravel roads and smaller farm tracks within the development area, including servitudes along the existing 132 kV power lines which run across the middle and along the south-eastern edge of the development area.

6.3 AVIAN HABITATS

These largely comprise degraded areas of natural **Karoo veld**, with taller vegetation and trees along **drainage lines**, and one or two small artificial and/or ephemeral **waterbodies**, while the existing network of **power lines** attracts certain species (in particular raptors and corvids which perch and sometimes nest on the support structures for these lines) to the area (Fig. 6.1). The broader area features vast expanses of remote but probably heavily grazed stock and game ranchland, with the Doringberg range and the Orange River valley system some 40-50 km away to the northeast.

6.4 THE AVIFAUNA

More than 200 bird species may at least occasionally occur on the site (Appendix 1), including up to 15 red-listed species, 66 endemics or near-endemics, and five red-listed endemics (Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus*, Black Harrier *Circus maurus*, Red Lark *Calendulauda burra* and Sclater's Lark *Spizocorys sclateri*). In general, however, the avifauna of the site is not particularly rich, and the habitats available are fairly uniform and unproductive. The site is not situated close to any presently recognised national Important Bird Areas (Barnes 1998), recognisable, key avian habitats or landscape features, or on any known or likely fly-ways.

***Figure 6.1a** Open, flat, grassy Karoo veld close to the wind monitoring mast on the Copperton WEF development site.*

***Figure 6.1b** The 132 kV power line passing through the proposed development area.*

***Figure 6.1c** Taller vegetation along the drainage lines which criss-cross the site.*

Surveys of large raptors nesting on the steel pylons supporting Eskom's transmission lines in the area place regularly active Martial Eagle *Polemaetus bellicosus* nests within 11 km south of the proposed development area (on tower 512 of the Hydra-Kronos 400 kV line), and within 22 km to the south-west (on tower 392 of the Aries-Kronos 400 kV line) (Jenkins *et al.* 2007).

Only 29 species were seen during the October site visit (Appendix 1), none of which were considered particularly significant. Coverage of the site was adequate (Fig. 6.2). Greater Kestrels were found breeding in Pied Crow *Corvus alba* nests on the 132 kV power poles, and Southern Pale Chanting Goshawk *Melierax canorus* nests were found on two of the drainage lines within/close to the proposed development area. Densities of regional endemics such as Northern Black Korhaan *Afrotis afraoides*, Karoo Korhaan *Eupodotis vigorsii*, Sabota Lark *Calendulauda sabota*, Eastern Clapper Lark *Mirafra fasciolata*, Spike-heeled Lark *Chersomanes albofasciata* and and Rufous-eared Warbler *Malcorus pectoralis* were particularly high on site. A fresh Ludwig's Bustard *Neotis ludwigii* collision victim was found under the 132 kV power line (Fig. 6.2).

Overall, the avifauna of the development site itself is entirely replaceable, at best replicating that which occurs across huge areas of Bushmanland. The birds of greatest potential relevance and importance in terms of the possible impacts of the wind energy facility are likely to be seasonal influxes of Ludwig's Bustard and Kori Bustard *Ardeotis kori*, locally resident or passing raptors - especially red-listed species - Martial Eagle, Tawny Eagle *Aquila rapax* and Lanner Falcon *Falco biarmicus*, all of which breed on the nearby Eskom transmission lines (Jenkins *et al.* 2007), but including regional endemics such as Jackal Buzzard *Buteo rufofuscus* and Pale Chanting Goshawk *Melierax canorus*, and local populations of endemic, and possibly red-listed passerines (possibly including Red Lark and/or Sclater's Lark), which may sometimes occur on or close to the site. Note: the site is on the southern edge of a recent range expansion by Sociable Weaver *Philetarius socius*, The huge communal grass nests built by this species may require active management if any are attached to critical infrastructure of the development.

On the basis of these observations, in combination with already documented information on the avifauna of the general area, eleven priority species are recognized as key in the assessment of avian impacts of the proposed Copperton Wind Energy Facility (Table 6.1). These are mostly nationally and/or globally threatened species which are known to occur, or could occur in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the wind farm project. Many Red-listed species were included as a pre-cautionary measure despite the fact that they have not been recorded in the area in either of the SABAP projects because the habitat on site looks suitable for these birds. Northern Black Korhaan and Karoo Korhaan were included because they are Karoo endemics, occur at relatively high densities in the general area and on the proposed development site, and are probably susceptible to wind farm impacts.

Figure 6.2. *Areas covered (blue line) on and around the proposed Copperton Wind Energy Facility (green polygon) during the October site visit, and all associated significant sightings and nest sites located within or close to the site.*

In summary, the birds of greatest potential relevance and importance in terms of possible impacts of the wind farm are likely to be:

1. Large terrestrial birds foraging on or commuting over the open Karoo flats within the development area – particularly including Ludwig's and Kori Bustard *Ardeotis kori*, and Secretarybird *Sagittarius serpentarius*. Again, these are all threatened species, generally highly collision-prone (Jenkins *et al.* 2010, Jenkins *et al.* 2011b), and at least moderately susceptible to disturbance and displacement.
2. Raptors foraging and/or resident in the area, particularly including Martial Eagle, Lanner Falcon and possibly Tawny Eagle. These are scarce and/or threatened species, potentially susceptible to collision with and displacement from the area by the turbine arrays. Perhaps the main threat to these birds is the risk of exposure to turbine collisions when hunting in the development area, or commuting through it to and from foraging areas further to the south-east.
3. Localized endemic passerines, particularly including Red and Sclater's Larks. These threatened species may be exposed to collision risk during aerial displays, and may also be susceptible to displacement from areas of important habitat.

Table 6.1 Priority bird species considered central to the avian impact assessment process for the Copperton Wind Energy Facility , selected mainly on the basis of South African (Barnes 2000) or global conservation status (www.iucnredlist.org or http://www.birdlife.org/datazone/species/), level of endemism, relative abundance on site (SABAP reporting rates, direct observation), and estimated conservation or ecological significance of the local population. Red-listed endemic species are shaded in grey.

Common name	**Scientific name**	**SA conservation status/ (Global conservation status)**	**Regional endemism**	**Average reporting rate (*n* = 9 cards)**	**Estimated importance of local population**	**Preferred habitat**	**Risk posed by**		
							Collision	**Electro-cution**	**Disturbance / habitat loss**
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	Near-endemic	33.3	Moderate	Open Karoo	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	-	0.0	Low	Open Karoo	High	-	Moderate
Northern Black Korhaan	*Afrotis afraoides*	-	Near-endemic	88.9	High	Open Karoo	Moderate	-	High?
Karoo Korhaan	*Eupodotis vigorsii*	-	Endemic	55.6	High	Open Karoo	Moderate	-	High?
Blue Crane	*Anthropoides paradiseus*	Vulnerable (Vulnerable)	Endemic	0.0	Low	Open Karoo, wetlands	High	-	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	-	0.0	High	Power lines, open Karoo	High	High	Moderate
Tawny Eagle	*Aquila rapax*	Vulnerable	-	0.0	Low	Power lines, open Karoo	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	0.0	Moderate	Open Karoo	High	-	Moderate
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	0.0	Moderate	Power lines, open Karoo	High	Moderate	Moderate
Red Lark	*Calendulauda burra*	Vulnerable (Vulnerable)	Endemic	0.0	Low?	Open Karoo	-	-	Moderate?
Sclater's Lark	*Spizocorys sclateri*	Near-threatened	Endemic	11.1	Low?	Open Karoo	-	-	Moderate

7. IMPACT ASSESSMENT

This proposal is for a medium-sized wind energy installation, sited well away from any recognized important areas for birds. The habitat contained within the area most directly affected by the proposal is generally unexceptional, as is much of its attendant avifauna. Hence, while the proposed wind farm is likely to have some meaningful, detrimental effect on the local birds (during both the construction and operational phases of the development), most of these effects will be of little significance.

Those impacts that may be significant include possible collision and/or displacement effects on large terrestrial birds and raptors. Pre- and post-construction monitoring will be important for improving understanding of the relative abundance and movements of these birds through the development area, the severity of the risk posed by the wind farm to these species, and how best to mitigate this risk. Estimating and mitigating impacts on nomadic, arid zone species such as Ludwig's Bustard will be particularly challenging. This species is prone to erratic influxes to areas of the Karoo, apparently in response to past rainfall, but these factors are not well understood (Allan 1994). Compounding this unpredictability, recent studies of power line collisions by this bird (Jenkins *et al.* 2009, Jenkins *et al.* 2011b) have shown no detectable pattern in collisions in relation to landscape features. Hence, while bustards are likely to occur on the site in numbers, it is not possible to predict when such influxes are most likely to happen, or where these birds will be most susceptible to turbine collisions, precluding any useful input on where, and where not, to place turbines at this stage. Again, adequate pre- and post-construction monitoring will be vital to understanding the risk posed by the wind farm to local bustards, and how best to mitigate this risk.

7.1 IMPACT DESCRIPTION AND ASSESSMENT

The impact assessment process was followed was broadly that described in the Scoping Report for the same development (Aurecon 2011). Impacts of the proposed wind farm are most likely to be manifest in the following ways:

(i) Disturbance and displacement of resident populations and/or seasonal influxes of large terrestrial birds (especially Ludwig's Bustard, but including Kori Bustard, Karoo Korhaan and Northern Black Korhaan and possibly Blue Crane) from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while commuting between resource areas (nest sites, roost sites).

(ii) Disturbance and displacement of resident/breeding or visiting raptors (especially Martial Eagle, Tawny Eagle, Lanner Falcon and Secretarybird) from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while slope-soaring or hunting, or by electrocution when perched on power infrastructure.

(iii) Disturbance and displacement of influxes of endemic passerines (especially Red Lark and Sclater's Lark) from foraging and/or nesting areas by construction and/or operation of the facility, and/or mortality of these species in collisions with the turbine blades.

All these impacts are likely to be amplified in the event that more than one wind energy facility is built in the immediate vicinity (<10 km from the boundaries) of the Copperton plant. At least two other projects have apparently been proposed, so this is a real possibility.

Table 7.1 *Impact characteristics: Copperton Wind Energy Facility– Birds.*

Summary	Construction	Operation
Project Aspect/ activity	(i) Disturbance associated with noise and movement. (ii) Loss of vegetation and avian habitat through site clearance, road upgrade and establishment of the camp, lay-down and assembly areas.	(i) Disturbance and/or displacement from foraging or nesting area by movement and/or noise of rotating turbine blades, and by space occupied by solar panels. (ii) Mortality in collisions with turbine blades and/or power lines, or by electrocution on new power infrastructure.
Impact Type	Direct	Direct
Receptors Affected	(i) All birds on site; key species Ludwig's Bustard, Kori Bustard, Northern Black Korhaan, Karoo Korhaan, Martial Eagle, Tawny Eagle, Lanner Falcon, Secretarybird, Red Lark, Sclater's Lark. (ii) Ludwig's Bustard, Kori Bustard, Northern Black Korhaan, Karoo Korhaan, Secretarybird, Red Lark, Sclater's Lark.	(iii) All birds on site; key species: Ludwig's Bustard, Kori Bustard, Northern Black Korhaan, Karoo Korhaan, Martial Eagle, Tawny Eagle, Lanner Falcon, Secretarybird, Red Lark, Sclater's Lark. (i) All birds on site; key species Ludwig's Bustard, Kori Bustard, Northern Black Korhaan, Karoo Korhaan, Martial Eagle, Tawny Eagle, Lanner Falcon, Secretarybird, Red Lark, Sclater's Lark.

Box 7.1 *Construction Impact: Copperton Wind Energy Facility – Birds*

(A) Habitat loss

Nature: Construction activities would result in a **negative direct** impact on the avifauna of the wind farm site.

Impact Magnitude – **Low-Medium**

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **medium-term** as the ecology of the area would be altered beyond the completion of the project.
- **Intensity**: Some priority species will experience loss of habitat, so the magnitude of the change will be **low-medium**.

Likelihood – There is a **high** likelihood that moderate areas of habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW-MEDIUM

Cumulative impacts: Could be amplified by multiple projects in the area, which seems to be a possibility.

Degree of Confidence: The degree of confidence is **high**.

(B) Disturbance

Nature: Construction activities would result in a **negative direct** impact on the avifauna of the wind farm site.

Impact Magnitude – **Medium**

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **short-term** as this effect will not extend beyond the life of the project.
- **Intensity**: Some priority species will be significantly disturbed, so the magnitude of the change will be **medium-high**.

Likelihood – There is a **high** likelihood that birds will be disturbed.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW-MEDIUM*

Cumulative impacts: Could be amplified by multiple projects in the area, which seems to be a possibility.

Degree of Confidence: The degree of confidence is **medium**.

**In terms of the impact assessment methodology applied, this rating could have been classed as 'Low', however, given the size of the proposed development and its associated infrastructure, a subjective decision was made to up the rating to 'Low-Medium'.*

Box 7.2 *Operation Impact: Copperton Wind Energy Facility – Birds*

(A) Disturbance and displacement

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the wind farm site.

Impact Magnitude – **Medium**

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected until the project stops operating.
- **Intensity**: Some priority species may be displaced for the duration of the project, and there will be some loss of habitat, so the magnitude of the change will be **medium**.

Likelihood – There is a **medium** likelihood that some priority species will be disturbed/displaced.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM

Cumulative impacts: Could be amplified by multiple projects in the area, which seems to be a possibility.

Degree of Confidence: The degree of confidence is **medium**.

(B) Mortality

Nature: Operational activities would result in a **negative direct** impact on the avifauna of the wind farm site.

Impact Magnitude – **Medium**

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating.
- **Intensity**: Some individuals of priority species may be killed in collision/electrocution incidents, so the magnitude of the change will be **medium**.

Likelihood – There is a **medium** likelihood that some individuals of priority species will be killed.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM

Cumulative impacts: Could be amplified by multiple projects in the area, which seems to be a possibility.

Degree of Confidence: The degree of confidence is **medium**.

Mitigation of these impacts will be best achieved in the following ways:

(i) On-site demarcation of 'no-go' areas identified during pre-construction monitoring (see below) to minimise disturbance impacts associated with the construction of the facility.

(ii) Minimizing the disturbance impacts associated with the operation of the facility by scheduling maintenance activities to avoid disturbances in sensitive areas (identified through operational monitoring).

(iii) Ensuring that any lighting on the turbines is kept to a minimum, and is coloured (red or green) and intermittent, rather than permanent and white, to reduce confusion effects for nocturnal migrants.

(iv) Painting one blade of each turbine black to maximize conspicuousness to oncoming birds. The evidence for this as an effective mitigation measure is not conclusive, but it is suggestive. It might be best to adopt an experimental approach to blade marking, identifying a sample of pairs of potentially high risk turbines in pre-construction monitoring, and marking the blades on one of each pair. Post-construction monitoring should allow empirical testing of efficacy, which would inform subsequent decisions about the need to mark blades more widely in this and other wind farms.

(v) Minimizing the length of any new power lines installed, and ensuring that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010), and that all new power infrastructure is adequately insulated and bird friendly in configuration (Lehman *et al.* 2007). Note that current understanding of power line collision risk in birds precludes any guarantee of successfully distinguishing high risk from medium or low risk sections of a new line (Jenkins *et al.* 2010, 2011b). The relatively low cost of marking the entire length of a new line during construction, especially quite a short length of line in an area frequented by collision prone birds, more than offsets the risk of not marking the correct sections, causing unnecessary mortality of birds, and then incurring the much greater cost of retro-fitting the line post-construction. In situations where new lines run in parallel with existing, unmarked power lines, this approach has the added benefit of reducing the collision risk posed by the older line.

(vi) Carefully monitoring the local avifauna pre- and post-construction (see below), and implementing appropriate additional mitigation as and when significant changes are recorded in the number, distribution or breeding behaviour of any of the priority species listed in this report, or when collision or electrocution mortalities are recorded for any of the priority species listed in this report. An essential weakness of the EIA process here is the dearth of knowledge about the actual movements of key species (bustards, eagles, other raptors) through the impact area. Such knowledge must be generated as quickly and as accurately as possible in order for this and other wind energy proposals in the area to proceed in an environmentally sustainable way.

(vii) Ensuring that the results of pre-construction monitoring are applied to project-specific impact mitigation in a way that allows for the potential cumulative effects on the local/regional avifauna of any other wind energy projects proposed for this area, including the Mainstream facility proposed for an area nearby. Viewed in isolation, the present project may pose only a limited threat to the avifauna of the area. However, in combination with a larger, neighbouring facility, it may contribute to the formation of a significant barrier to energy-efficient travel between resource areas for regionally important bird populations, and/or significant levels of mortality in these populations in collisions with what may become a substantial array of many 100s of turbines (Masden *et al.* 2010).

(viii) Additional mitigation might include re-scheduling construction or maintenance activities on site, shutting down problem turbines either permanently or at certain times of year or in certain conditions. The requirement for these measures would need to be determined after pre- and post- construction monitoring.

Note: Differences in the two project layout alternatives are not particularly relevant to bird impacts, and there is no logical or obvious reason to favour one design over the other in this context.

Table 7.1 *Pre- and Post- Mitigation Significance: Copperton Wind Energy Facility - Birds*

Phase	Pre-mitigation Significance	Residual Impact Significance
Construction		
Habitat loss	**LOW-MEDIUM**	**LOW**
Disturbance	**LOW-MEDIUM**	**LOW**
Operation		
Displacement	**MEDIUM**	**LOW-MEDIUM**
Mortality	**MEDIUM**	**LOW-MEDIUM**

Implementation of the required mitigation measures should reduce Construction Phase impacts to Low or Low-Medium, and Operation Phase impacts to Low-Medium (Table 7.2).

Strict adherence to the monitoring scheme outlined below, and strict compliance with mitigation stipulations listed above and those arising from the monitoring scheme, will be requisite in order for the proposed development to proceed sustainably.

8. MONITORING

8.1. GENERAL PRINCIPLES

The Birds & Wind Energy Specialist Group (BAWESG) has recently published it's best practice guidelines for bird monitoring at proposed wind energy development sites in South Africa (Jenkins *et al.* 2011). In terms of these guidelines, the primary aims of baseline or pre-construction monitoring are:

(i) To estimate the number/density of birds regularly present or resident within the broader impact area of the energy facility before its construction.

(ii) To document patterns of bird movements in the vicinity of the proposed facility before its construction.

(iii) To estimate predicted collision risk (the frequency with which individuals or flocks fly through the future rotor swept area of the proposed wind farm) for key species.

(iv) To inform an assessment of the merits of the application in the avian impact assessment report in terms of points (i) to (iii).

(v) To establish a pre-impact baseline for bird numbers, distributions and movements.

(vi) To mitigate impacts by informing the final design, and the construction and management strategy of the development.

Other generic stipulations of these guidelines include the following (Jenkins *et al.* 2011 and references therein):

(i) Monitoring data should be generated for both the broader impact zone of the proposed WEF, and for one or more comparable control sites, in order to allow comparison of data from pre- and post-construction monitoring to be calibrated in terms of an equivalent data set for a suitable control area.

(ii) Baseline monitoring requires periodic visits to both the development and control sites, sufficient in frequency to adequately sample all major variations in environmental conditions, and spanning a total study period of not less than 12 months.

(iii) Monitoring scope and intensity should be set in terms of the size, complexity and perceived sensitivity of each individual development site, as determined by the contracted avian specialist.

(iv) Variables measured/mapped on each site visit should include:

a. Density estimates for small terrestrial birds (in most cases not priority species, but potentially affected on a landscape scale by multiple developments in one area)
b. Absolute counts, density estimates or abundance indices for large terrestrial birds and raptors
c. Passage rates of birds flying through the proposed development area
d. Occupancy/numbers/breeding success at any focal raptor sites
e. Bird numbers at any focal wetlands
f. Full details of any incidental sightings of priority species.

8.2 *PROJECT SPECIFICS*

The proposed Copperton Wind Energy Facility is a moderately-sized wind farm, and while it is set in a relatively flat and homogenous habitat, there are some potentially important bird impacts which could result from this development were it to be authorized. The pre-construction monitoring work required to inform the final layout and mitigation strategy should be conducted over the mandatory 12 months, and include a minimum of four data collection iterations spread more or less evenly over that period, in addition to an initial visit to the site with the consulting specialist in order to orientate the required field team of two observers.

A suitable location for the control or reference survey area required by the monitoring guidelines should be identified during the orientation site visit preceding the first data collection iteration. Ideally, this monitoring project should be run in concert with others apparently in process in the area, and a common control site should serve the purposes of all the local developments.

8.2.1. Sample counts of small terrestrial species

Eight walked transects, each about 1 km in length should be set up on the development site during the initial, site orientation visit. Similarly, four transects should be established on the control site. The transects should be located in open Karoo and along the wooded drainage lines in proportion to their availability on each site. Each transect should be walked once per visit to the site, with the data collection procedures following the protocols laid out in the best practice guidelines (Jenkins *et al.* 2011).

8.2.2. Counts of large terrestrial species and raptors

An absolute count of large terrestrial birds and raptors should be done once per visit at both the development site and at the control, using a standardized combination of driving and walking to cover the required ground, and scanning from any available vantage points. The particulars of the route and methods used to derive these absolute tallies for key species should be determined for both sites at orientation. Data should be collected as per the protocols laid out in the best practice guidelines (Jenkins *et al.* 2011).

8.2.3 Focal site surveys and wetland monitoring

Any habitats within the broader impact zone of a proposed wind energy facility, or an equivalent area around the control site, deemed likely to support nest sites of key raptor species (including owls) - cliff-lines or quarry faces, power lines, stands of large trees, marshes and drainage lines - should be surveyed using documented protocols in the initial stages of the monitoring project. All such sites should be mapped accurately, and checked on each visit to the study area to confirm continued occupancy, and to record any breeding activity, and the outcomes of such activity, that may take place over the survey period (Jenkins *et al.* 2011). Similarly, any major wetlands on and close to either the development area or the control should be identified, mapped and surveyed for waterbirds on each visit to the site, using the standard protocols set out by the CWAC initiative (Taylor *et al.* 1999). In this instance, there are no focal sites or key wetland areas that were identified during the initial site visit, except perhaps for the existing power line within the proposed development area, which supports breeding raptors. Time for some work of this nature should be built in to the budget for the project to allow for some such sites to be identified either during orientation or during subsequent data collection activities.

8.2.4. Incidental observations

All other, incidental sightings of priority species (and particularly those suggestive of breeding or important feeding or roosting sites or flight paths) or other birds of interest, relevance or importance within the broader study area should be carefully plotted and documented. These could include details of nocturnal species (especially owls) heard calling at night (Jenkins *et al.* 2011). Again, all incidental sightings data should be collected as per the protocols laid out in the best practice guidelines (Jenkins *et al.* 2011).

Table 4. *Provisional breakdown of time required in the field for each component of the pre-construction monitoring project required to inform the final layout and mitigation strategy of the Copperton Wind Energy Facility.*

	Walked transects		Vantage Points		Fixed Point Counts		Absolute Counts		Wetland surveys		Focal Sites		Effort per iteration (hours)	Total effort (hours)
	n	**hours**	***n***	**hours**	***n***	**hours**	***n***	**hours**	***n***	**hours**	***n***	**hours**		
Wind farm site	8	6	2	24	0	0	1	4	1	2	2	4	40	160
Control site	4	3	1	12	0	0	1	2	0	0	1	2	19	76

8.2.5. Movements and flight paths

Counts of bird traffic over and around the development area and the control site should be conducted from at least three vantage points (two on the development site, one on the control) which should be selected during the initial orientation site visit. At least 12 hours of observation should be accumulated at each vantage point for each monitoring iteration. All data should be collected as per the protocols laid out in the best practice guidelines (Jenkins *et al.* 2011). Overall, the monitoring project at the experimental and control sites should take up about 236 x 2 person-hours (Table 4), in addition to about 40 x 3 person-hours for the initial orientation visit, or about 600 person-hours in total. Note that an equivalent post-construction monitoring project will be required in order to measure the actual impacts of the facility should it be built, and to inform and refine the final bird impact mitigation strategy.

9. REFERENCES

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Appendix 1. Annotated list of the bird species considered likely to occur within the impact zone of the proposed Copperton Wind Energy Facility (species in bold were seen during the October site visit).

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Common Ostrich	*Struthio camelus*	-	-	X					-	-	High
Orange River Francolin	*Scleroptila levaillantoides*	-	Near-endemic	X	X				Moderate	-	High
Cape Spurfowl	*Pternistis capensis*	-	Endemic		X				Moderate	-	High
Common Quail	*Coturnix coturnix*	-	-	X					-	-	High
Helmeted Guineafowl	***Numida meleagris***	**-**	**-**		**X**				**Moderate**	**-**	**High**
Egyptian Goose	*Alopochen aegyptiaca*	-	-			X			High	High	-
South African Shelduck	*Tadorna cana*	-	Endemic			X			High	-	-
Yellow-billed Duck	*Anas undulata*	-	-			X			Moderate	-	-
Cape Shoveler	*Anas smithii*	-	Endemic			X			Moderate	-	-
Red-billed Teal	*Anas erythrorhyncha*	-	-			X			Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Kurrichane Buttonquail	*Turnix sylvaticus*	-	-	X					-	-	High
Lesser Honeyguide	*Indicator minor*	-	-		X				-	-	Moderate
Golden-tailed Woodpecker	*Campethera abingoni*	-	-		X				-	-	Moderate
Cardinal Woodpecker	*Dendropicos fuscescens*	-	-		X				-	-	Moderate
Acacia Pied Barbet	*Tricholaema leucomelas*	-	Near-endemic		X				-	-	Moderate
African Grey Hornbill	*Tockus nasutus*	-	-		X				-	-	Moderate
African Hoopoe	*Upupa africana*	-	-		X				-	-	Moderate
Common Scimitarbill	*Rhinopomastus cyanomelas*	-	-		X				-	-	Moderate
European Roller	*Coracias garrulus*	-	-	X	X				-	-	-
Pied Kingfisher	*Ceryle rudis*	-	-			X			-	-	-
Swallow-tailed Bee-eater	*Merops hirundineus*	-	-	X	X	X			-	-	Moderate
European Bee-eater	*Merops apiaster*	-	-						-	-	-

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
White-backed Mousebird	*Colius colius*	-	Endemic		X				-	-	Moderate
Red-faced Mousebird	*Urocolius indicus*	-	-		X				-	-	Moderate
Jacobin Cuckoo	*Clamator jacobinus*	-	-		X				-	-	Moderate
Diderick Cuckoo	*Chrysococcyx caprius*	-	-		X				-	-	Moderate
Rosy-faced Lovebird	*Agapornis roseicollis*	-	Near-endemic		X				-	-	Moderate
African Palm-Swift	*Cypsiurus parvus*	-	-		X				-	-	-
Alpine Swift	*Tachymarptis melba*	-	-					X	-	-	-
Common Swift	*Apus apus*	-	-					X	-	-	-
Bradfield's Swift	*Apus bradfieldi*	-	Near-endemic					X	-	-	-
Little Swift	*Apus affinis*	-	-					X	-	-	-
White-rumped Swift	*Apus caffer*	-	-					X	-	-	-
Barn Owl	*Tyto alba*	-	-	X	X				-	Moderate	Moderate
Southern White-faced Scops-Owl	*Ptilopsis granti*	-	-		X				-	-	Moderate

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Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Spotted Eagle-Owl	*Bubo africanus*	-	-	X	X		X		-	High	Moderate
Pearl-spotted Owlet	*Glaucidium perlatum*	-	-		X				-	-	Moderate
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	-	-	X					-	-	Moderate
Rock Dove	*Columba livia*	-	-					X	-	-	Moderate
Speckled Pigeon	***Columba guinea***	**-**	**-**					**X**	**-**	**-**	**Moderate**
Laughing Dove	***Streptopelia senegalensis***	**-**	**-**		**X**				**-**	**-**	**Moderate**
Cape Turtle-Dove	***Streptopelia capicola***	**-**	**-**		**X**				**-**	**-**	**Moderate**
Red-eyed Dove	*Streptopelia semitorquata*	-	-		X				-	-	Moderate
Namaqua Dove	*Oena capensis*	-	-	X	X				-	-	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable	Near-endemic	X					High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	-	X					High	-	Moderate
Northern Black Korhaan	***Afrotis afraoides***	**-**	**Endemic**	**X**					**Moderate**	**-**	**Moderate**
Karoo Korhaan	***Eupodotis vigorsii***	**-**	**Endemic**	**X**					**Moderate**	**-**	**Moderate**

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Blue Crane	*Anthropoides paradiseus*	Vulnerable	Endemic	X		X			High	-	Moderate
Common Moorhen	*Gallinula chloropus*	-	-			X			-	-	-
Red-knobbed Coot	*Fulica cristata*	-	-			X			-	-	-
Namaqua Sandgrouse	*Pterocles namaqua*	-	Near-endemic	X		X			-	-	-
Double-banded Sandgrouse	*Pterocles bicinctus*	-	-	X		X			-	-	-
Burchell's Sandgrouse	*Pterocles burchelli*	-	Near-endemic	X		X			-	-	-
Marsh Sandpiper	*Tringa stagnatilis*	-	-			X			-	-	-
Common Greenshank	*Tringa nebularia*	-	-			X			-	-	-
Wood Sandpiper	*Tringa glareola*	-	-			X			-	-	-
Common Sandpiper	*Actitis hypoleucos*	-	-			X			-	-	-
Little Stint	*Calidris minuta*	-	-			X			-	-	-
Curlew Sandpiper	*Calidris ferruginea*	-	-			X			-	-	-
Ruff	*Philomachus pugnax*	-	-			X			-	-	-

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Spotted Thick-knee	*Burhinus capensis*	-	-	X	X				-	-	-
Black-winged Stilt	*Himantopus himantopus*	-	-			X			-	-	-
Pied Avocet	*Recurvirostra avosetta*	-	-			X			-	-	-
Kittlitz's Plover	*Charadrius pecuarius*	-	-			X			-	-	-
Three-banded Plover	*Charadrius tricollaris*	-	-			X			-	-	-
Chestnut-banded Plover	*Charadrius pallidus*	Near-threatened	-			X			-	-	-
Blacksmith Lapwing	*Vanellus armatus*	-	-			X			-	-	-
Crowned Lapwing	*Vanellus coronatus*	-	-	X					-	-	-
Double-banded Courser	*Rhinoptilus africanus*	-	-	X					-	-	-
Burchell's Courser	*Cursorius rufus*	-	Near-endemic	X					-	-	-
White-winged Tern	*Chlidonias leucopterus*	-	-			X			-	-	-
Black-shouldered Kite	*Elanus caeruleus*	-	-	X	X		X		-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Black Kite	*Milvus migrans*	-	-	X				X	-	-	-
African Fish-Eagle	*Haliaeetus vocifer*	-	-					X	-	High	-
Black-chested Snake-Eagle	*Circaetus pectoralis*	-	-				X	X	-	Moderate	Moderate
Black Harrier	*Circus maurus*	Near-threatened	Endemic	X		X			-	-	Moderate
African Harrier-Hawk	*Polyboroides typus*	-	-		X			X	-	-	Moderate
Southern Pale Chanting Goshawk	***Melierax canorus***	**-**	**Near-endemic**	**X**	**X**		**X**		**-**	**Moderate**	**Moderate**
Gabar Goshawk	*Melierax gabar*	-	-		X				-	-	Moderate
Steppe Buzzard	*Buteo vulpinus*	-	-	X			X	X	-	Moderate	Moderate
Jackal Buzzard	*Buteo rufofuscus*	-	Endemic	X			X	X	-	Moderate	Moderate
Tawny Eagle	*Aquila rapax*	Vulnerable	-		X		X	X	-	High	Moderate
Verreauxs' Eagle	*Aquila verreauxii*	-	-				X	X	Moderate	High	Moderate
Booted Eagle	*Aquila pennatus*	-	-					X	-	-	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable	-				X	X	Moderate	High	Moderate

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	X				X	High	-	Moderate
Pygmy Falcon	***Polihierax semitorquatus***	**-**	**-**	**X**	**X**		**X**		**-**	**-**	**Moderate**
Rock Kestrel	***Falco rupicolus***	**-**	**-**	**X**			**X**	**X**	**-**	**-**	**Moderate**
Greater Kestrel	***Falco rupicoloides***	**-**	**-**	**X**			**X**		**-**	**-**	**Moderate**
Red-footed Falcon	*Falco vespertinus*	-	-	X			X	X	-	-	-
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	X			X	X	High	Moderate	-
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	X			X	X	High	Moderate	-
Little Grebe	*Tachybaptus ruficollis*	-	-			X			-	-	-
Black-necked Grebe	*Podiceps nigricollis*	-	-			X			-	-	-
African Darter	*Anhinga rufa*	-	-			X			-	-	-
Reed Cormorant	*Phalacrocorax africanus*	-	-			X			-	-	-
Little Egret	*Egretta garzetta*	-	-			X			-	-	-
Grey Heron	*Ardea cinerea*	-	-			X			Moderate	Moderate	-

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Black-headed Heron	*Ardea melanocephala*	-	-	X		X			Moderate	Moderate	-
Cattle Egret	*Bubulcus ibis*	-	-			X			-	-	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-					X	High	-	-
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-					X	High	-	-
Hadeda Ibis	***Bostrychia hagedash***	**-**	**-**		**X**			**X**	**Moderate**	**-**	**-**
African Sacred Ibis	*Threskiornis aethiopicus*	-	-			X		X	Moderate	-	-
African Spoonbill	*Platalea alba*	-	-			X		X	Moderate	-	-
Black Stork	*Ciconia nigra*	Near-threatened	-			X	X	X	High	Moderate	-
Abdim's Stork	*Ciconia abdimii*	-	-			X	X	X	Moderate	Moderate	-
White Stork	*Ciconia ciconia*	-	-			X	X	X	High	High	-
Fork-tailed Drongo	*Dicrurus adsimilis*	-	-		X				-	-	Moderate
Brubru	*Nilaus afer*	-	-		X				-	-	Moderate
Crimson-breasted Shrike	*Laniarius atrococcineus*	-	Near-endemic		X				-	-	Moderate
Bokmakierie	***Telophorus zeylonus***	**-**	**Near-endemic**		**X**				**-**	**-**	**Moderate**

Common name	Scientific name	Conservation status	Regional endemicity						Susceptibility to		
				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Pririt Batis	*Batis pririt*	-	Near-endemic		X				-	-	Moderate
Cape Crow	*Corvus capensis*	-	-	X	X		X		-	-	Moderate
Pied Crow	***Corvus albus***	**-**	**-**	**X**	**X**		**X**		**-**	**-**	**Moderate**
White-necked Raven	*Corvus albicollis*	-	-	X			X		-	-	Moderate
Red-backed Shrike	*Lanius collurio*	-	-	X					-	-	Moderate
Lesser Grey Shrike	*Lanius minor*	-	-	X					-	-	Moderate
Common Fiscal	*Lanius collaris*	-	-	X	X				-	-	Moderate
Cape Penduline-Tit	*Anthoscopus minutus*	-	Near-endemic	X					-	-	Moderate
Ashy Tit	*Parus cinerascens*	-	Near-endemic	X					-	-	Moderate
Brown-throated Martin	*Riparia paludicola*	-	-			X		X	-	-	Moderate
Barn Swallow	*Hirundo rustica*	-	-			X		X	-	-	Moderate
White-throated Swallow	*Hirundo albigularis*	-	-			X			-	-	Moderate

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				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Greater Striped Swallow	***Hirundo cucullata***	**-**	**-**			**X**		**X**	**-**	**-**	**Moderate**
Rock Martin	***Hirundo fuligula***	**-**	**-**			**X**		**X**	**-**	**-**	**Moderate**
African Red-eyed Bulbul	*Pycnonotus nigricans*	-	Near-endemic		X				-	-	Moderate
Fairy Flycatcher	*Stenostira scita*	-	Endemic		X				-	-	Moderate
Long-billed Crombec	*Sylvietta rufescens*	-	-	X	X				-	-	Moderate
Yellow-bellied Eremomela	*Eremomela icteropygialis*	-	-	X	X				-	-	Moderate
African Reed-Warbler	*Acrocephalus baeticatus*	-	-			X			-	-	Moderate
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	-	-			X			-	-	Moderate
Willow Warbler	*Phylloscopus trochilus*	-	-		X				-	-	Moderate
Layard's Tit-Babbler	*Parisoma layardi*	-	Endemic	X	X				-	-	Moderate
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	-	Near-endemic		X				-	-	Moderate

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				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Orange River White-eye	*Zosterops pallidus*	-	Endemic		X				-	-	Moderate
Grey-backed Cisticola	*Cisticola subruficapilla*	-	Near-endemic	X	X				-	-	Moderate
Levaillant's Cisticola	*Cisticola tinniens*	-	-			X			-	-	Moderate
Zitting Cisticola	*Cisticola juncidis*	-	-			X			-	-	Moderate
Desert Cisticola	***Cisticola aridulus***	**-**	**-**			**X**			**-**	**-**	**Moderate**
Black-chested Prinia	***Prinia flavicans***	**-**	**-**		**X**				**-**	**-**	**Moderate**
Karoo Prinia	*Prinia maculosa*	-	Endemic	X	X				-	-	Moderate
Namaqua Warbler	*Phragmacia substriata*	-	Endemic		X				-	-	Moderate
Rufous-eared Warbler	***Malcorus pectoralis***	**-**	**Endemic**	**X**					**-**	**-**	**Moderate**
Eastern Clapper Lark	***Mirafra fasciolata***	**-**	**Near-endemic**	**X**					**-**	**-**	**Moderate**
Sabota Lark	***Calendulauda sabota***	**-**	**-**	**X**					**-**	**-**	**Moderate**
Fawn-coloured Lark	*Calendulauda africanoides*	-	Near-endemic	X					-	-	Moderate

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				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Red Lark	*Calendulauda burra*	Vulnerable	Endemic	X					-	-	Moderate
Spike-heeled Lark	***Chersomanes albofasciata***	**-**	**-**	**X**					**-**	**-**	**Moderate**
Karoo Long-billed Lark	*Certhilauda subcoronata*	-	Endemic	X					-	-	Moderate
Black-eared Sparrowlark	*Eremopterix australis*	-	Endemic	X					-	-	Moderate
Grey-backed Sparrowlark	***Eremopterix verticalis***	**-**	**Near-endemic**	**X**					**-**	**-**	**Moderate**
Red-capped Lark	*Calandrella cinerea*	-	-	X					-	-	Moderate
Stark's Lark	*Spizocorys starki*	-	Endemic	X					-	-	Moderate
Pink-billed Lark	*Spizocorys conirostris*	-	Near-endemic	X					-	-	Moderate
Sclater's Lark	*Spizocorys sclateri*	Near-threatened	Endemic	X					-	-	Moderate
Large-billed Lark	***Galerida magnirostris***	**-**	**Endemic**	**X**					**-**	**-**	**Moderate**
Karoo Thrush	*Turdus smithi*	-	Endemic		X				-	-	Moderate
Chat Flycatcher	***Bradornis infuscatus***	**-**	**Near-endemic**	**X**					**-**	**-**	**Moderate**
Marico Flycatcher	*Bradornis mariquensis*	-	Near-endemic	X	X				-	-	Moderate

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				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Fiscal Flycatcher	*Sigelus silens*	-	Endemic		X				-	-	Moderate
Cape Robin-Chat	*Cossypha caffra*	-	-		X				-	-	Moderate
Kalahari Scrub-Robin	*Cercotrichas paena*	-	Near-endemic	X	X				-	-	Moderate
Karoo Scrub-Robin	*Cercotrichas coryphoeus*	-	Endemic	X	X				-	-	Moderate
Mountain Wheatear	***Oenanthe monticola***	**-**	**Near-endemic**	**X**					**-**	**-**	**Moderate**
Capped Wheatear	*Oenanthe pileata*	-	-	X					-	-	Moderate
Sickle-winged Chat	*Cercomela sinuata*	-	Endemic	X					-	-	Moderate
Karoo Chat	*Cercomela schlegelii*	-	Near-endemic	X					-	-	Moderate
Tractrac Chat	*Cercomela tractrac*	-	Near-endemic	X					-	-	Moderate
Familiar Chat	***Cercomela familiaris***	**-**	**-**	**X**					**-**	**-**	**Moderate**
Ant-eating Chat	***Myrmecocichla formicivora***	**-**	**Endemic**	**X**					**-**	**-**	**Moderate**
Pale-winged Starling	*Onychognathus nabouroup*	-	Near-endemic					X	-	-	Moderate
Cape Glossy Starling	*Lamprotornis nitens*	-	-		X				-	-	Moderate

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				Karoo veld	**Drainage lines**	**Dams & ephemeral waterbodies**	**Power lines**	**Fly over**	**Collision**	**Electro-cution**	**Disturbance / habitat loss**
Pied Starling	*Spreo bicolor*	-	Endemic					X	-	-	Moderate
Wattled Starling	*Creatophora cinerea*	-	-	X	X			X	-	-	Moderate
Common Starling	*Sturnus vulgaris*	-	-		X				-	-	Moderate
Malachite Sunbird	*Nectarinia famosa*	-	-		X				-	-	Moderate
Dusky Sunbird	*Cinnyris fuscus*	-	Near-endemic	X	X				-	-	Moderate
Scaly-feathered Finch	*Sporopipes squamifrons*	-	Near-endemic	X					-	-	Moderate
White-browed Sparrow-Weaver	*Plocepasser mahali*	-	-	X	X				-	-	Moderate
Sociable Weaver	***Philetairus socius***	**-**	**Endemic**	**X**	**X**				**-**	**-**	**Moderate**
Southern Masked-Weaver	*Ploceus velatus*	-	-		X	X			-	-	Moderate
Red-billed Quelea	*Quelea quelea*	-	-	X	X	X		X	-	-	Moderate
Southern Red Bishop	*Euplectes orix*	-	-			X			-	-	Moderate
African Quailfinch	*Ortygospiza atricollis*	-	-	X					-	-	Moderate

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				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Red-headed Finch	*Amadina erythrocephala*	-	Near-endemic	X	X				-	-	Moderate
Black-faced Waxbill	*Estrilda erythronotos*	-	-		X				-	-	Moderate
Common Waxbill	*Estrilda astrild*	-	-			X			-	-	Moderate
Violet-eared Waxbill	*Granatina granatina*	-	-	X	X				-	-	Moderate
Pin-tailed Whydah	*Vidua macroura*	-	-		X				-	-	Moderate
House Sparrow	***Passer domesticus***	**-**	**-**		**X**				**-**	**-**	**Moderate**
Cape Sparrow	***Passer melanurus***	**-**	**Near-endemic**	**X**	**X**				**-**	**-**	**Moderate**
Southern Grey-headed Sparrow	*Passer diffusus*	-	-	X	X				-	-	Moderate
Cape Wagtail	***Motacilla capensis***	**-**	**-**			**X**			**-**	**-**	**Moderate**
African Pipit	*Anthus cinnamomeus*	-	-	X					-	-	Moderate
Long-billed Pipit	*Anthus similis*	-	-	X					-	-	Moderate
Kimberley Pipit	*Anthus pseudosimilis*	-	Endemic	X					-	-	Moderate

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				Karoo veld	Drainage lines	Dams & ephemeral waterbodies	Power lines	Fly over	Collision	Electro-cution	Disturbance / habitat loss
Black-headed Canary	*Serinus alario*	-	Endemic	X					-	-	Moderate
Black-throated Canary	*Crithagra atrogularis*	-	-	X					-	-	Moderate
Yellow Canary	***Crithagra flaviventris***	**-**	**Near-endemic**	**X**					**-**	**-**	**Moderate**
White-throated Canary	*Crithagra albogularis*	-	Near-endemic	X					-	-	Moderate
Lark-like Bunting	*Emberiza impetuani*	-	Near-endemic	X					-	-	Moderate
Cape Bunting	*Emberiza capensis*	-	Near-endemic	X					-	-	Moderate