

OLIFANTS RIVER WIND ENERGY FACILITY

Avian impact assessment
- Scoping Phase -



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EXECUTIVE SUMMARY

This study contains an extensive review of relevant literature on wind energy facility impacts on avifauna, and identifies potential impacts of the proposed Olifants River Wind Energy Facility on the avifauna of the area. These expected impacts are: habitat destruction by construction of the facility itself and any associated power lines or substation/s, disturbance by both activities and possible displacement or disturbance of sensitive species by the operation of the facility, collision with blades of the wind turbines and other associated infrastructure.

The impact zone of the proposed wind energy facility features a mixture of open, heavily grazed, undulating Strandveld, and the saltmarshes of the Olifants River floodplain. The area could support nearly 250 bird species, including 20 Red-listed species, 62 endemics, and five red-listed endemics. The species of greatest conservation significance which may be impacted by the wind energy facility, both in terms of the collision and disturbance impacts of the facility itself, and of the disturbance and mortality risks posed by its peripheral infrastructure, are: (i) aggregations of a wide variety of wetland and possibly coastal birds, foraging within the floodplain area of the Olifants River or commuting between this and other wetland resource areas to the north or south, (ii) a range of locally resident or visiting raptors nesting, foraging in or moving through the area, and (iii) seasonal influxes of large terrestrial birds commuting between roosting sites and feeding areas.

The proposed development would pose a significant threat to these birds, and particularly to the community of wetland birds associated with the river floodplain and the nearby estuary. To mitigate this anticipated impact, a development exclusion zone extending to at least 500 m from the edge of the floodplain on both banks is strongly recommended. A comprehensive 12 month-long bird monitoring programme is outlined, which will serve to inform the full EIA study for this proposal, by providing the required quantitative information on the abundance and distribution of key species, and the patterns of movement of these and other birds through the development area.

CONSULTANT'S DECLARATION OF INDEPENDENCE

Andrew Jenkins (*AVISENSE* Consulting cc) is an independent consultant to Savannah Environmental Pty (Ltd) and South African Renewable Green Energy (Pty) Ltd (SARGE). He has no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work.

1. INTRODUCTION

South African Renewable Green Energy (Pty) Ltd (SARGE) is planning to construct a wind energy facility (project name 'Olifants River Wind Energy Facility') just west of Lutzville and spanning the lower reaches of the Olifants River, on the west coast of the Western Cape Province, South Africa (Fig 1). Savannah Environmental Pty (Ltd) was appointed to do the Environmental Impact Assessment study, and subsequently appointed *AVISENSE* Consulting to conduct the specialist avifaunal assessment. The study was conducted by Dr Andrew Jenkins, an ornithologist with over 20 years of experience in avian research and impact assessment work. He has been involved in the design and/or execution of many of the completed EIA and EMP studies for wind energy facilities in South Africa to date, including the only two operational facilities at Darling and Klipheuwel, Western Cape Province.

2. TERMS OF REFERENCE

The terms of reference for the scoping phase, as supplied by Savannah Environmental Pty (Ltd), were to provide:

- A description of the affected environment and the manner in which it may be affected.
- A description and evaluation of the avian issues and impacts identified, including detail on the nature and extent of any potential direct, indirect and cumulative impacts.
- A statement on the potential significance of identified issues based on the above evaluation.
- A comparative evaluation of any identified, feasible alternatives.
- Identification of any potentially significant impacts which will require particular attention in the EIA phase, with recommendations on the methodology to be adopted in assessing such, expressed as a Plan of Study for the EIA.

3 STUDY METHODOLOGY

3.1. Approach

This desktop study included the following steps:

- A review of available published and unpublished literature pertaining to bird interactions with wind energy facilities is provided summarising the issues involved and the current level of knowledge in this field. Various information sources (listed

below), including data on the birdlife of the area and previous studies of bird interactions with wind energy facility and electricity infrastructure, were examined.

- An inclusive, annotated list of the avifauna likely to occur within the impact zone of the proposed wind energy facility was compiled using a combination of the existing distributional data, birds and habitats seen during a short site visit made on November 7-8 2011, and previous experience/knowledge of the avifauna of the general area.
- A short-list of priority bird species (defined in terms of conservation status and endemism) which could possibly be impacted by the proposed wind energy facility was extracted from the total bird list. 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.
- A summary of more likely and significant impacts of the wind energy facility on the local avifauna was drawn up, and a brief methodology was devised for the EIA phase for confirming these impacts and developing an effective mitigation strategy.

3.2. Data sources used

The following data sources and reports were used in the compilation of this report:

- 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 relevant quarter-degree squares (SABAP 1: 3118CA Papendorp) or pentads (SABAP 2: 3130_1810, 3135_1810). A composite list of species likely to occur in the impact zone of the wind energy facility was drawn up as a combination of these data, refined by a more specific assessment of the actual habitats affected, based on general knowledge of the avifauna of the region (APPENDIX 1).
- Conservation status and endemism of all species considered likely to occur in the area was determined as per the most recent iteration of the national Red-list for birds (Barnes 2000), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Data from the Animal Demography Unit's Coordinated Avifaunal Roadcount project (CAR: <http://car.adu.org.za/>, Young *et al.* 2003).
- EIA and EMP reports for other developments in the same area (Allan & Jenkins 1990, Jenkins 1998).
- 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 (van Rooyen 2001, Jenkins 2001, 2003, Küyler 2004, Jenkins 2008a, 2009).

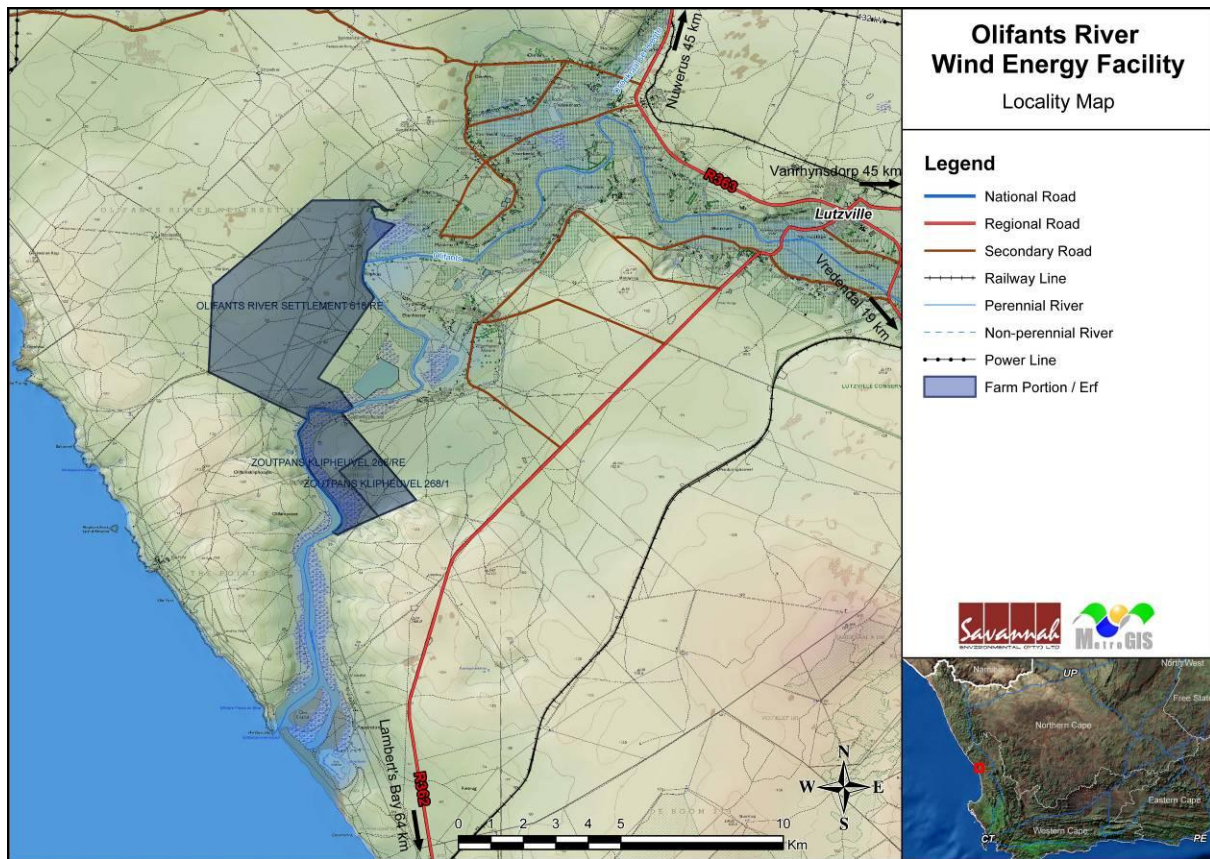


FIGURE 1. Location of the proposed Olifants River Wind Energy Facility.

3.3. Limitations & assumptions

Any inaccuracies in the above sources of information could limit this study. The SABAP 1 data for this area was quite sparse originally (61 cards submitted for the relevant square) and is now is now over >15 years old (Harrison *et al.* 1997), and there is presently no SABAP 2 data available for the two relevant pentads. This deficiency was rectified to some extent by making a short a visit to the site to observe the avian habitats and avifauna present directly.

Given that there are currently only three, very small wind energy facilities operative in South Africa (Coega, Klipheuwel and Darling, currently numbering only 1, 3 and 4 operational turbines respectively), practical experience of the environmental effects of wind energy facilities in this country is extremely limited, and we must base our estimates of the possible impacts of new facilities farms largely on lessons learnt internationally. While many of the established, general principles can probably be usefully applied here, care should be taken in adapting international knowledge and experience to uniquely South African birds and conditions.

4. BACKGROUND TO THE STUDY

4.1 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).

4.1.1 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.

Table 1. Results of recent published studies of the effects of wind energy facilities on local avifauna.

Location	<i>n</i> wind farm/s assessed	Turbine hub height (m)	<i>n</i> 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 <i>et al.</i> 2008
East Anglia, UK	2	60	8	Croplands	Gamebirds, corvids, larks and see-eaters	Minimal, only gamebirds significantly affected	N/A	Devereaux <i>et al.</i> 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 <i>et al.</i> 2009
Netherlands	3	67-78	7-10	Farmland	Various	N/A	27.0-39.0	Krijgsveld <i>et al.</i> 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 <i>Circus cyaneus</i> sightings, other species also decreased	N/A	Pearce-Higgins <i>et al.</i> 2009

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.

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.

4.1.2 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.

4.2 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).

4.2.1 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).

4.2.2 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).

4.2.3 Electrocutation 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). Electrocutation 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 electrocutation 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).



FIGURE 2. Location of the proposed Olifants River Wind Energy Facility in relation to the Olifant’s River Mouth – a national Important Bird Area (Barnes 1998).

4.3. Description of the proposed wind energy facility

The proposed wind energy facility will be located on Erf 618 of the farm Olifants River Settlement, and Portion 1 and the remainder of the farm Zoutpans Klipheuvél 268 (Fig. 1), in an inclusive area of about 3000 ha, about 7 km west of Lutzville, and on the Olifants River about 5 km upstream from its mouth, on the Atlantic west coast of the Western Cape Province, South Africa (Fig. 1). The facility will comprise up to 115 3 MW wind turbines, with an installed generating capacity of about 350 MW, and will include a dedicated substation, a 132 kV power line link to the national grid, and a network of new or upgraded access and service roads.

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1 Vegetation of the study area

The affected environment falls within the Namaqualand Sandveld bioregion of the Succulent Karoo biome (Mucina & Rutherford 2006). The local climate is temperate, featuring warm, dry, windy summers, and wetter, cooler winters. The area receives about 85 mm of rain per annum, with mean temperatures ranging from about 6-7°C on winter nights, to about 30°C during the day in summer. Altitude on the site varies from about 10-60 m above sea level. The Succulent Karoo is primarily defined by a low, winter rainfall regime (20-290 mm per annum), and consists of flat to undulating plains with some hilly and broken veld. It is characterised by dwarf succulent plants and an almost total absence of trees. Grasses are rare, except in some sandy areas, but overall species diversity is surprisingly high. The proposed development area features a combination of Namaqualand Strandveld (low, species-rich succulent shrubland) on the undulating plains on either side of the Olifants River, and Arid Estuarine Salt Marshes (low, succulent dwarf shrubland with grassy mats and patches of reeds) within the river floodplain itself (Mucina & Rutherford 2006).

5.2 Avian microhabitats

Within the broader impact zone these comprise:

1. **Open Strandveld:** the dominant non-riparian microhabitat, covering most of the proposed development area and supporting the bulk of the terrestrial species diversity and the key endemics (Fig. 3a).
2. **Permanent, seasonal and ephemeral wetlands:** the course of the Olifants River is obviously the key wetland in the area and is a very important avian habitat. Within the floodplain, and in addition to the main watercourse, are a number of artificial impoundments, pools, vleis, backwaters and tributaries (Fig. 3b).
3. **Rocky outcrops:** these occur along the edges of the floodplain and up the courses of small, lateral tributaries where these have cut through resistant bands of rock (Fig. 3b).
4. **Alien trees:** There are scattered, small stands of alien trees (mostly eucalypts) around the farmsteads or settlements in the general area (Fig. 3c).
5. **Cultivated lands** (and including old mining infrastructure, farmhouses, outbuildings and other rural infrastructure): These occur along the fringes of the floodplain area, and in the vicinity of settlements at Soutpansklipheuwel, Olifantsdrift and Ebenhaeser (Fig. 3c).



FIGURE 3a. Open Strandveld on Soutpansklipheuwel, looking west towards the Olifants River.



FIGURE 3b. The Olifants River and the floodplain area, from one of the rocky outcrops on the west bank of the river.



FIGURE 3c. The hills to the west of the floodplain, looking towards the settlements of Ebenhaeser and Olifantsdrift.

5.3 Avifauna of the impact area

The impact zone of the WEF and its associated infrastructure could support as many as 246 bird species (APPENDIX 1), of which 20 species are red-listed, 62 species are regional endemics or near-endemics, and five species - Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus*, African Black Oystercatcher *Haematopus moquini*, Damara Tern *Sterna balaenarum*, Black Harrier *Circus maurus* - are red-listed endemics (Barnes 2000, Hockey *et al.* 2005).

The study area is located about 5 km north-east of the Olifants River Estuary (including the Papendorp Salt Works, situated just east of the mouth), which has been recognised as a national Important Bird Area (IBA - Barnes 1998). It is one of only four perennial estuaries on the west coast, making it an extremely attractive haven for many coastal bird species. Approximately 125 bird species have been recorded there, most of which are water birds, and over 15 000 water birds regularly occur on the estuary, including significant numbers of several Red Data species, such Greater Flamingo *Phoenicopterus ruber*, Lesser Flamingo *Phoenicopterus minor*, Caspian Tern *Sterna caspia*, African Marsh Harrier *Circus ranivorus* (breeds), African Black Oystercatcher (probably breeds on the coastline), Great White Pelican *Pelecanus onocrotalus*, Chestnut-banded Plover *Charadrius pallidus* and Damara Tern. The estuary forms a vital staging ground for various species moving between waterbodies to the south such as Langebaan Lagoon, and the Orange River Mouth to the north, including large numbers of migrating Palearctic waders, especially Curlew Sandpiper *Calidris ferruginea* (Taylor *et al.* 1999, Barnes 1998). The lower Olifants River floodplain is also known to support breeding Black Harrier (R.E. Simmons pers. comm.), while Martial Eagle is known to breed on utility structures in the general area (Pers. obs), and the surrounding open Karoo is likely to receive erratic influxes of Ludwig's Bustard after good rains (Allan & Jenkins 1990, Allan 1994).

Ninety-five species were seen during a site visit on November 7-8 2011 (Appendix 1). The area was adequately covered by vehicle and on foot (Fig. 4), and SABAP 2 atlas card were completed for the pentads 3330_1810, and 3335_1810. Significant sightings included over 300 Lesser Flamingos on the wetland immediately west of Ebenhaeser, and 3-4 Caspian Terns, Black Harrier and African Marsh Harrier around Soutpansklipheuwel, as well as the generally significant numbers and diversity of wetland birds using the tidal saltmarshes fringing the river, including hundreds of waders (including Pied Avocet *Recurvirostra avosetta*, Black-winged Stilt *Himantopus himantopus*, Eurasian Curlew *Numenius arquata*, Common Whimbrel *Numenius phaeopus*, Common Greenshank *Tringa nebularia*, Marsh Sandpiper *Tringa stagnatilis*, Curlew Sandpiper, Ruff *Philomachus pugnax* and Little Stint *Calidris minuta*) and waterfowl (including South African Shelduck *Tadorna cana*, Egyptian Goose *Alopochen aegyptiaca*, Spur-winged Goose *Plectropterus gambensis*, Cape Teal *Anas capensis*, Red-billed Teal *Anas erythrorhyncha*, Cape Shoveler *Anas smithii*, Yellow-billed Duck *Anas undulata* and Southern Pochard *Netta erythroptalma*).

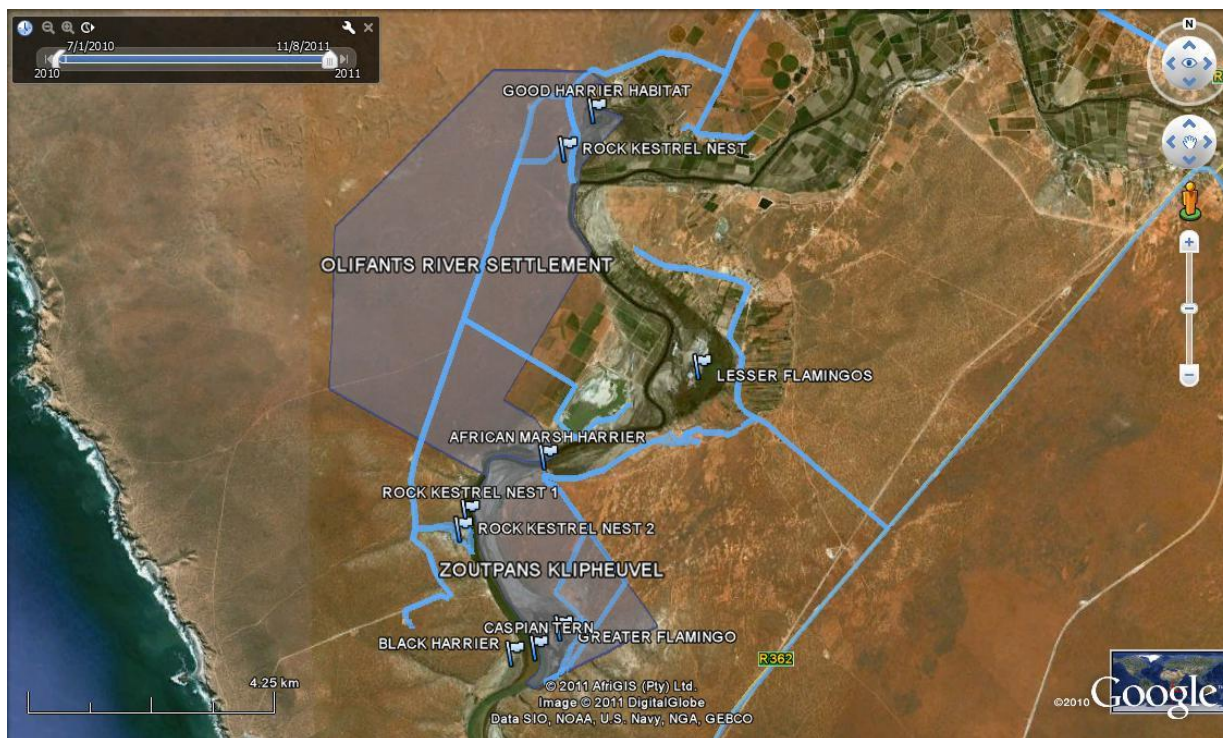


FIGURE 4. Area covered (blue line) and significant sightings made during the site visit on November 7-8 2011.

On the basis of these on-site observations, in combination with the available bird atlas data for the general area, 13 priority species are recognised as key in the assessment of avian impacts of the proposed Olifants River Wind Energy Facility (Table 2), and as suitable surrogates for impacts on other species. 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 alternative energy project.

In summary, the birds of greatest potential relevance and importance in terms of the possible impacts of the proposed alternative energy facility are likely to be:

- (i) Large numbers of wetland and possibly coastal birds, including red-listed endemics such as Damara Tern, and red-listed species such as flamingos, Great White Pelican, Caspian Tern and Chestnut-banded Plover, either roosting or foraging within the floodplain area, or commuting between this and other key resource areas to the north or south.
- (ii) A range of locally resident or visiting raptors, particularly Black Harrier, African Marsh Harrier and Martial Eagle, but also including Secretarybird *Sagittarius serpentarius*, Peregrine Falcon *Falco peregrinus* and Lanner Falcon *Falco biarmicus*, nesting, foraging in or moving through the area.
- (iii) Seasonal influxes of Ludwig's Bustard to the coastal plain (Allan 1994, Young *et al.* 2003, Hockey *et al.* 2005), commuting between roosting sites and feeding areas.

Table 2. Priority bird species considered central to the avian impact assessment process for the Olifants River Wind Energy Facility, selected 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 SABAP reporting rate (N = 61 cards)	Estimated importance of local population	Preferred habitat	Risk posed by		
							Collision	Electro-cution	Disturbance / habitat loss
Ludwig's Bustard	<i>Neotis ludwigii</i>	Vulnerable (Endangered)	Near-endemic	5.0	Moderate	Open Strandveld, cultivated lands	High	-	Moderate
Caspian Tern	<i>Sterna caspia</i>	Near-threatened	-	39.0	High	Floodplain	Moderate	-	-
Damara Tern	<i>Sternula balaenarum</i>	Endangered	-	0.0	Low	Floodplain	Moderate	-	-
Chestnut-banded Plover	<i>Charadrius pallidus</i>	Near-threatened	-	20.0	Moderate	Floodplain	Moderate	-	-
African Marsh Harrier	<i>Circus ranivorus</i>	Vulnerable	-	23.0	High	Floodplain, cultivated lands	Moderate	-	Moderate
Black Harrier	<i>Circus maurus</i>	Near-threatened (Vulnerable)	Endemic	20.0	High	Floodplain, Open Strandveld	Moderate	-	Moderate
Martial Eagle	<i>Polemaetus bellicosus</i>	Vulnerable (Near-threatened)	-	0.0	Moderate	Open Strandveld	High	High	Moderate
Secretarybird	<i>Sagittarius serpentarius</i>	Near-threatened	-	2.0	Low	Floodplain, Open Strandveld	High	-	Moderate
Lanner Falcon	<i>Falco biarmicus</i>	Near-threatened	-	0.0	Low	Floodplain, cultivated lands	High	Moderate	Moderate
Peregrine Falcon	<i>Falco peregrinus</i>	Near-threatened	-	0.0	Low	Floodplain, cultivated lands	High	Moderate	Moderate
Greater Flamingo	<i>Phoenicopterus ruber</i>	Near-threatened	-	54.0	High	Floodplain, flying through	High	-	Moderate

Common name	Scientific name	SA conservation status/ (Global conservation status)	Regional endemism	Average SABAP reporting rate (N = 61 cards)	Estimated importance of local population	Preferred habitat	Risk posed by		
							Collision	Electro-cution	Disturbance / habitat loss
Lesser Flamingo	<i>Phoenicopterus minor</i>	Near-threatened	-	51.0	High	Floodplain, flying through	High	-	Moderate
Great White Pelican	<i>Pelecanus onocrotalus</i>	Near-threatened	-	44.0	High	Floodplain, flying over	High	-	Moderate

6. PROVISIONAL ASSESSMENT OF IMPACTS

Of the conservation priority, red-listed species, all are considered to be at some risk of colliding with the blades of the turbines or associated power lines, three species are considered to be at risk of electrocution on any bird-unfriendly power infrastructure associated with the wind energy facility, and ten species are considered to be at risk of being disturbed and/or losing habitat during construction and possibly in the longer term (Table 2). It is not possible at this stage to determine with confidence the relative significance of these various potential impacts, mainly because too little information is available on the relative abundance and movements of local populations of the implicated species. The significance of impacts will be investigated in more detail during the EIA phase after accumulating 12 months of monitoring data (see below). The main area of concern is the proximity of the proposed wind energy facility to a wetland of the size and regional significance of the Olifants River Estuary (Barnes 1998). The facility would pose a threat both in terms of disturbance of birds using the floodplain, and in terms of collision risk for these birds when commuting out of the floodplain en route to other wetlands to the north or south. In order to mitigate both these potential impacts, **there should be no development at all within a buffer area extending at least to 500 m from the outer edge of the floodplain on both banks (Fig. 5).**

The impact area of the development may occasionally support significant populations of Ludwig's Bustard and Black Harrier. Both are red-listed, endemic or near-endemic species, and both (particularly Ludwig's Bustard) are highly responsive to seasonal and inter-annual changes in environmental conditions in the Succulent Karoo, and are prone to relatively large-scale influxes into this region during or immediately after substantial rainfall events (Allan 1994, Curtis *et al.* 2004, Hockey *et al.* 2005). The exact nature and pattern of these influxes is not well understood in either species, and is therefore not easy to predict. Collision with the turbine blades is potentially the most significant impact of the proposed development, and could negatively affect a variety of collision prone species, most notably aggregations of wetland birds which might travel through the impact zone (especially when such movements occur during unfavourable weather conditions and/or at night), a suite predatory birds present in the area, especially Black Harrier and Martial Eagle, and possibly active pursuit hunters such as Peregrine Falcon and Lanner Falcon, and individuals or loose flocks of Ludwig's Bustard.

At present, it is only possible to *speculate* on the biology and possible mitigation of the most likely risk factors (Table 3), an exercise which suggests that **collision mortality and displacement or disturbance impacts are probable, may well be significant, and would probably require considerable mitigation effort.**

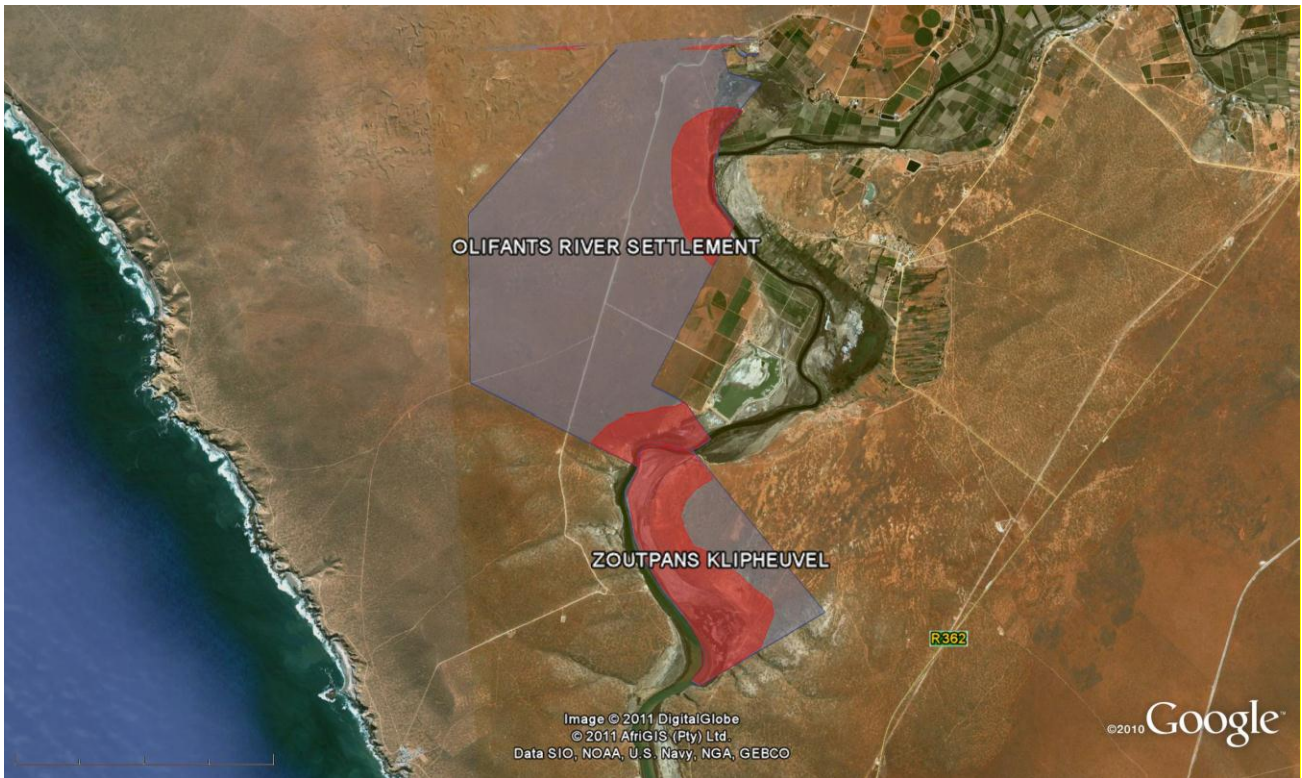


FIGURE 5. Development buffer areas (red shaded) along the edge of the Olifants River floodplain.

7. CONCLUSIONS AND PLAN OF STUDY FOR EIA PHASE

The scoping phase has identified potential avifaunal issues associated with the proposed wind energy facility and its possible associated infrastructure. These issues will be investigated in more detail during the full EIA phase. In particular, the significance of bird collisions with the turbines will be assessed in order to determine whether the risk warrants mitigation such as no-go areas for turbines, patterning of turbine blades, or periodic shutting down of the wind energy facility (as discussed above). This will be assessed mainly in terms of (i) the actual or estimated abundance of priority bird species in the area, and (ii) the distribution of relevant microhabitats and food resources, and the way in which the latter is likely to influence aggregation and movement of these birds through the impact zone of the proposed wind energy facility.

Table 3. Provisional bird impacts matrix for the Olifants River Wind Energy Facility.

Impact	Cause	Affected taxa	Likelihood	Duration	Extent	Significance	Mitigation
Disturbance	Construction & maintenance	Wetland birds, raptors, large terrestrials	High	Short	Local	Low	Optimize timing and minimise duration of construction activity
	Operation - noise and movement	Wetland birds, raptors, large terrestrials	Moderate	Life of the facility	Local	<i>Cannot be specified at this stage</i>	Minimise noise output of facility
Habitat loss: habitat destruction	Construction footprint	Raptors, large terrestrials, endemic passerines	High	Life of the facility	Local	Low	Minimise construction footprint
Habitat loss: displacement	Operation - noise and movement	Wetland birds, raptors, large terrestrials, endemic passerines	Moderate	Life of the facility?	Local	<i>Cannot be specified at this stage</i>	Minimise prominence in landscape and noise output
Mortality	Electrocution on associated infrastructure	Raptors and possibly large wetland spp.	High	Life of the facility	Local	<i>Cannot be specified at this stage</i>	Use bird friendly hardware and power line designs
Mortality	Collision with turbine blades and associated power lines	Commuting wetland birds and large terrestrials, commuting or foraging raptors	Moderate	Life of the facility	Local	<i>Cannot be specified at this stage</i>	Turbine and power line siting, mark turbine blades/power lines, limit operational times or conditions, radar-sensitive management of turbine operation

The Birds & Wind Energy Specialist Group (BAWESG) has recently published it's the 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 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 AIA report in terms of points (i) to (iii).
- (v) To establish a pre-impact baseline of bird numbers, distributions and movements.
- (vi) To mitigate impacts by informing the final design, 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.

7.2 Project specifics

The proposed Olifants River Wind Energy Facility is a large development, set in close proximity to regionally significant wetland area, classed as a national Important Bird Area (Barnes 1998). The baseline monitoring work required to inform the Environmental Impact Assessment process which may follow the production of this scoping report should be conducted over the mandatory

12 months, and include a minimum of five 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 field team of two observers.

A suitable location for an independent but comparable and nearby control survey area should be identified during the orientation site visit.

Sample counts of small terrestrial species

Ten walked transects, each about 1 km in length, should be set up on the development site, and five on the control site. These should be established during orientation, and located in order to ensure adequate sampling of the full variety of terrestrial habitats present on each site. Each transect should be walked once per visit to the site, and data should be collected as per the protocols laid out in the best practice guidelines (Jenkins *et al.* 2011).

Counts of large terrestrial species and raptors

An absolute count of large terrestrial species and raptors should be done once per visit to the site, 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).

Focal site surveys and 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 protocol 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). There are a number of such sites relevant to the Olifants River development, and others may be found as the monitoring project progresses, and should thereafter be incorporated into the project.

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). Clearly, wetlands will be a vital component of this monitoring project, and suitable counting locations for the floodplain area of the river should be selected on both the development and control sites during orientation, and

counted through the full spectrum of tidal and seasonal variation. Further such sites may be found as the monitoring project progresses, and will be incorporated into the project.

Incidental observations

All other, incidental sightings of priority species (and particularly those suggestive of breeding or important feeding or roosting sites or flight paths) 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).

Movements and flight paths

Counts of bird traffic over and around the development area and the control site should be conducted from at least six vantage points (four on the development site, two on the control) which should be selected during the 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).

Table 4. Provisional breakdown of time required in the field for each component of the baseline monitoring project required to inform the EIA for the Olifants River Wind Energy Facility.

	Walked transects		Vantage Points		Absolute Counts		Wetland surveys		Focal Sites		Monitoring effort per iteration (hours)	Total monitoring effort (hours)
	n	hours	n	hours	n	hours	n	hours	n	hours		
Olifants River	10	6	4	48	1	4	3	9	2	4	71	355
Control site	5	3	2	24	1	4	1	3	1	2	36	180

Overall, the monitoring project at Clover Valley should take up about 535 x 2 person hours, in addition to about 40 x 3 person hours in the initial orientation visit, or about 1200 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.

8. REFERENCES

- Acha, A. 1997. Negative impact of wind generators on the Eurasian Griffon *Gyps fulvus* in Tarifa, Spain. *Vulture News* 38:10-18.
- Allan, D.G. 1994. The abundance and movements of Ludwig's Bustard *Neotis ludwigii*. *Ostrich* 65: 95-105.
- Allan, D.G. & Jenkins, A.R. 1990. West Coast heavy mineral sands project: Birdlife on the proposed mining site. Unpublished report. University of Cape Town, Cape Town.
- Anderson, M.D. 2001. The effectiveness of two different marking devices to reduce large terrestrial bird collisions with overhead electricity cables in the eastern Karoo, South Africa. Draft report to Eskom Resources and Strategy Division. Johannesburg. South Africa.
- Avian Powerline Interation Committee (APLIC). 1994. Mitigating bird collisions with power lines: the state of the art in 1994. Edison Electric Institute. Washington DC.
- Barclay, R.M.R, Baerwald, E.F. & Gruver, J.C. 2007. Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology* 85: 381-387.
- Barrios, L. & Rodríguez, A. 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. *Journal of Applied Ecology* 41: 72-81.
- Barnes, K.N. (ed.) 1998. The Important Bird Areas of southern Africa. BirdLife South Africa, Johannesburg.
- Barnes, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.
- Bevanger, K. 1994. Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. *Ibis* 136: 412-425.
- Bevanger, K. 1995. Estimates and population consequences of Tetraonid mortality caused by collisions with high tension power lines in Norway. *Journal of Applied Ecology* 32: 745-753.
- Bevanger, K. 1998. Biological and conservation aspects of bird mortality caused by electric power lines. *Biological Conservation* 86: 67-76.
- Bright, J., Langston, R., Bullman, R. Evans, R., Gardner, S., & Pearce-Higgins, J. 2008. Map of bird sensitivities to wind farms in Scotland: A tool to aid planning and conservation. *Biological Conservation* 141: 2342-2356.
- Crockford, N.J. 1992. A review of the possible impacts of wind farms on birds and other wildlife. Joint Nature Conservation Committee. JNCC Report number 27. Peterborough, United Kingdom.

- Curry, R.C., & Kerlinger, P. 2000. Avian mitigation plan: Kenetech model wind turbines, Altamont Pass WRA, California. In: Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.
- Curtis, O., Simmons, R.E. & Jenkins, A.R. 2004. Black Harrier *Circus maurus* of the Fynbos biome, South Africa: a threatened specialist or an adaptable survivor? *Bird Conservation International* 14: 233-245.
- De Lucas, M., Janss, G.F.E., Whitfield, D.P. & Ferrer, M. 2008. Collision fatality of raptors in wind farms does not depend on raptor abundance. *Journal of Applied Ecology* 45: 1695-1703.
- Devereaux, C/L., Denny, M.J.H. & Whittingham, M.J. 2008. Minimal effects of wind turbines on the distribution of wintering farmland birds. *Journal of Applied Ecology* 45: 1689-1694.
- 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 Science* 1134: 233-266.
- Erickson, W.P., Johnson, G.D., Strickland, M.D., Young, D.P., Sernka, K.J., Good, R.E. 2001. Avian collisions with wind turbines: a summary of existing studies and comparison to other sources of avian collision mortality in the United States. National Wind Coordinating Committee Resource Document.
- Erickson, W.P., Johnson, G.D., Strickland, M.D., Kronner, K. & Becker, P.S. 1999. Baseline avian use and behaviour at the CARES Wind Plant Site, Klickitat County, Washington. Unpublished report to the National Renewable Energy Laboratory. NREL, Colorado.
- Everaert, J. 2003. Wind turbines and birds in Flanders: Preliminary study results and recommendations. *Natuur. Oriolus* 69: 145-155.
- Farfán, M.A., Vargas, J.M. & Duarte, J. 2009. What is the impact of wind farms on birds. A case study in southern Spain. *Biodiversity Conservation* 18: 3743-3758.
- Gill, J.P., Townsley, M. & Mudge, G.P. 1996. Review of the impact of wind farms and other aerial structures upon birds. *Scottish Natural Heritage Review* 21.
- Hanowski, J.M., & Hawrot, R.Y. 2000. Avian issues in development of wind energy in western Minnesota. In Proceedings of the National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.
- Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1&2. BirdLife South Africa, Johannesburg.
- Hockey, P.A.R., Dean, W.R.J., Ryan, P.G. (Eds) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

- Hodos, W. 2002. Minimization of motion smear: Reducing avian collisions with turbines. Unpublished subcontractor report to the National Renewable Energy Laboratory. NREL/SR 500-33249.
- Howell, J.A. 1995. Avian mortality at rotor sweep areas equivalent to Altamont Pass and Montezuma Hills, California. Prepared for Kenetech Wind Power, San Francisco, California.
- Janss, G. 2000a. Bird behaviour in and near a wind farm at Tarifa, Spain: Management considerations. In: Proceedings of National Avian-Wind Power Planning Meeting III, San Diego California, May 1998.
- Janss, G.F.E. 2000b. Avian mortality from power lines: a morphologic approach of a species-specific mortality. *Biological Conservation* 95: 353-359.
- Jaroslow, B. 1979. A review of factors involved in bird-tower kills, and mitigation procedures. In: G.A. Swanson (Tech co-ord). The Mitigation symposium. A national workshop on mitigation losses of Fish and Wildlife Habitats. US Forest Service General Technical Report. RM-65.
- Jenkins, A. 1998. Site evaluation for Namakwa Sands heavy minerals sands mine. Unpublished report to the Environmental Evaluation Unit. University of Cape Town, Cape Town.
- Jenkins, A.R. 2001. The potential impact of a demonstration wind farm facility on the birds of the Darling / Yzerfontein area, Western Cape Province, South Africa. Unpublished report to the Environmental Evaluation Unit, University of Cape Town, Cape Town.
- Jenkins, A.R. 2003. Populations and movements of priority bird species in the vicinity of the proposed Darling Demonstration Wind Farm facility. Unpublished report to the Environmental Evaluation Unit, University of Cape Town, Cape Town.
- Jenkins, A.R. 2008a. A proposed new list of the threatened raptors of southern Africa. *Gabar* 19 (1): 27-40.
- Jenkins, A.R. 2008b. Eskom generation wind energy facility – Western Cape: Avifaunal impact assessment. Report to Savannah Environmental Pty (Ltd).
- Jenkins, A.R. 2011. Winds of change: birds and wind energy development in South Africa. *Africa – Birds & Birding* 15(6): 35-38.
- Jenkins, A., Gibbons, B. & Visagie, R. 2009. Long-term fixed site monitoring of wildlife interactions with power lines across a range of biomes: establishment and maintenance of a long-term bird;power line interaction monitoring site in the De Aar (Hydra) area of the eastern Karoo, Northern Cape. Unpublished report to Eskom.
- 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.

- Jenkins, A.R., van Rooyen, C.S., Smallie, J.J., Anderson, M.D. & Smit, H.A. 2011. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Endangered Wildlife Trust/BirdLife South Africa, Johannesburg.
- Kemper, C.A. 1964. A tower for TV: 30 000 dead birds. *Audubon Magazine* 66: 86-90.
- Kerlinger, P. & Dowdell, J. 2003. Breeding bird survey for the Flat Rock wind power project, Lewis County, New York. Prepared for Atlantic Renewable Energy Corporation.
- Kerlinger, P., Gehring, J.L., Erickson, W.P., Curry, R., Jain, A. & Guarnaccia, J. 2010. Night migrant fatalities and obstruction lighting at wind turbines in North America. *The Wilson Journal of Ornithology* 122: 744-754.
- King, D.I. & Byers, B.E. 2002. An evaluation of powerline rights-of-way as habitat for early-successional shrubland birds. *Wildlife Society Bulletin* 30: 868-874.
- Kingsley, A. & Whittam, B. 2005. Wind turbines and birds – A background review for environmental assessment. Unpublished report for Environment Canada/Canada Wildlife Service.
- Krijgsveld, K.L., Akershoek, K., Schenk, F., Dijk, F. & Dirksen, S. 2009. Collision risk of birds with modern large wind turbines. *Ardea* 97: 357-366.
- Küyler, E.J. 2004. The impact of the Eskom Wind Energy Demonstration Facility on local avifauna – Results from the monitoring programme for the time period June 2003 to Jan 2004. Unpublished report to Eskom Peaking Generation.
- Kuvlevsky, W.P. Jnr, 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: 2487-2498.
- Larsen, J.K. & Guillemette, M. 2007. Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. *Journal of Applied Ecology* 44: 516-522.
- Lehman, R.N., Kennedy, P.L. & Savidge, J.A. 2007. The state of the art in raptor electrocution research: a global review. *Biological Conservation* 136: 159-174.
- Madders, M. & Whitfield, D.P. 2006. Upland raptors and the assessment of wind farms impacts. *Ibis* 148: 43-56.
- Masden, E.A., Fox, A.D., Furness, R.W., Bullman, R. & Haydon, D.T. 2009. Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework. *Environmental Impact Assessment Review* 30: 1-7.
- McIsaac, H.P. 2001. Raptor acuity and wind turbine blade conspicuity. Pp. 59-87. National Avian-Wind Power Planning Meeting IV, Proceedings. Prepared by Resolve, Inc., Washington DC.

- Mucina, L. & Rutherford, M.C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. South African National Biodiversity Institute, Pretoria.
- National Wind Co-ordinating Committee. 2004. Wind turbine interactions with birds and bats: A summary of research results and remaining questions. Fact Sheet, Second Edition.
- Newton, I. & Little, B. 2009. Assessment of wind-farm and other bird casualties from carcasses found on a Northumbrian beach over an 11-year period. *Bird Study* 56: 158-167.
- Noguera, J.C., Pérez, I. & Mínguez, E. 2010. Impacts of terrestrial wind farms on diurnal raptors: developing a spatial vulnerability index and potential vulnerability maps. *Ardeola* 57: 41-53.
- Pennycuik, C.J. 1989. Bird flight performance: a practical calculation manual. Oxford University Press, Oxford.
- Pierce-Higgins, J.W., Stephen, L., Langston, R.H.W., Bainbridge, I.P. & Bullman, R. 2009. The distribution of breeding birds around upland wind farms. *Journal of Applied Ecology*, Published Online, September 24, 2009.
- Richardson, W.J. 2000. Bird migration and wind turbines: Migration timing, flight behaviour and collision risk. In Proceedings of the National Avian-wind Power Planning Meeting III, San Diego, California, May 1998.
- Scottish National Heritage. 2005. Survey methods for use in assessing the impacts of onshore windfarms on bird communities. Unpublished Report.
- Shaw, J., Jenkins, A.R. & Ryan, P.G. 2010a. Modelling power line collision risk in the Blue Crane *Anthropoides paradiseus* in South Africa. *Ibis* 152: 590-599.
- Shaw, J., Jenkins, A.R., Ryan, P.G. & Smallie, J. 2010b. A preliminary survey of avian mortality on power lines in the Overberg, South Africa. *Ostrich* 81: 109-113.
- Stewart, G.B., Pullin, A.S. & Coles, C.F. 2007. Poor evidence-base for assessment of windfarm impacts on birds. *Environmental Conservation* 34: 1-11.
- Smallwood, K.S. & Thelander, C. 2008. Bird mortality in the Altamont Pass Wind Resource Area, California. *Journal of Wildlife Management* 72: 215-223.
- Smallwood, K.S., Rugge, L. & Morrison, M.L. 2009. Influence of behavior on bird mortality in wind energy developments. *Journal of Wildlife Management* 73: 1082-1098.
- Sovacool, B.K. 2009. Contextualizing avian mortality: a preliminary appraisal of bird and bat fatalities from wind, fossil-fuel, and nuclear electricity. *Energy Policy* 37: 2241-2248.
- Tapia, L., Dominguez, J. & Rodriguez, L. 2009. Using probability of occurrence to assess potential interaction between wind farms and a residual population of golden eagle *Aquila chrysaetos* in NW Spain. *Biodiversity & Conservation* 18: 2033-2041.

- Van Rooyen, C. 2001. Bird Impact Assessment Study – Eskom Wind Energy Demonstration Facility, Western Cape South Africa. Prepared for Eskom Enterprises, TSI Division.
- Van Rooyen, C.S. 2004a. The Management of Wildlife Interactions with overhead lines. In *The fundamentals and practice of Overhead Line Maintenance (132kV and above)*, pp217-245. Eskom Technology, Services International, Johannesburg.
- Van Rooyen, C.S. 2004b. Investigations into vulture electrocutions on the Edwardsdam-Mareetsane 88kV feeder, Unpublished report, Endangered Wildlife Trust, Johannesburg.
- Weir, R. D. 1976. Annotated bibliography of bird kills at manmade obstacles: a review of the state of the art and solutions. Canadian Wildlife Services, Ontario Region, Ottawa.
- Walker, D., McGrady, M., McCluskie, A., Madders, M. & McLeod, D.R.A. 2005. Resident Golden Eagle ranging behavior before and after construction of a windfarm in Argyll. *Scottish Birds* 25: 24-40.
- Winkelman, J.E. 1995. Bird/wind turbine investigations in Europe. In *Proceedings of the National Avian- wind Power Planning Meeting 1994*.
- Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.D. & Colahan, B.D. (eds). 2003. *Big birds on farms: Mazda CAR report 1993-2001*. Avian Demography Unit, Cape Town.

APPENDIX 1. Annotated list of the bird species likely to occur within the impact zone of the proposed Olifants River Wind Energy Facility.

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Common Ostrich	<i>Struthio camelus</i>	-	-	X				X	-	-	Moderate
Grey-winged Francolin	<i>Scleroptila africanus</i>	-	Endemic	X	X			X	Moderate	-	
Cape Spurfowl	<i>Pternistis capensis</i>	-	Endemic	X					Moderate	-	Moderate
Common Quail	<i>Coturnix coturnix</i>	-	-		X			X		-	Moderate
Helmeted Guineafowl	<i>Numida meleagris</i>	-	-		X		X	X	Moderate	-	Moderate
Maccoa Duck	<i>Oxyura maccoa</i>	-	-		X				Moderate	-	-
Egyptian Goose	<i>Alopochen aegyptiaca</i>	-	-		X				High	High	-
South African Shelduck	<i>Tadorna cana</i>	-	Endemic		X				High	-	-
Spur-winged Goose	<i>Plectropterus gambensis</i>	-	-		X				High	High	-
Cape Teal	<i>Anas capensis</i>	-	-		X				Moderate	-	-
African Black Duck	<i>Anas sparsa</i>	-	-		X				Moderate	-	-
Mallard	<i>Anas platyrhynchos</i>	-	-		X				Moderate	-	-
Yellow-billed Duck	<i>Anas undulata</i>	-	-		X				Moderate	-	-
Cape Shoveler	<i>Anas smithii</i>	-	Endemic		X				Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Red-billed Teal	<i>Anas erythrorhyncha</i>	-	-		X				Moderate	-	-
Southern Pochard	<i>Netta erythrophthalma</i>	-	-		X				Moderate	-	-
Greater Honeyguide	<i>Indicator indicator</i>	-	-				X		-	-	Moderate
Ground Woodpecker	<i>Geocolaptes olivaceus</i>	-	Endemic	X		X			-	-	Moderate
Cardinal Woodpecker	<i>Dendropicos fuscescens</i>	-	-				X		-	-	Moderate
Acacia Pied Barbet	<i>Tricholaema leucomelas</i>	-	Near-endemic				X		-	-	Moderate
African Hoopoe	<i>Upupa africana</i>	-	-				X	X	-	-	Moderate
Malachite Kingfisher	<i>Alcedo cristata</i>	-	-		X				-	-	Moderate
Giant Kingfisher	<i>Megaceryle maximus</i>	-	-		X				-	-	Moderate
Pied Kingfisher	<i>Ceryle rudis</i>	-	-		X				-	-	Moderate
European Bee-eater	<i>Merops apiaster</i>	-	-	X	X				-	-	Moderate
White-backed Mousebird	<i>Colius colius</i>	-	Endemic	X					-	-	Moderate
Speckled Mousebird	<i>Colius striatus</i>	-	-	X					-	-	Moderate
Red-faced Mousebird	<i>Urocolius indicus</i>	-	-	X					-	-	Moderate
Klaas's Cuckoo	<i>Chrysocolaptes klaas</i>	-	-	X			X		-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Diderick Cuckoo	<i>Chrysococcyx caprius</i>	-	-	X			X		-	-	-
Burchell's Coucal	<i>Centropus burchellii</i>	-	-		X				-	-	Moderate
Alpine Swift	<i>Tachymarptis melba</i>	-	-	X		X			-	-	-
Common Swift	<i>Apus apus</i>	-	-	X	X	X	X	X	-	-	-
African Black Swift	<i>Apus barbatus</i>	-	-	X		X			-	-	-
Little Swift	<i>Apus affinis</i>	-	-				X	X	-	-	-
Horus Swift	<i>Apus horus</i>	-	-	X	X				-	-	-
White-rumped Swift	<i>Apus caffer</i>	-	-		X		X	X	-	-	-
Barn Owl	<i>Tyto alba</i>	-	-	X		X	X	X	-	Moderate	Moderate
Cape Eagle-Owl	<i>Bubo capensis</i>	-	-			X			-	High	Moderate
Spotted Eagle-Owl	<i>Bubo africanus</i>	-	-	X		X	X	X	-	High	Moderate
Fiery-necked Nightjar	<i>Caprimulgus pectoralis</i>	-	-	X	X		X		-	-	Moderate
Freckled Nightjar	<i>Caprimulgus tristigma</i>	-	-			X			-	-	Moderate
Rufous-cheeked Nightjar	<i>Caprimulgus rufigena</i>	-	-	X			X		-	-	Moderate
Rock Dove	<i>Columba livia</i>	-	-			X		X	-	-	-
Speckled Pigeon	<i>Columba guinea</i>	-	-			X		X	-	-	-
Laughing Dove	<i>Streptopelia senegalensis</i>	-	-	X				X	-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Cape Turtle-Dove	<i>Streptopelia capicola</i>	-	-	X			X	X	-	-	Moderate
Red-eyed Dove	<i>Streptopelia semitorquata</i>	-	-		X		X	X	-	-	Moderate
Namaqua Dove	<i>Oena capensis</i>	-	-	X				X	-	-	Moderate
Ludwig's Bustard	<i>Neotis ludwigii</i>	Vulnerable	Near-endemic	X				X	High	-	Moderate
Kori Bustard	<i>Ardeotis kori</i>	Vulnerable	-	X					High	-	Moderate
Southern Black Korhaan	<i>Afrotis afra</i>	-	Endemic	X				X	Moderate	-	Moderate
Karoo Korhaan	<i>Eupodotis vigorsii</i>	-	Endemic	X					Moderate	-	Moderate
Blue Crane	<i>Anthropoides paradiseus</i>	Vulnerable	Endemic	X	X			X	High	-	Moderate
Red-chested Flufftail	<i>Sarothrura rufa</i>	-	-		X				-	-	Moderate
African Rail	<i>Rallus caerulescens</i>	-	-		X				-	-	-
Black Crake	<i>Amauornis flavirostris</i>	-	-		X				-	-	-
African Purple Swamphen	<i>Porphyrio madagascariensis</i>	-	-		X				-	-	-
Common Moorhen	<i>Gallinula chloropus</i>	-	-		X				-	-	-
Red-knobbed Coot	<i>Fulica cristata</i>	-	-		X				-	-	-
Namaqua Sandgrouse	<i>Pterocles namaqua</i>	-	Near-endemic	X				X	-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
African Snipe	<i>Gallinago nigripennis</i>	-	-		X				-	-	Moderate
Bar-tailed Godwit	<i>Limosa lapponica</i>	-	-		X				-	-	-
Common Whimbrel	<i>Numenius phaeopus</i>	-	-		X	X			-	-	-
Eurasian Curlew	<i>Numenius arquata</i>	-	-		X	X			-	-	-
Marsh Sandpiper	<i>Tringa stagnatilis</i>	-	-		X				-	-	-
Common Greenshank	<i>Tringa nebularia</i>	-	-		X				-	-	-
Wood Sandpiper	<i>Tringa glareola</i>	-	-		X				-	-	-
Terek Sandpiper	<i>Xenus cinereus</i>	-	-		X				-	-	-
Common Sandpiper	<i>Actitis hypoleucos</i>	-	-		X				-	-	-
Ruddy Turnstone	<i>Arenaria interpres</i>	-	-		X	X			-	-	-
Red Knot	<i>Calidris canutus</i>	-	-		X	X			-	-	-
Sanderling	<i>Calidris alba</i>	-	-		X	X			-	-	-
Little Stint	<i>Calidris minuta</i>	-	-		X	X			-	-	-
Curlew Sandpiper	<i>Calidris ferruginea</i>	-	-		X	X			-	-	-
Ruff	<i>Philomachus pugnax</i>	-	-		X				-	-	-
Wilson's Phalarope	<i>Steganopus tricolor</i>	-	-		X				-	-	-
Red-necked Phalarope	<i>Phalaropus lobatus</i>	-	-		X				-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Red Phalarope	<i>Phalaropus fulicaria</i>	-	-		X				-	-	-
Greater Painted-snipe	<i>Rostratula benghalensis</i>	Near-threatened	-		X				-	-	Moderate
African Jacana	<i>Actophilornis africanus</i>	-	-		X				Moderate	-	-
Water Thick-knee	<i>Burhinus vermiculatus</i>	-	-		X				Moderate	-	Moderate
Spotted Thick-knee	<i>Burhinus capensis</i>	-	-	X				X	Moderate	-	Moderate
African Black Oystercatcher	<i>Haematopus moquini</i>	Near-threatened	Endemic		X	X			Moderate	-	-
Black-winged Stilt	<i>Himantopus himantopus</i>	-	-		X				Moderate	-	-
Pied Avocet	<i>Recurvirostra avocetta</i>	-	-		X				Moderate	-	-
Grey Plover	<i>Pluvialis squatarola</i>	-	-		X	X			Moderate	-	-
Common Ringed Plover	<i>Charadrius hiaticula</i>	-	-		X	X			-	-	-
Kittlitz's Plover	<i>Charadrius pecuarius</i>	-	-		X			X	-	-	-
Three-banded Plover	<i>Charadrius tricollaris</i>	-	-		X				-	-	-
Chestnut-banded Plover	<i>Charadrius pallidus</i>	Near-threatened	-		X				-	-	-
White-fronted Plover	<i>Charadrius marginatus</i>	-	-		X	X			-	-	-
Lesser Sand Plover	<i>Charadrius mongolus</i>	-	-		X				-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Greater Sand Plover	<i>Charadrius leschenaultii</i>	-	-		X				-	-	-
Blacksmith Lapwing	<i>Vanellus armatus</i>	-	-		X				Moderate	-	-
Crowned Lapwing	<i>Vanellus coronatus</i>	-	-					X	Moderate	-	Moderate
Double-banded Courser	<i>Rhinoptilus africanus</i>	-	-					X	Moderate	-	Moderate
Kelp Gull	<i>Larus dominicanus</i>	-	-			X			Moderate	Moderate	-
Grey-headed Gull	<i>Larus cirrocephalus</i>	-	-		X	X			Moderate	-	-
Hartlaub's Gull	<i>Larus hartlaubii</i>	-	Endemic		X	X			Moderate	-	-
Caspian Tern	<i>Sterna caspia</i>	Near-threatened	-		X				Moderate	-	-
Swift Tern	<i>Sterna bergii</i>	-	-		X	X			Moderate	-	-
Sandwich Tern	<i>Sterna sandvicensis</i>	-	-		X	X			Moderate	-	-
Common Tern	<i>Sterna hirundo</i>	-	-		X	X			Moderate	-	-
Arctic Tern	<i>Sterna paradisaea</i>	-	-			X			Moderate	-	-
Antarctic Tern	<i>Sterna vittata</i>	-	-			X			Moderate	-	-
Little Tern	<i>Sterna albifrons</i>	-	-		X	X			Moderate	-	-
Damara Tern	<i>Sterna balaenarum</i>	Endangered	Breeding endemic			X			Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
White-winged Tern	<i>Chlidonias leucopterus</i>	-	-		X				Moderate	-	-
Osprey	<i>Pandion haliaetus</i>	-	-		X				Moderate	Moderate	-
Black-shouldered Kite	<i>Elanus caeruleus</i>	-	-	X			X	X	Moderate	-	Moderate
Black Kite	<i>Milvus migrans</i>	-	-	X			X	X	Moderate	-	-
African Fish-Eagle	<i>Haliaeetus vocifer</i>	-	-		X				Moderate	High	-
Black-chested Snake-Eagle	<i>Circaetus pectoralis</i>	-	-	X					Moderate	Moderate	Moderate
African Marsh-Harrier	<i>Circus ranivorus</i>	Vulnerable	-	X	X			X	Moderate	-	Moderate
Black Harrier	<i>Circus maurus</i>	Near-threatened	Endemic	X	X			X	High	-	Moderate
African Harrier-Hawk	<i>Polyboroides typus</i>	-	-				X		Moderate	-	-
Southern Pale Chanting Goshawk	<i>Melierax canorus</i>	-	Near-endemic	X					Moderate	Moderate	Moderate
Gabar Goshawk	<i>Melierax gabar</i>	-	-				X		Moderate	-	Moderate
Black Sparrowhawk	<i>Accipiter melanoleucus</i>	-	-				X		Moderate	-	Moderate
Steppe Buzzard	<i>Buteo vulpinus</i>	-	-	X			X	X	Moderate	Moderate	-
Jackal Buzzard	<i>Buteo rufofuscus</i>	-	Endemic	X		X	X	X	Moderate	Moderate	Moderate
Tawny Eagle	<i>Aquila rapax</i>	Vulnerable	-	X					High	High	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Verreauxs' Eagle	<i>Aquila verreauxii</i>	-	-			X			High	High	-
Booted Eagle	<i>Aquila pennatus</i>	-	-	X			X	X	Moderate	-	-
Martial Eagle	<i>Polemaetus bellicosus</i>	Vulnerable	-	X			X		High	High	Moderate
Secretarybird	<i>Sagittarius serpentarius</i>	Near-threatened	-	X				X	High	-	Moderate
Lesser Kestrel	<i>Falco naumanni</i>	Vulnerable	-	X			X	X	-	-	Moderate
Rock Kestrel	<i>Falco rupicolus</i>	-	-	X		X		X	-	-	Moderate
Greater Kestrel	<i>Falco rupicoloides</i>	-	-	X					-	-	Moderate
Lanner Falcon	<i>Falco biarmicus</i>	Near-threatened	-	X		X		X	High	Moderate	Moderate
Peregrine Falcon	<i>Falco peregrinus</i>	Near-threatened	-	X		X		X	High	Moderate	-
Little Grebe	<i>Tachybaptus ruficollis</i>	-	-		X				-	-	-
Great Crested Grebe	<i>Podiceps cristatus</i>	-	-		X				Moderate	-	-
Black-necked Grebe	<i>Podiceps nigricollis</i>	-	-		X				Moderate	-	-
White-breasted Cormorant	<i>Phalacrocorax lucidus</i>	-	-		X	X			Moderate	Moderate	-
Little Egret	<i>Egretta garzetta</i>	-	-		X	X			-	-	-
Yellow-billed Egret	<i>Egretta intermedia</i>	-	-		X				-	-	-
Great Egret	<i>Egretta alba</i>	-	-		X				-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Grey Heron	<i>Ardea cinerea</i>	-	-		X				Moderate	Moderate	-
Black-headed Heron	<i>Ardea melanocephala</i>	-	-		X			X	Moderate	Moderate	Moderate
Purple Heron	<i>Ardea purpurea</i>	-	-		X				-	-	-
Cattle Egret	<i>Bubulcus ibis</i>	-	-		X			X	-	-	-
Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>	-	-		X				-	-	-
Little Bittern	<i>Ixobrychus minutus</i>	-	-		X				-	-	-
Hamerkop	<i>Scopus umbretta</i>	-	-		X				-	-	-
Greater Flamingo	<i>Phoenicopterus ruber</i>	Near-threatened	-		X				High	-	-
Lesser Flamingo	<i>Phoenicopterus minor</i>	Near-threatened	-		X				High	-	-
Glossy Ibis	<i>Plegadis falcinellus</i>	-	-		X				-	-	-
Hadedda Ibis	<i>Bostrychia hagedash</i>	-	-		X		X	X	Moderate	-	-
African Sacred Ibis	<i>Threskiornis aethiopicus</i>	-	-		X			X	Moderate	-	-
African Spoonbill	<i>Platalea alba</i>	-	-		X				Moderate	-	-
Great White Pelican	<i>Pelecanus onocrotalus</i>	Near-threatened	-		X				High	-	-
Black Stork	<i>Ciconia nigra</i>	Near-threatened	-		X			X	High	Moderate	-
White Stork	<i>Ciconia ciconia</i>	-	-	X	X			X	High	High	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Fork-tailed Drongo	<i>Dicrurus adsimilis</i>	-	-				X		-	-	Moderate
Bokmakierie	<i>Telophorus zeylonus</i>	-	Near-endemic	X					-	-	Moderate
Pirit Batis	<i>Batis pririt</i>	-	Near-endemic	X					-	-	Moderate
Cape Crow	<i>Corvus capensis</i>	-	-	X			X	X	-	-	Moderate
Pied Crow	<i>Corvus albus</i>	-	-	X			X	X	-	-	Moderate
White-necked Raven	<i>Corvus albicollis</i>	-	-	X		X	X	X	-	-	-
Red-backed Shrike	<i>Lanius collurio</i>	-	-	X					-	-	-
Common Fiscal	<i>Lanius collaris</i>	-	-	X			X	X	-	-	Moderate
Cape Penduline-Tit	<i>Anthoscopus minutus</i>	-	Near-endemic	X					-	-	Moderate
Grey Tit	<i>Parus afer</i>	-	Endemic	X					-	-	Moderate
Sand Martin	<i>Riparia riparia</i>	-	-		X				-	-	-
Brown-throated Martin	<i>Riparia paludicola</i>	-	-		X				-	-	Moderate
Banded Martin	<i>Riparia cincta</i>	-	-	X	X				-	-	-
Barn Swallow	<i>Hirundo rustica</i>	-	-	X	X			X	-	-	-
White-throated Swallow	<i>Hirundo albigularis</i>	-	-		X				-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat					Susceptibility to		
				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Pearl-breasted Swallow	<i>Hirundo dimidiata</i>	-	-	X	X				-	-	Moderate
Greater Striped Swallow	<i>Hirundo cucullata</i>	-	-	X	X			X	-	-	Moderate
Rock Martin	<i>Hirundo fuligula</i>	-	-			X			-	-	Moderate
Cape Bulbul	<i>Pycnonotus capensis</i>	-	Endemic	X					-	-	Moderate
Fairy Flycatcher	<i>Stenostira scita</i>	-	Endemic	X					-	-	Moderate
Cape Grassbird	<i>Sphenoeacus afer</i>	-	Endemic	X					-	-	Moderate
Long-billed Crombec	<i>Sylvietta rufescens</i>	-	-	X					-	-	Moderate
Yellow-bellied Eremomela	<i>Eremomela icteropygialis</i>	-	-	X					-	-	Moderate
Karoo Eremomela	<i>Eremomela gregalis</i>	-	Endemic	X					-	-	Moderate
Little Rush-Warbler	<i>Bradypterus baboecala</i>	-	-		X				-	-	Moderate
African Reed-Warbler	<i>Acrocephalus baeticatus</i>	-	-		X				-	-	Moderate
Greater Swamp-Warbler	<i>Acrocephalus rufescens</i>	-	-		X				-	-	Moderate
Lesser Swamp-Warbler	<i>Acrocephalus gracilirostris</i>	-	-		X				-	-	Moderate
Layard's Tit-Babbler	<i>Parisoma layardi</i>	-	Endemic	X					-	-	Moderate

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Chestnut-vented Tit-Babbler	<i>Parisoma subcaeruleum</i>	-	Near-endemic	X					-	-	Moderate
Cape White-eye	<i>Zosterops virens</i>	-	Endemic	X					-	-	Moderate
Grey-backed Cisticola	<i>Cisticola subruficapilla</i>	-	Near-endemic	X					-	-	Moderate
Levaillant's Cisticola	<i>Cisticola tinniens</i>	-	-	X	X				-	-	Moderate
Zitting Cisticola	<i>Cisticola juncidis</i>	-	-					X	-	-	Moderate
Cloud Cisticola	<i>Cisticola textrix</i>	-	Near-endemic					X	-	-	Moderate
Karoo Prinia	<i>Prinia maculosa</i>	-	Endemic	X					-	-	Moderate
Namaqua Warbler	<i>Phragmacia substriata</i>	-	Endemic		X				-	-	Moderate
Rufous-eared Warbler	<i>Malcorus pectoralis</i>	-	Endemic	X					-	-	Moderate
Bar-throated Apalis	<i>Apalis thoracica</i>	-	-	X					-	-	Moderate
Cape Clapper Lark	<i>Mirafrapa apiata</i>	-	Endemic	X				X	-	-	Moderate
Karoo Lark	<i>Calendulauda albescens</i>	-	Endemic	X				X	-	-	Moderate
Spike-heeled Lark	<i>Chersomane albobfasciata</i>	-	-	X				X	-	-	Moderate
Cape Long-billed Lark	<i>Certhilauda curvirostris</i>	-	Endemic	X				X	-	-	Moderate
Grey-backed Sparrowlark	<i>Eremopterix verticalis</i>	-	Near-endemic	X				X	-	-	Moderate

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Red-capped Lark	<i>Calandrella cinerea</i>	-	-	X				X	-	-	Moderate
Large-billed Lark	<i>Galerida magnirostris</i>	-	Endemic	X				X	-	-	Moderate
Cape Rock-Thrush	<i>Monticola rupestris</i>	-	Endemic			X			-	-	Moderate
Sentinel Rock-Thrush	<i>Monticola explorator</i>	-	Endemic			X			-	-	Moderate
Karoo Thrush	<i>Turdus smithi</i>	-	Endemic				X		-	-	Moderate
Chat Flycatcher	<i>Bradornis infuscatus</i>	-	Near-endemic	X					-	-	Moderate
Fiscal Flycatcher	<i>Sigelus silens</i>	-	Endemic	X			X		-	-	Moderate
Spotted Flycatcher	<i>Mucicapa striata</i>	-	-				X		-	-	Moderate
Cape Robin-Chat	<i>Cossypha caffra</i>	-	-	X			X		-	-	Moderate
Karoo Scrub-Robin	<i>Cercotrichas coryphoeus</i>	-	Endemic	X					-	-	Moderate
African Stonechat	<i>Saxicola torquatus</i>	-	-	X	X			X	-	-	Moderate
Mountain Wheatear	<i>Oenanthe monticola</i>	-	Near-endemic	X		X			-	-	Moderate
Capped Wheatear	<i>Oenanthe pileata</i>	-	-					X	-	-	Moderate
Sickle-winged Chat	<i>Cercomela sinuata</i>	-	Endemic	X					-	-	Moderate
Karoo Chat	<i>Cercomela schlegelii</i>	-	Near-endemic	X					-	-	Moderate

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Tractrac Chat	<i>Cercomela tractrac</i>	-	Near-endemic	X					-	-	Moderate
Familiar Chat	<i>Cercomela familiaris</i>	-	-	X				X	-	-	Moderate
Ant-eating Chat	<i>Myrmecocichla formicivora</i>	-	Endemic	X					-	-	Moderate
Red-winged Starling	<i>Onychognathus morio</i>	-	-	X		X		X	-	-	Moderate
Pied Starling	<i>Spreo bicolor</i>	-	Endemic	X				X	-	-	Moderate
Wattled Starling	<i>Creatophora cinerea</i>	-	-	X				X	-	-	Moderate
Common Starling	<i>Sturnus vulgaris</i>	-	-					X	-	-	Moderate
Malachite Sunbird	<i>Nectarinia famosa</i>	-	-	X			X		-	-	Moderate
Southern Double-collared Sunbird	<i>Cinnyris chalybeus</i>	-	Endemic	X			X		-	-	Moderate
Dusky Sunbird	<i>Cinnyris fuscus</i>	-	Near-endemic	X					-	-	Moderate
Cape Weaver	<i>Ploceus capensis</i>	-	Endemic	X	X		X	X	-	-	Moderate
Southern Masked-Weaver	<i>Ploceus velatus</i>	-	-	X	X		X	X	-	-	Moderate
Red-billed Quelea	<i>Quelea quelea</i>	-	-	X	X			X	-	-	Moderate
Southern Red Bishop	<i>Euplectes orix</i>	-	-	X	X			X	-	-	Moderate
Yellow Bishop	<i>Euplectes capensis</i>	-	-	X					-	-	Moderate

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				Strandveld	Wetlands	Rocky outcrops	Alien trees	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
African Quailfinch	<i>Ortygospiza atricollis</i>	-	-					X	-	-	Moderate
Common Waxbill	<i>Estrilda astrild</i>	-	-		X			X	-	-	Moderate
Pin-tailed Whydah	<i>Vidua macroura</i>	-	-		X			X	-	-	Moderate
House Sparrow	<i>Passer domesticus</i>	-	-					X	-	-	Moderate
Cape Sparrow	<i>Passer melanurus</i>	-	Near-endemic	X			X	X	-	-	Moderate
Cape Wagtail	<i>Motacilla capensis</i>	-	-	X	X	X		X	-	-	Moderate
Cape Longclaw	<i>Macronyx capensis</i>	-	Endemic	X				X	-	-	Moderate
African Pipit	<i>Anthus cinnamomeus</i>	-	-	X				X	-	-	Moderate
Plain-backed Pipit	<i>Anthus leucophrys</i>	-	-					X	-	-	Moderate
Long-billed Pipit	<i>Anthus similis</i>	-	-					X	-	-	Moderate
Cape Canary	<i>Serinus canicollis</i>	-	Endemic	X					-	-	Moderate
Black-headed Canary	<i>Serinus alario</i>	-	Endemic	X					-	-	Moderate
Black-throated Canary	<i>Crithagra atrogularis</i>	-	-	X				X	-	-	Moderate
Yellow Canary	<i>Crithagra flaviventris</i>	-	Near-endemic	X				X	-	-	Moderate
White-throated Canary	<i>Crithagra albogularis</i>	-	Near-endemic					X	-	-	Moderate

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Lark-like Bunting	<i>Emberiza impetuani</i>	-	Near-endemic					X	-	-	Moderate
Cape Bunting	<i>Emberiza capensis</i>	-	Near-endemic	X				X	-	-	Moderate