RICHTERSVELD WIND ENERGY FACILITY

BIRD IMPACT ASSESSMENT

AVISENSE CONSULTING

EXECUTIVE SUMMARY

This study contains a review of the relevant literature on the impacts on avifauna of wind energy facilities (WEFs) and their associated electrical infrastructure, and identifies potential impacts of the proposed Richtersveld WEF on the avifauna of the Alexander Bay area. The expected impacts are: *habitat destruction* by the construction of the facility itself and its associated power lines or substation/s, *disturbance and/or displacement* by construction and maintenance activities and possibly by the operation of the facility, and *mortality* caused by collision with the wind turbine blades, collision with the power line network associated with the WEF, and electrocution on the required power line and substation infrastructure.

The impact zone of the proposed WEF features relatively homogenous, semi-arid, undulating Duneveld, situated about 6 km west of the Atlantic coastline and 25 km south-east of the Orange River mouth. Over 130 bird species, including 13 red-listed species, 51 endemics, and three red-listed endemics may occur within the broader area. The birds of greatest potential relevance and importance in terms of the possible impacts of the WEF are likely to be (i) a concentration of the localised, threatened endemic Barlow's Lark *Calendulauda barlowi* (ii) flocks of overflying wetland birds, in particular Greater Flamingo *Phoenicopterus ruber* , Lesser Flamingo *Phoenicopterus minor* and Great White Pelican *Pelecanus onocrotalus* (iii) resident or seasonal influxes of large terrestrial species, especially Ludwig's Bustard *Neotis ludwigii*, and (iv) resident or visiting raptors, in particular Lanner Falcon *Falco biarmicus*, Martial Eagle *Polemaetus bellicosus* and possibly Black Harrier *Circus maurus*, Peregrine Falcon *Falco peregrinus* and Secretarybird *Sagittarius serpentarius*.

The proposed WEF could have a significant, long-term impact on the avifauna of the area. The most obvious and immediate negative impacts are likely to be in terms of disturbance and/or collision mortality of the species listed above. These effects, which may also impact on other threatened species, may be reduced to acceptable and sustainable levels by strict adherence to a proposed mitigation scheme. A comprehensive programme to fully monitor the actual impacts of the WEF on the broader avifauna of the area is highly recommended and outlined, from pre-construction and into the operational phase of the project.

1. *INTRODUCTION*

G7 Renewable Energies (G7) is planning to construct a Wind Energy Facility (project name 'Richtersveld Wind Energy Facility'), between the towns of Port Nolloth and Alexander Bay, in the Northern Cape Province, South Africa. Environmental Resources Management (Southern Africa) Pty Ltd was appointed to do the Environmental Impact Assessment study, and subsequently sub-contracted Dr Andrew Jenkins (*AVISENSE* Consulting cc) to conduct the specialist avifaunal assessment. Dr Jenkins is an experienced ornithologist, with over 20 years experience in avian research and impact assessment work. He has been involved in many power line and wind farm EIA and EMP studies in South Africa, and also does research on raptors, bustards and cranes in various parts of the country.

2. *DEVELOPMENT PROPOSAL*

The proposed Richtersveld WEF will be located on portions of the farms Rooibank (Farm 7/2), Witbank (Farm 6/2) and part of Farm 1 (Re/1), about 25 km south-east of Lambert's Bay and 55 km north-west of Port Nolloth, on the west coast of the Northern Cape Province (Fig. 2.1). The facility will be spread over an area of about 120 km^2, and include up to 75 wind turbines (provisionally laid out to maximize power production – Fig. 2.2), each with a generating capacity of up to 3 MW, and standing 100 m high at hub-height, with a rotor diameter of 117 m. The facility will also include a 220 kV on-site substation and a network of access and service roads. It will link into the national power grid via a short 220 kV power line, connecting to the existing Oranjemond-Gromis 220 kV transmission line via a dedicated substation (Fig. 2.2).

3. *SCOPE*

The required scope of the specialist avifaunal study (as stipulated by ERM) included the provision of:

(i) A baseline description of the study area in terms of avifauna;
(ii) An assessment of potential avifauna impacts associated with the development according to the impact assessment methodology specified by ERM;
(iii) A description of relevant and implementable mitigation measures to reduce, avoid, or minimise negative impacts and enhance positive impacts;
(iv) An assessment of information gaps, uncertainties, study limitations and underlying assumptions;
(v) Listed recommendations, including possible monitoring studies;
(vi) A comprehensive list of all referenced information sources.

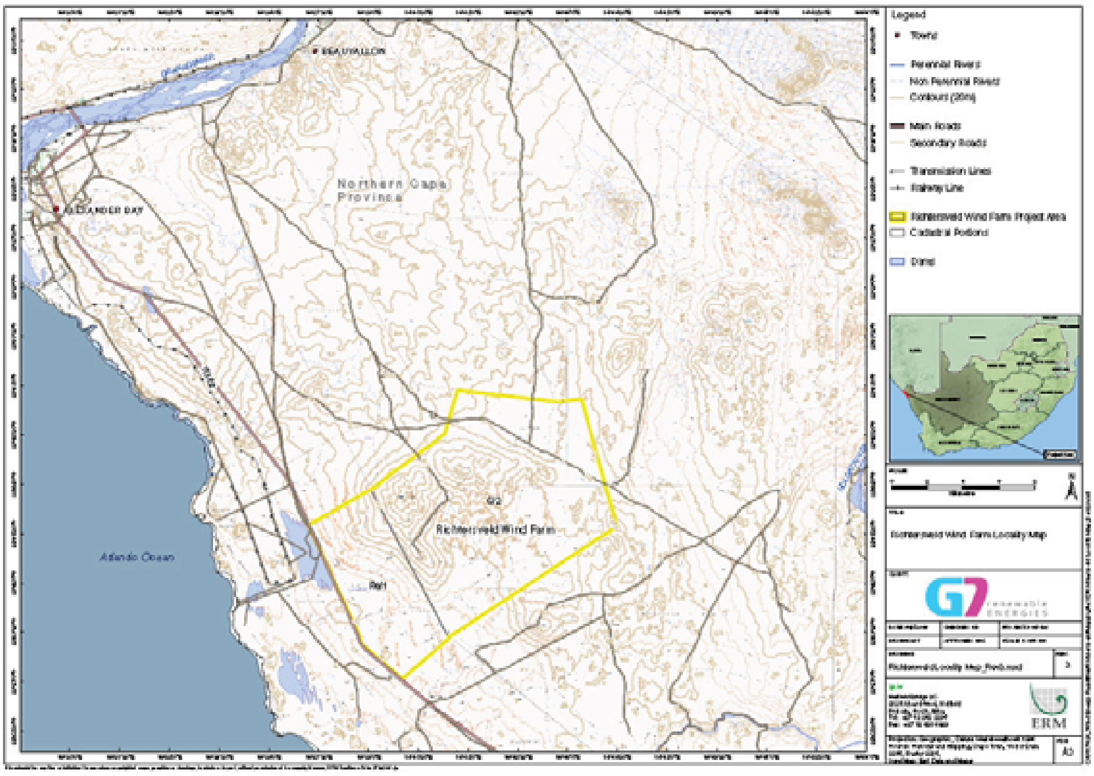

Figure 2.1   Location of the proposed Richtersveld WEF.

4. *METHODS*

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

4.1 *SCOPING*

This initial, desktop component comprised:

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

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

(iii) The compilation of a short-list of priority bird species (defined in terms of conservation status and endemism) which could be impacted by the proposed WEF. These species were subsequently considered as largely 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.

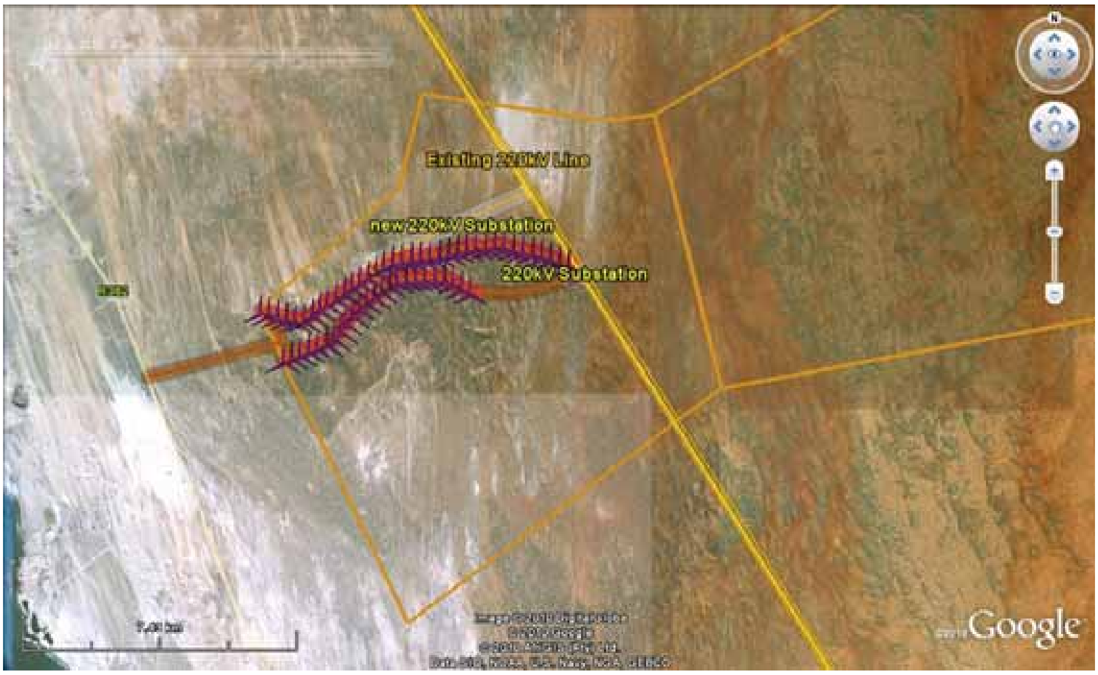

Figure 2.2 Proposed road (brown), power line (yellow) and turbine (purple) layout of the Richtersveld WEF.

4.2 SITE VISIT

The site visit was conducted on 20-21 September 2010, and involved:

(i) Ground-truthing of predicted habitats and birds present, mainly by visiting as much of the inclusive area of the proposed development as possible, with an emphasis on sampling the avifauna in all of the primary habitats available.

(ii) The compilation of SABAP 2 atlas cards for all the pentads visited.

(iii) Searching for large terrestrial species, raptors and endemic passerines within the study area to determine the relative importance and on-site distribution of local populations of these key taxa, including brief surveys of the most prominent rock faces in the area for cliff-nesting species (Malan 2010).

(iv) Estimating the extent and direction of possible movements of birds within/through the anticipated impact zone of the WEF, in relation to the distribution of available resources – nesting or roosting sites (e.g. cliff-lines, wetlands, stands of trees, existing power lines) and foraging areas (e.g. croplands, wetlands).

4.3 IMPACT ASSESSMENT

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

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

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

(iii) Recommendations on mitigation where necessary.

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

4.1.1 DATA SOURCES USED

The following published and unpublished data sources were used:

(i) Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al.* 1997) were obtained from the Animal Demography Unit website (http://sabap2.adu.org.za/index.php) for the SABAP 1 quarter-degree squares covering the proposed wind energy facility and its associated infrastructure (2816DA Grootderm – 19 cards submitted over the atlas period, 2616DC Visagiesfontein – 5 cards submitted), and for the relevant SABAP 2 pentads (2840_1635, 2840_1640, 2845_1635, 2845_1635 – two cards submitted for these pentads combined so far; Total for SABAP 1 + 2 = 26 cards for the area). Note that the SABAP 1 data are now >15 years old. A composite list of species likely to occur in the impact zone of the WEF was drawn up as a combination of these data, refined by a more specific assessment of the actual habitats affected and general knowledge of birds in the region (Appendix 1).

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

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

(iv) 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, Küyler 2004, Jenkins 2001, 2003, 2008a, 2009).

5. *ENVIRONMENTAL IMPACTS OF WIND ENERGY FACILITIES*

5.1 *INTERACTIONS BETWEEN WIND ENERGY FACILITIES AND BIRDS*

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

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

5.1.1 Collisions with turbines

Collision rates

As more monitoring has been conducted at a growing number of sites, some generic standards and common units have been established, with bird collisions with turbine blades generally measured in mortalities per turbine per year (mortalities.turbine^{-1}.year^{-1}), per Mega-Watt per year (mortalities.MW^{-1}.year^{-1}), or per Giga-Watt Hour (mortalities.GWh^{-1}) (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^{-1}.year^{-1} in Oregon, to as high as 10 mortalities.turbine^{-1}.year^{-1} 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.turbine^{-1}.year^{-1}, and nearly 3000 mortalities.turbine^{-1}.year^{-1} overall (Smallwood & Thelander 2008), including >60 Golden Eagles, and at a mean rate of about 2-4 mortalities MW^{-1}.year^{-1}.

At the Tarifa and Navarre wind energy facilities on the Straits of Gibraltar, southern Spain, about 0.04-0.08 birds are killed turbine^{-1}.year^{-1} (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 5.1). 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 5.1).

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 at Couga 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 birds observed 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^{-1}.year^{-1}.

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, exponentially increasing collision risk (Drewitt & Langston 2006, 2008).

Larger wind energy facilities, with more turbines, are almost by definition more likely to incur significant numbers of bird casualties (Kingsley & Whittam 2005), and 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 to be used 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).

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 single collision incidents).

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

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

Certain species are morphologically specialized 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 $MW^{-1} yr^{-1}$, Smallwood & Thelander 2008), and of vultures and kestrels at Tarifa, Spain (0.15-0.19 casualties $turbine^{-1} yr^{-1}$, Barrios & Rodríguez 2004, de Lucas *et al.* 2008, Table 5.1), 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 could theoretically cause its localized 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 conspicuity 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 maximizes 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). In sensitive areas, monitoring could include using a combination of occasional, direct observation of birds commuting or foraging through and around the wind energy facility, coupled with constant, remote tracking of avian traffic using specialized 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 passed safely through the array.

5.1.2 *Habitat loss – destruction, disturbance and displacement*

Although the final, destructive footprint of most wind energy facilities 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 wind 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), and are highly species-specific in operation.

5.2 *IMPACTS OF ASSOCIATED INFRASTRUCTURE*

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

5.2.1 *Construction and maintenance of power lines and substations*

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

5.2.2 *Collision with power lines*

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

5.2.3 Electrocution on power infrastructure

Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004b, Lehman *et al.* 2007). Electrocution risk is strongly influenced by the voltage and design of the power lines erected (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 energized components. Mitigation of electrocution risk involves the use of bird-safe structures (ideally with critical air gaps >2 m), the physical exclusion of birds from high risk areas of live infrastructure, and comprehensive insulation of such areas (van Rooyen 2004b, Lehman *et al.* 2007).

6. THE AFFECTED ENVIRONMENT

6.1 THE NATURAL ENVIRONMENT

The proposed WEF is located at the interface of the Southern Namib Desert and Namaqualand Sandveld Bioregions, and at the junction of the Succulent Karoo and Desert Biomes, although it falls almost wholly within the former. The area is dominated by Richtersveld Coastal Duneveld in the west, and by Northern Richtersveld Yellow Duneveld in the east, both vegetations low and generally sparse, with the density, height and species composition varying with aspect and gradient of the dune slope, and position on the slope (Mucina & Rutherford 2006).

The site is situated on the west coastal plain, about 6 km east of the Atlantic coastline, and about 50 km west of Richtersveld Mountains. It features undulating terrain (averaging about 150 m above sea level), rising to nearly 320 m a.s.l. at Visagiesfonteinkop in the centre of the development area. The local climate is harsh although somewhat tempered by the close presence of the sea. Summers are warm, dry and windy summers, with cooler winters with some rainfall. The area receives about 50 mm of rain per annum, with mean maximum daytime temperatures of about 27ºC in summer, mean minimum nocturnal temperatures of about 8ºC in winter, and with a high frequency of coastal fog.

6.2 THE ALTERED ENVIRONMENT

The area is little used except for low intensity small stock farming. There is a small farm building at Witbank, otherwise there are no permanent residences on or near to the site. There is a major tarred roadway between the development area and the coast, which connects Alexander Bay and Port Nolloth (Fig. 2.2), otherwise the general area is serviced only by a network of sandy tracks. The Eskom Gromis-Oranjemund 220 kV transmission line runs through the eastern half of the study site (Fig. 2.2), and there is a large communications tower near to the wind monitoring mast at the crest of Visagiefonteinkop.

6.3 AVIAN HABITATS

The site features relatively homogenous, semi-arid habitat, and consequently supports a relatively depauperate avifauna. Most of the site features tracts of Duneveld, either with harder, paler sand and a westerly aspect, sloping up to the crest of the Kop (Richtersveld Central Duneveld) (Fig. 6.1a), or with softer, redder sand and an easterly aspect sloping down towards Witbank (Northern Richtersveld Yellow Duneveld) (Fig. 6.1b). Around the crest of the hill there is a rocky ridgeline (Fig. 6.1c) which potentially attracts a slightly different community of birds, perhaps supplemented by cliff-dwelling or rock-loving species moving into the area occasionally from the prominent koppies situated some 5 km to the west – Boegoeberg North and South (Fig. 6.1c and cover). The Eskom transmission line provides nesting, roosting and foraging habitat for corvids and various birds of prey.

The study area is situated about 25 km south-east of the Orange River Mouth Wetlands Important Bird Area and Ramsar site (Barnes 1998), which attracts large numbers of wetland birds.

6.4 THE AVIFAUNA

More than 130 bird species could possibly occur on the site (Appendix 1), including up to 13 red-listed species, 51 endemics or near-endemics, and three red-listed endemics (Ludwig's Bustard *Neotis ludwigii*, Black Harrier *Circus maurus* and Barlow's Lark *Calendulauda barlowi* of which at least two – Ludwig's Bustard and Barlow's Lark - might breed either on the site or within the broader impact area of the proposed WEF.

Figure 6.1a Richtersveld Coastal Duneveld on the western slopes of the Richtersveld WEF development site.

Figure 6.1b Northern Richtersveld Yellow Duneveld on the eastern aspects of the WEF site.

Figure 6.1c Looking west from the rocky ridge in the centre of the development area towards the coast and the two Boegoeberg koppies.

Figure 6.2 Location of the proposed Richtersveld WEF site, in relation to the nearby Orange River Mouth Wetlands Important Bird Area (Barnes 1998).

Twenty-seven species were seen during site visit on September 20-21 2010 (Appendix 1; a SABAP 2 atlas cards was compiled for the pentad 2845_1640). Significant observations included (i) a relatively high density of Barlow's Lark, apparently restricted to the west-facing slopes of the site (Fig. 6.3), particularly along the main access road leading up to Visagiesfonteinkop (these birds were replaced by the more widespread Karoo Lark *Calendulauda albescens* on the redder sands on the eastern slopes of the site), and (ii) a pair of Lanner Falcons *Falco biarmicus* perched near to an old crow nest on a pylon of the Eskom transmission line (Fig. 6.3). It was not possible to determine whether or not the Lanners were breeding at this location at the time, but signs under the pylon suggested that they are at least resident on this structure.

If and when the salt pans situated just west of the main road, and between the study site and the sea, are full of water, they are likely to attract numbers of wetland birds, in particular both Greater Flamingo *Phoenicopterus ruber* and Lesser Flamingo *Phoenicopterus minor*. These birds, and possibly also Great White Pelicans Pelecanus onocrotalus, may move into or through the general area in numbers on their way to and from wetland resource areas to the north (Orange River Mouth) and (more distantly) to the south.

The area probably doesn't support significant numbers of larger raptors, although the cliffs of the Boegoeberg koppies could hold breeding Verreaux's Eagle *Aquila* *verreauxii* and/or Cape Eagle Owl *Bubo capensis*, as well as Booted Eagle *Aquila pennatus*, and the Eskom transmission line probably supports at least one breeding pair of Martial Eagle *Polemaetus bellicosus* within 10 km north or south of the development site. Issues with access to these areas precluded gaining any further clarity on the status of these birds in the area, and this should be a priority of the pre-construction monitoring programme outlined below.

While none were seen in the area during the site visit, in some years under certain conditions (e.g. after good rainfall), there are likely to be significant numbers of the nomadic Ludwig's Bustard in the area (Allan 1994).

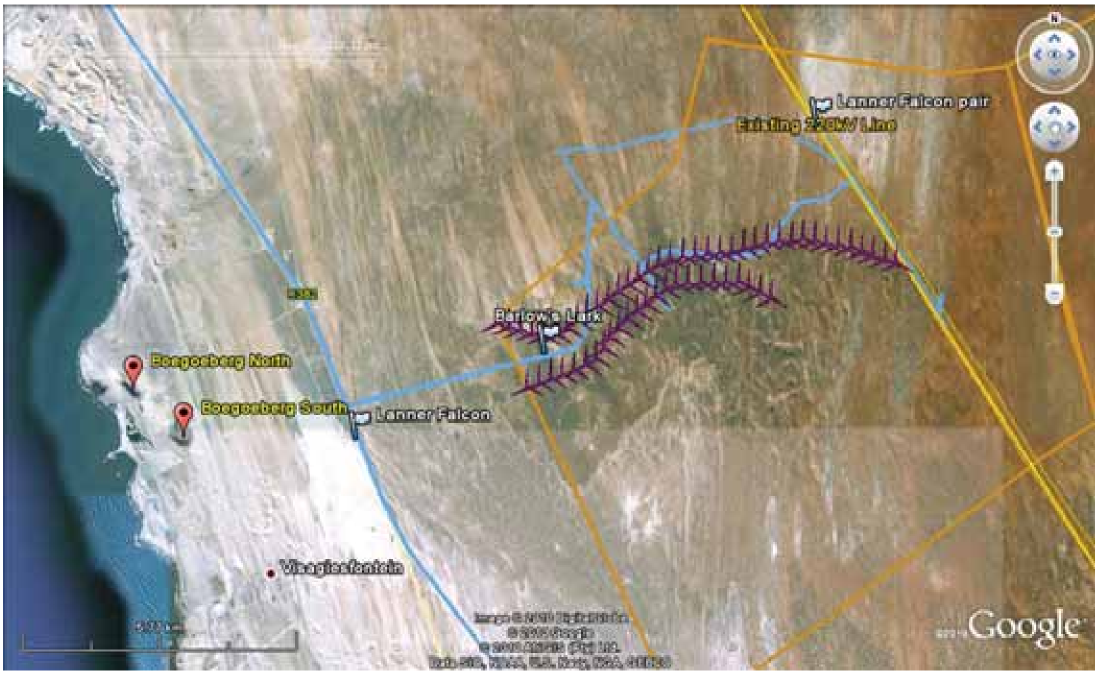

Figure 6.3 Important sightings and locations recorded during the site visit in relation to the coverage of the site (blue line) and the proposed turbine layout of the Richtersveld WEF.

Fifteen priority species are recognized as key in the assessment of avian impacts of the proposed Richtersveld WEF (Table 6.2). These are mostly nationally and/or globally threatened species which are known to occur, or could occur in relatively high numbers in the broader impact area of the development and which are likely to be, or could be, negatively affected by the WEF project. Martial Eagle was included despite the fact that it was not recorded in either SABAP 1 or SABAP 2 data for the area because the habitat on the site looks suitable.

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

Common name	Scientific name	SA conservation status/ (Global conservation status)	Regional endemism	Average SABAP reporting rate (*n* = 26 cards)	Estimated importance of local population	Preferred habitat	Risk posed by		
							Collision	Electro-cution	Disturbance / habitat loss
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	Near-endemic	7.6	Moderate	Duneveld, fly over	High	-	High
Kori Bustard	*Ardeotis kori*	Vulnerable	-	3.8	Low	Duneveld, fly over	High	-	High
Black Harrier	*Circus maurus*	Near-threatened (Vulnerable)	Endemic	3.8	Low	Dunevled, fly over	Moderate	-	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	-	0.0	Moderate	Duneveld, fly over	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	3.8	Moderate	Duneveld, fly over	High	-	Moderate
Peregrine Falcon	*Falco peregrines*	Near-threatened	-	3.8	Low	Fly over			
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	7.6	Moderate	Duneveld, fly over	High	Moderate	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-	3.8	Moderate	Fly over	High	-	-
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-	3.8	Moderate	Fly over	High	-	-
Great White Pelican	*Pelecanus onocrotalus*	Near-threatened	-	19.2	Moderate	Fly over	High	-	-
Barlow's Lark	*Calendulauda barlowi*	Near-threatened	Endemic	7.6	High	Duneveld	-	-	High

Overall, the most important aspects of the avifauna on the Richtersveld WEF site, and those most relevant to this impact assessment, are:

(i) Habitat occupied by good numbers of Barlow's Lark may be directly affected by the proposed WEF, with disturbance, habitat loss, displacement and possibly even collision impacts on this highly restricted, red-listed endemic.

(ii) Flocks of overflying wetland birds, possibly numbering from 10s to 100s of birds, commuting between resource areas along the coast or associated with the nearby salt pans. Of particular concern here are Greater and Lesser Flamingo and Great White Pelican, all of which are threatened species and known to be collision prone. Collision risk in the flamingo's is exaggerated by the fact that they do most of their distance flying at night.

(iii) Seasonal influxes of large terrestrial birds, especially Ludwig's Bustard and possibly also Kori Bustard *Ardeotis kori*. The former is a nomadic, nationally 'Vulnerable' and globally 'Endangered', near-endemic species, highly susceptible to collision mortality on power lines (Jenkins *et al.* 2009, 2010), and probably susceptible to turbine collision mortality. Numbers of Ludwig's Bustard in the general area of the proposed WEF were very high at the time of the site visit. Movements by this species are triggered by rainfall (Allan 1994), and so are inherently erratic and unpredictable in this semi-arid environment, where the quantity and timing of winter rains are highly variable between years. Hence, it is difficult to anticipate the extent to which Ludwig's Bustard may be exposed to collision risk or the less direct impacts of displacement by the proposed WEF, but should the conditions prevailing in the spring of 2010 be repeated during the life of the facility, there is a good chance that large numbers of this threatened species will be subjected to these effects.

(iv) Resident and breeding raptors, in particular Lanner Falcon (at least one pair resident on the development site), Martial Eagle, Verreaux's Eagle, Booted Eagle and possibly Peregrine Falcon *Falco peregrinus*, Black Harrier (Curtis *et al.* 2004) and Secretarybird *Sagittarius serpentarius*. All of these birds, and especially the large eagles, have extensive foraging ranges, likely to take them from core breeding areas close to the development site well into the turbine arrays. All are threatened or locally scarce species, all are soaring birds to some extent, and all may be susceptible to displacement from prime foraging areas or collision with the turbine blades.

7. *IMPACT ASSESSMENT*

This is a medium-sized WEF, proposed for a site with limited but appreciable intrinsic avian biodiversity value. While the diversity and abundance of birds on the site is relatively low, it does contain important habitat for a localised endemic species. While the proposed development does not obviously impinge on a significant avian fly-way, it may affect some bird traffic between wetland resource areas to the north and south. There are regionally and/or nationally important populations of impact susceptible species present in the area or commuting through it (some only seasonally or sporadically), and the proposed facility may have a significant detrimental effect on these birds, particularly during its operational phase.

7.1 IMPACT DESCRIPTION AND ASSESSMENT

Impacts of the proposed WEF are most likely to be manifest in the following ways:

(i) Disturbance and displacement of resident Barlow's Lark from foraging and/or nesting areas by construction and/or operation of the facility, and /or mortality of these birds in collisions with the turbine blades.

(ii) Displacement of flocks of wetland birds (especially flamingo spp. and Great White Pelican) from regular fly-ways between resource areas by construction and/or operation of the facility, and/or mortality of these species in collisions with the turbine blades or with any additional power lines constructed.

(iii) Disturbance and displacement of resident or seasonal influxes of large terrestrial birds (especially Ludwig's Bustard and possibly also Kori Bustard) from foraging and/or nesting areas by construction and/or operation of the facility, and /or mortality of these birds in collisions with the turbine blades or associated new power lines while commuting between resource areas (foraging sites, roost sites).

(iv) Disturbance and displacement of visiting or resident/breeding raptors (especially Lanner Falcon, Martial Eagle, Verreaux's Eagle, Booted Eagle) from foraging and/or nesting areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while hunting in the area, or by electrocution when perched on power infrastructure.

(v)

Table 7.1 Impact characteristics: Richtersveld WEF – Birds.

Summary	**Construction**	**Operation**
Project Aspect/ activity	(i) Disturbance associated with noise and movement. (ii) Loss of vegetation and avian habitat through site clearance, road upgrade and establishment of the camp, lay-down and assembly areas.	(i) Disturbance and/or displacement from foraging or nesting areas or regular flight paths by movement and/or noise of rotating turbine blades. (ii) Mortality in collisions with turbine blades and/or power lines, or by electrocution on new power infrastructure.
Impact Type	Direct	Direct
Receptors Affected	(i) Key species: Ludwig's Bustard, Martial Eagle, Lanner Falcon, Barlow's Lark. (ii) Key species: Ludwig's Bustard, Barlow's Lark	(i) Key species: Ludwig's Bustard, Martial Eagle, Lanner Falcon. Greater Flamingo, Lesser Flamingo, Great White Pelican, Barlow's Lark. (ii) Key species: Ludwig's Bustard, Martial Eagle, Lanner Falcon. Greater Flamingo, Lesser Flamingo, Great White Pelican, Barlow's Lark.

Box 7.1 Construction Impact: Richtersveld WEF – Birds

(A) Habitat loss

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

Impact Magnitude – **Medium**

- **Extent**: The extent of the impact is limited to the **site**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be altered at least for the lifetime of the facility.
- **Intensity**: Loss of habitat for priority species will be relatively small for most species, but possibly significant for Barlow's Lark, so the magnitude of the change will be **medium**.

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

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM

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

(B) Disturbance

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

Impact Magnitude – **Low-Medium**

- **Extent**: The extent of the impact is limited to the **site**.
- **Duration**: The duration would be **temporary** as this effect will not extend beyond the life of the project.
- **Intensity**: Some threatened species may be disturbed, so the magnitude of the change will be **medium**.

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

IMPACT SIGNIFICANCE (PRE-MITIGATION) – LOW-MEDIUM

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

Box 7.2 Operation Impact: Richtersveld WEF – Birds

(A) Disturbance and displacement

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

Impact Magnitude – **Medium-High**

- **Extent**: The extent of the impact may be **regional** for Barlow's Lark.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected until the project stops operating.
- **Intensity**: Some priority species may be displaced for the duration of the project, with energetic or demographic consequences, so the magnitude of the change will be **medium**.

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

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM-HIGH

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

(B) Mortality

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

Impact Magnitude – **Medium**

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

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

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM

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

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

(i) On-site demarcation of 'no-go' areas identified during pre-construction monitoring (see below) to minimise disturbance impacts associated with the construction of the facility. These will apply to particularly to areas preferred by Barlow's Lark.

(ii) Minimizing the disturbance impacts associated with the operation of the facility, by scheduling maintenance activities to avoid disturbance in sensitive areas (identified through operational monitoring). These sensitive areas will apply to particularly to habitats favoured by Barlow's Lark.

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

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

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

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

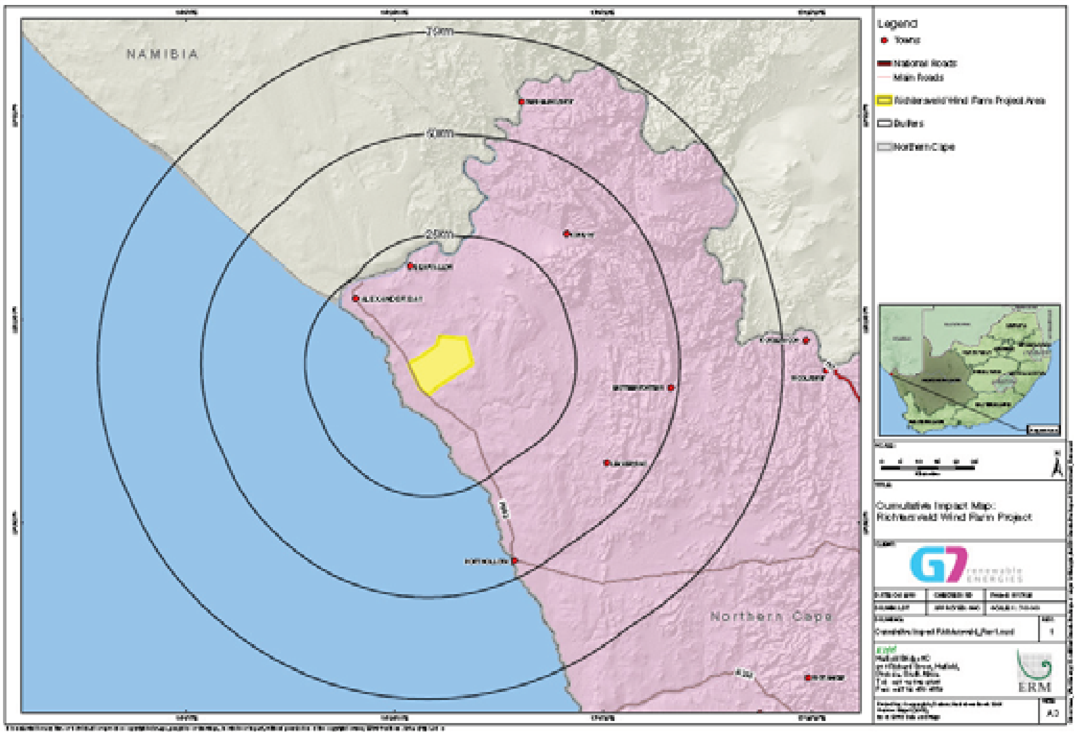

Figure 7.1 ***Richtersveld WEF site in the context of other WEF developments planned within a 75 km radius. Note that there are no such projects at present.***

(vii) Ensuring that the results of pre-construction monitoring are applied to project-specific impact mitigation in a way that allows for the potentially considerable cumulative effects on the local/regional avifauna of additional wind energy projects proposed for this area. Viewed in isolation, each WEF project may pose only a limited threat to the local avifauna. However, collectively, close neighbouring projects may result in the formation of significant barriers to energy-efficient travel between resource areas for regionally important bird populations, and/or significant levels of mortality in these populations in collisions with what may become extensive arrays of

100s of turbines across regular flight paths (Masden *et al.* 2010). In the case of the Richtersveld WEF, there are no other projects currently proposed within a 75 km radius of the present site (Fig. 7.1).

Table 7.2 Pre- and Post- Mitigation Significance: Richtersveld WEF - Birds

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

Implementation of the required mitigation measures should reduce Construction Phase impacts to Low or Low-Medium, and Operation Phase impacts to Low-Medium or Medium (Table 7.1).

8. *MONITORING*

The primary aims of a long-term monitoring programme would be to:

(i) Determine the densities of birds resident within the impact area of the WEF before construction of the facility, and afterwards, once the facility, or phases of the facility, become operational.

(ii) Document patterns of bird activity and movements in the vicinity of the proposed WEF before construction, and afterwards, once the facility is operational.

(iii) Monitor patterns of bird activity and movement in relation to weather conditions, time of day and season for at least a full calendar year after the WEF is commissioned.

(iv) Register and as far as possible document the circumstances surrounding all avian collisions with the WEF turbines for at least a full calendar year after the facility becomes operational.

Pre-construction monitoring would determine the need for any additional mitigations requirements to be implemented during the construction or operational phases of the development (see below).

Bird density and activity monitoring should focus on rare and/or endemic, potentially disturbance or collision prone species, which occur with some regularity in the area (Table 6.1, Appendix 1). Ultimately, the study should provide much needed quantitative information on the effects of the WEF on the distribution and abundance of birds, and the actual risk it poses to the local avifauna, and serve to inform and improve mitigation measures to reduce this risk. It will also establish a precedent and a template for research and monitoring of avian impacts at possible, future WEF sites in the region. This programme outline is informed by monitoring studies established in other countries (e.g. Erickson *et al.* 1999,Scottish National Heritage 2005), but is based substantially on those developed for both the Darling and the Klipheuwel wind power demonstration facilities in South Africa (Jenkins 2003, Küyler 2004). The bulk of the work involved should be done by an expert ornithologist or under the supervision of such.

The protocols set out there pre-date the final drafting of the standard monitoring protocols for pre- and post-construction monitoring of birds at South African wind energy developments, as drawn up by BAWESG. Once the latter protocols have been finalised, they should supplement, and where necessary replace, the measures stipulated here, as determined by the specialist advising the monitoring programme.

8.1 MONITORING PROTOCOLS

8.1.1 Avian densities before and after

A set of at least 10 walk-transect routes, each of at least 1000 m in length, should be established in areas representative of all the avian habitats present within a 10 km radius of the centre of the WEF development site. Each of these should be walked at least once every two months over the 6-12 months preceding construction, and at least once every two months over the same calendar period, at least 6-12 months after the WEF is commissioned. The transects should be walked after 06h00 and before 09h00, and the species, number and perpendicular distance from the transect line of all birds seen should be recorded for subsequent analysis and comparison. These transects are particularly critical for establishing and monitoring Barlow's Lark habitat affinities and numbers on the site.

In addition:

(i) The cliff-lines and power lines within or close to the development area (e.g. those on the Boegoeberg koppies) should be surveyed for cliff-nesting raptors at least every six months using documented protocols (Malan 2009).

(ii) Known large eagle nest sites should also be checked twice annually for signs of occupation and breeding activity.

(iii) All sightings of key species (Table 6.1) on site should be carefully plotted and documented.

8.1.2 *Bird activity monitoring*

Monitoring of bird activity in the vicinity of the WEF by should be done over a 2-3 day period at least every two months for the 6-12 months preceding construction, and at least once per quarter for a full calendar year starting at least six months after the WEF is commissioned. Each monitoring day should involve:

(i) Half-day counts of all priority species flying over or past the WEF impact area (see passage rates below, and note the stipulated use of radar as a companion to active pre-construction monitoring)

(ii) Opportunistic surveys of bustards and raptors seen when travelling around the WEF site.

8.1.3 *Passage rates of priority bird species*

Counts of bird traffic over and around the proposed/operational WEF should be conducted from suitable vantage points (and a number of these should be selected and used to provide coverage of avian flights in relation to all areas of the WEF), and extend alternately from dawn to midday, or from midday to dusk, so that the equivalent of four full days of counts is completed each count period. This should provide an adequate (if minimal) sample of bird movements around the facility in relation to a representative cross-section of conditions and times of day, for all seasons of the year.

Once in position at the selected count station, the observer should record (preferably on a specially designed data sheet) the date, count number, start-time and conditions at start - extent of cloud cover, temperature, wind velocity and visibility – and proceed with the count. The counts should detail all individuals or flocks of the stipulated priority bird species, all raptors, and any additional species of particular interest or conservation concern, seen flying within 500 m of the envisaged or actual periphery of the WEF. Each record should include the following data: time, updated weather assessment, species, number, mode of flight (flapping, gliding, soaring), flight activity (commuting, hunting other), direction of flight, vertical zoning relative to the envisaged or actual turbine string (low – below or within the rotor arc, medium – within *c.*100 m of the upper rotor arc, high – >100 m above the upper rotor arc), and horizontal zoning relative to the envisaged or actual turbine string (near – through the turbine string or within the outer rotor arc, middle – within *c.*100 m of the outer rotor arc, distant - >100 m beyond the outer rotor arc) and, for post construction monitoring, notes on any obvious evasive behaviour or flight path changes observed in response to the WEF. The time and weather conditions should again be noted at the end of each count.

8.1.4 *Additional mitigation based on monitoring data*

Additional mitigation might include re-scheduling construction or maintenance activities on site, shutting down problem turbines either permanently or at certain times of year or in certain conditions, and the continued use of radar to track bird traffic, and to selectively and temporarily shut-down turbines as and when birds impinge on the turbine array.

8.2 *AVIAN COLLISIONS*

Collision monitoring should have two components: (i) experimental assessment of search efficiency and scavenging rates of bird carcasses on the site, and (ii) regular searches of the vicinity of the wind farm for collision casualties.

8.2.1 *Assessing search efficiency and scavenging rates*

The value of surveying the area for collision victims only holds if some measure of the accuracy of the survey method is developed (Morrison 2002). To do this, a sample of suitable bird carcasses (of similar size and colour to the priority species – e.g. Egyptian Goose *Alopochen aegyptiacus*, domestic waterfowl and pigeons) should be obtained and distributed randomly around the site without the knowledge of the surveyor, some time before the site is surveyed. This process should be repeated opportunistically (as and when suitable bird carcasses become available) for the first two months of the monitoring period, with the total number of carcasses not less than 20. The proportion of the carcasses located in surveys will indicate the relative efficiency of the survey method.

Simultaneous to this process, the condition and presence of all the carcasses positioned on the site should be monitored throughout the initial two-month period, to determine the rates at which carcassess are scavenged from the area, or decay to the point that they are no longer obvious to the surveyor. This should provide an indication of scavenge rate that should inform subsequent survey work for collision victims, particularly in terms of the frequency of surveys required to maximize survey efficiency and/or the extent to which estimates of collision frequency should be adjusted to account for scavenge rate (Osborn *et al.* 2000, Morrison 2002). Scavenger numbers and activity in the area may vary seasonally so, ideally, scavenge and decomposition rates should be measured twice during the monitoring year, once in winter and once in summer.

8.2.2 *Collision victim surveys*

The area within a radius of at least 50 m of each of the turbines at the facility should be checked regularly for bird casualties (Anderson *et al.* 1999, Morrison 2002). The frequency of these surveys should be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period (see above), but they should be done at least weekly for the first two months of the study. The area around each turbine, or a larger area encompassing the entire WEF, should be divided into quadrants, and each should be carefully and methodically searched for any sign of a bird collision incident (carcasses, dismembered body parts, scattered feathers, injured birds). All suspected collision incidents should be comprehensively documented, detailing the precise location (preferably a GPS reading), date and time at which the evidence was found, and the site of the find should be photographed with all the evidence *in situ*. All physical evidence should then be collected, bagged and carefully labelled, and refrigerated or frozen to await further examination. If any injured birds are recovered, each should be contained in a suitably-sized cardboard box. The local conservation authority should be notified and requested to transport casualties to the nearest reputable veterinary clinic or wild animal/bird rehabilitation centre. In such cases, the immediate area of the recovery should be searched for evidence of impact with the turbine blades, and any such evidence should be fully documented (as above).

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Appendix 1. Annotated list of the bird species considered likely to occur within the impact zone of the proposed Richtersveld WEF (species in bold were seen during the September site visit).

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Common Ostrich	***Struthio camelus***	**-**	**-**	**Domestic stock**	**X**			**-**	**-**	**High**
Cape Spurfowl	*Pternistis capensis*	-	Endemic	Uncommon resident	X			Moderate	-	Moderate
Common Quail	*Coturnix coturnix*	-	-	Uncommon migrant	X			Moderate	-	-
Egyptian Goose	*Alopochen aegyptiaca*	-	-	Uncommon visitor			X	High	Moderate	-
South African Shelduck	*Tadorna cana*	-	Endemic	Common visitor			X	High	-	-
Spur-winged Goose	*Plectropterus gambensis*	-	-	Uncommon visitor			X	High	-	-
Yellow-billed Duck	*Anas undulata*	-	-	Uncommon visitor			X	Moderate	-	-
Cape Shoveler	*Anas smithii*	-	-	Uncommon visitor			X	Moderate	-	-
Red-billed Teal	*Anas erythrorhyncha*	-	-	Uncommon visitor			X	Moderate	-	
Ground Woodpecker	*Geocalaptes olivaceus*	-	Endemic	Uncommon resident		X		-	-	Moderate
Acacia Pied Barbet	*Tricholaema leucomelas*	-	Near-endemic	Uncommon resident	X			-	-	Moderate
African Hoopoe	*Upupa africana*	-	-	Uncommon resident	X			-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Swallow-tailed Bee-eater	*Merops hirundineus*	-	-	Uncommon visitor	X		X	-	-	-
European Bee-eater	*Merops apiaster*	-	-	Uncommon migrant	X			-	-	-
White-backed Mousebird	*Colius colius*	-	Endemic	Common resident	X			-	-	Moderate
Red-faced Mousebird	*Urocolius indicus*	-	-	Uncommon resident	X			-	-	Moderate
Rosy-faced Lovebird	*Agapornis roseicollis*	-	Near-endemic	Uncommon visitor	X			-	-	-
Alpine Swift	*Tachymarptus melba*	-	-	Common visitor		X	X	Moderate	-	-
Common Swift	*Apus apus*	-	-	Uncommon migrant			X	Moderate	-	-
Little Swift	*Apus affinis*	-	-	Uncommon visitor			X	Moderate	-	-
White-rumped Swift	*Apus caffer*	-	-	Common visitor			X	Moderate	-	-
Barn Owl	*Tyto alba*	-	-	Uncommon resident	X	X		Moderate	-	Moderate
Cape Eagle Owl	*Bubo capensis*	-	-	Uncommon visitor		X		Moderate	-	Moderate
Spotted Eagle-Owl	*Bubo africanus*	-	-	Uncommon resident	X	X		Moderate	-	Moderate
Freckled Nightjar	*Caprimulgus tristigma*	-	-	Uncommon resident		X				
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	-	-	Uncommon resident	X			Moderate	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Rock Dove	*Columba livia*	-	-	Uncommon visitor	X	X	X	Moderate	-	-
Speckled Pigeon	*Columba guinea*	-	-	Uncommon resident	X	X	X	Moderate	-	-
Laughing Dove	*Streptopelia senegalensis*	-	-	Common resident	X			-	-	Moderate
Cape Turtle-Dove	*Streptopelia capicola*	-	-	Common resident	X			-	-	Moderate
Red-eyed Dove	*Streptopelia semitorquata*	-	-	Uncommon visitor	X		X	Moderate	-	Moderate
Namaqua Dove	*Oena capensis*	-	-	Common resident	X			-	-	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable	Near-endemic	Uncommon visitor	X		X	High	-	High
Kori Bustard	*Ardeotis kori*	Vulnerable	-	Uncommon visitor	X		X	High	-	High
Southern Black Korhaan	*Afrotis afra*	-	Endemic	Common resident	X			Moderate	-	Moderate
Namaqua Sandgrouse	*Pterocles namaqua*	-	-	Common resident	X		X	Moderate	-	-
Spotted Thick-knee	***Burhinus capensis***	**-**	**-**	**Common resident**	**X**			**Moderate**	**-**	**Moderate**
Black-winged Stilt	*Himantopus himantopus*	-	-	Uncommon visitor			X	Moderate	-	-
Pied Avocet	*Recurvirostra avosetta*	-	-	Uncommon visitor			X	Moderate	-	-
Kittlitz's Plover	*Charadrius pecuarius*	-	-	Uncommon visitor			X	-	-	-
Three-banded Plover	*Charadrius tricollaris*	-	-	Uncommon visitor			X	-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Crowned Lapwing	*Vanellus coronatus*	-	-	Uncommon resident	X		X	Moderate	-	-
Double-banded Courser	*Rhinoptilus africanus*	-	-	Uncommon resident	X		X	Moderate	-	-
Burchell's Courser	*Cursorius rufus*	-	Near-endemic	Uncommon resident	X		X	Moderate	-	-
Black-shouldered Kite	*Elanus caeruleus*	-	-	Rare visitor			X	Moderate	-	Moderate
Black-chested Snake-Eagle	*Circaetus pectoralis*	-	-	Uncommon visitor	X		X	High	Moderate	-
Black Harrier	*Circus maurus*	Near-threatened	Endemic	Rare visitor	X		X	High	-	High
Southern Pale Chanting Goshawk	***Melierax canorus***	**-**	**Near-endemic**	**Common resident**	**X**	**X**	**X**	**Moderate**	**Moderate**	**-**
Steppe Buzzard	*Buteo vulpinus*	-	-	Uncommon migrant	X		X	Moderate	Moderate	-
Jackal Buzzard	*Buteo rufofuscus*	-	Endemic	Common resident	X	X	X	Moderate	Moderate	-
Verreaux's Eagle	*Aquila verreauxii*	-	-	Uncommon visitor		X	X	High	High	-
Booted Eagle	*Aquila pennatus*	-	-	Uncommon visitor	X	X	X	Moderate	Moderate	-
Martial Eagle	*Polemaetus bellicosus*	Vulnerable	-	Uncommon resident	X		X	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	Uncommon resident	X		X	High	High	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Lesser Kestrel	*Falco naumanni*	Vulnerable	-	Rare migrant	X		X	Moderate	-	-
Rock Kestrel	***Falco rupicolus***	**-**	**-**	**Common resident**	**X**	**X**	**X**	**Moderate**	**-**	**-**
Greater Kestrel	***Falco rupicoloides***	**-**	**-**	**Common resident**	**X**			**Moderate**	**-**	**-**
Lanner Falcon	***Falco biarmicus***	**Near-threatened**	**-**	**Uncommon resident**	**X**	**X**	**X**	**High**	**Moderate**	**-**
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	Uncommon resident	X	X	X	High	Moderate	-
Reed Cormorant	*Phalacrocorax africanus*	-	-	Uncommon visitor			X	High	-	-
White-breasted Cormorant	*Phalacrocorax lucidus*	-	-	Uncommon visitor			X	High	-	Moderate
Grey Heron	*Ardea cinerea*	-	-	Uncommon visitor			X	High	-	-
Black-headed Heron	*Ardea melanocephala*	-	-	Common visitor	X		X	High	-	-
Cattle Egret	*Bubulcus ibis*	-	-	Uncommon visitor			X	High	-	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-	Uncommon visitor			X	High	-	Moderate
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-	Rare visitor			X	High	-	Moderate
African Sacred Ibis	*Threskiornis aethiopicus*	-	-	Uncommon visitor			X	High	-	-
Great White Pelican	*Pelecanus onocrolatus*	Near-threatened	-	Uncommon visitor			X	High	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Black Stork	*Ciconia nigra*	Near-threatened	-	Rare visitor			X	High	-	-
Bokmakierie	***Telophorus zeylonus***	**-**	**Near-endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Pririt Batis	*Batis pririt*	-	Near-endemic	Uncommon resident	X			-	-	Moderate
Cape Crow	***Corvus capensis***	**-**	**-**	**Common resident**	**X**			**Moderate**	**Moderate**	**-**
Pied Crow	***Corvus albus***	**-**	**-**	**Common resident**	**X**	**X**		**Moderate**	**Moderate**	**-**
Common Fiscal	*Lanius collaris*	-	-	Common resident	X			-	-	Moderate
Cape Penduline Tit	*Anthroscopus minutus*	-	Near-endemic	Common resident	X			-	-	Moderate
Grey Tit	***Parus afer***	**-**	**Endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Brown-throated Martin	*Riparia paludicola*	-	-	Common visitor	X		X	-	-	Moderate
Barn Swallow	*Hirundo rustica*	-	-	Common migrant	X		X	-	-	Moderate
White-throated Swallow	*Hirundo albigularis*	-	-	Uncommon migrant	X		X	-	-	Moderate
Rock Martin	*Hirundo fuligula*	-	-	Common resident	X	X	X	-	-	Moderate
African Red-eyed Bulbul	*Pycnonotus nigricans*	-	Near-endemic	Uncommon visitor	X					
Cape Bulbul	*Pycnonotus capensis*	-	Endemic	Uncommon resident	X			-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Fairy Flycatcher	*Stenostira scita*	-	Endemic	Uncommon resident	X			-	-	Moderate
Long-billed Crombec	***Sylvietta rufescens***	**-**	**-**	**Common resident**	**X**			**-**	**-**	**Moderate**
Yellow-bellied Eremomela	*Eremomela icteropygialis*	-	-	Uncommon resident	X			-	-	Moderate
Karoo Eremomela	*Eremomela gregalis*	-	Endemic	Common resident	X			-	-	Moderate
Layard's Tit-Babbler	*Parisoma layardi*	-	Endemic	Uncommon resident	X			-	-	Moderate
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	-	Near-endemic	Common resident	X			-	-	Moderate
Orange River White-eye	*Zosetrops pallidus*	-	Endemic	Uncommon resident	X			-	-	Moderate
Grey-backed Cisticola	***Cisticola subruficapilla***	**-**	**-**	**Common resident**	**X**			**-**	**-**	**Moderate**
Karoo Prinia	***Prinia maculosa***	**-**	**Endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Namaqua Warbler	*Phragmacia substriata*	-	Endemic	Uncommon resident	X			-	-	Moderate
Rufous-eared Warbler	***Malcorus pectoralis***	**-**	**Endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Cinnamon-breasted Warbler	*Euryptila subcinnamomea*	-	Endemic	Uncommon resident	X			-	-	Moderate
Cape Clapper Lark	*Mirafra apiata*	-	Endemic	Common resident	X			-	-	Moderate
Karoo Lark	***Calendulauda albescens***	**-**	**Endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Barlow's Lark	***Calendulauda barlowi***	**Near-threatened**	**Endemic**	**Common resident**	**X**			**-**	**-**	**High**
Cape Long-billed Lark	***Certhilauda curvirostris***	**-**	**Endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Spike-heeled Lark	***Chersomanes albofasciata***	**-**	**Near-endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Grey-backed Sparrowlark	*Eremopterix verticalis*	-	-	Common visitor	X			-	-	Moderate
Black-eared Sparrowlark	*Eremopterix australis*	-	Endemic	Common visitor	X			-	-	Moderate
Red-capped Lark	***Calandrella cinerea***	**-**	**-**	**Common resident**	**X**			**-**	**-**	**Moderate**
Large-billed Lark	*Galerida magnirostris*	-	Endemic	Common resident	X			-	-	Moderate
Chat Flycatcher	***Bradornis infuscatus***	**-**	**Near-endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Karoo Scrub-Robin	***Cercotrichas coryphoeus***	**-**	**Endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
African Stonechat	***Saxicola torquatus***	**-**	**-**	**Common resident**	**X**			**-**	**-**	**Moderate**
Mountain Wheatear	*Oenanthe monticola*	-	Near-endemic	Common resident	X	X		-	-	Moderate
Capped Wheatear	***Oenanthe pileata***	**-**	**-**	**Common resident**	**X**			**-**	**-**	**Moderate**
Sickle-winged Chat	*Cercomela sinuata*	-	Endemic	Uncommon resident	X			-	-	Moderate
Karoo Chat	*Cercomela schlegelii*	-	Near-endemic	Uncommon resident	X			-	-	Moderate
Familiar Chat	*Cercomela familiaris*	-	-	Common resident	X			-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Tractrac Chat	***Cercomela tractrac***	**-**	**Near-endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Ant-eating Chat	*Myrmecocichla formicivora*	-	Endemic	Common resident	X			-	-	Moderate
Pale-winged Starling	*Onychognathus nabouroup*	-	Near-endemic	Uncommon visitor		X		-	-	Moderate
Red-winged Starling	*Onychognathus morio*	-	-	Common resdient	X	X		-	-	Moderate
Pied Starling	*Spreo bicolor*	-	Endemic	Common resident	X			-	-	Moderate
Wattled Starling	*Creatophora cinerea*	-	-	Uncommon visitor	X		X	-	-	Moderate
Common Starling	*Sturnus vulgaris*	-	-	Uncommon visitor			X	-	-	Moderate
Malachite Sunbird	*Nectarinia famosa*	-	-	Common resident	X			-	-	Moderate
Southern Double-collared Sunbird	*Cinnyris chalybeus*	-	Endemic	Common resident	X			-	-	Moderate
Dusky Sunbird	*Cinnyris fuscus*	-	Near-endemic	Common resident	X			-	-	Moderate
Cape Weaver	*Ploceus capensis*	-	Endemic	Uncommon visitor	X			-	-	Moderate
Southern Masked-Weaver	*Ploceus velatus*	-	-	Common resident	X			-	-	Moderate
Southern Red Bishop	*Euplectes orix*	-	-	Uncommon visitor	X		X	-	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status				Susceptibility to		
					Duneveld	Rocky ridges	Fly over	Collision	Electrocution	Disturbance / habitat loss
Common Waxbill	*Estrilda astrild*	-	-	Uncommon visitor	X			-	-	Moderate
House Sparrow	*Passer domesticus*	-	-	Uncommon visitor	X		X	-	-	Moderate
Cape Sparrow	***Passer melanurus***	**-**	**Near-endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Cape Wagtail	*Motacilla capensis*	-	-	Common visitor	X			-	-	Moderate
African Pipit	*Anthus cinnamomeus*	-	-	Common resident	X			-	-	Moderate
Black-headed Canary	*Serinis alario*	-	Endemic	Uncommon resident	X			-	-	Moderate
Yellow Canary	***Crithagra flaviventris***	**-**	**Near-endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
White-throated Canary	***Crithagra albogularis***	**-**	**Near-endemic**	**Common resident**	**X**			**-**	**-**	**Moderate**
Lark-like Bunting	*Emberiza impetuani*	-	-	Common visitor	X			-	-	Moderate
Cape Bunting	*Emberiza capensis*	-	Near-endemic	Common resident	X	X		-	-	Moderate