Annex F

Avian Specialist Report

ROGGEVELD 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 Roggeveld WEF on the avifauna of the Sutherland/Matjiesfontein 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 open, undulating to steeply sloping Renosterveld and Karoo. Land-use is mainly small stock farming. Over 210 bird species, including 14 red-listed species, 69 endemics, and three red-listed endemics may occur in the broader area. The birds of greatest potential relevance and importance in terms of the possible impacts of the WEF are likely to be (i) resident or visiting slope soaring raptors which use the cliff-lines of the escarpment edge for nesting and/or foraging, and (ii) seasonal influxes and/or resident populations of threatened large terrestrial birds (e.g. bustards).

The proposed WEF is likely to have a significant, long-term impact on the avifauna of the area, although the negative effects on key rare, red-listed and/or endemic species may be minimal. The most obvious, immediate and important negative impacts are likely to be on (i) Verreaux's Eagle *Aquila verreauxii* , Martial Eagle *Polemaetus bellicosus* and Black Harrier *Circus maurus* – nesting pairs of all these species occur within or peripheral to the development site and may be subject to loss of foraging habitat and the risk of collision with the turbine blades, and (ii) Ludwig's Bustard *Neotis ludwigii* - seasonal influxes of this threatened endemic may be displaced from foraging areas and exposed to collision risk with the turbine blades and with new power lines. These effects, which may also impact on other priority species, can probably be reduced to acceptable and sustainable levels by adherence to a proposed mitigation scheme, although the size of the proposed development, and cumulative impact of this and at least five other large wind energy facilities within a 75 km radius, confer significant changes on the natural environment of the region.

A comprehensive programme to fully monitor the actual impacts of the WEF on the broader avifauna of the area is 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 'Roggeveld Wind Energy Facility), approximately equidistant between the towns of Sutherland (to the north) and Matjiesfontein (to the south), and straddling the border between the Northern and Western Cape Provinces, 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*

Comment [M1]: Check against the latest and updated project description.

The proposed Roggeveld WEF will be located on various portions of the farms Wilgebosch Rivier 188, Karree Bosch 200, Klipbanksfontein 198, Ekkraal 199, Rietfontein 197, Bon Espirance 73, Brand Valley 75, Fortuin 74 and Barendskraal 76, in an area about 20 km north of Matjiesfontein, and about 35 km south of Sutherland (Fig. 2.1). The facility will be spread over an area of about 400 km^2, and include up to 250 wind turbines (provisionally laid out to maximize power production – Fig. 2.2). The turbines will have a generation capacity of up to 3 MW, and each will stand about 80 m high at hub-height, with a rotor diameter of 90-100 m. The facility will also include at least one on-site substation, a workshop, and a network of access and service roads. The wind farm will be connected to the national power grid using the existing transmission network.

3. *SCOPE*

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

(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.

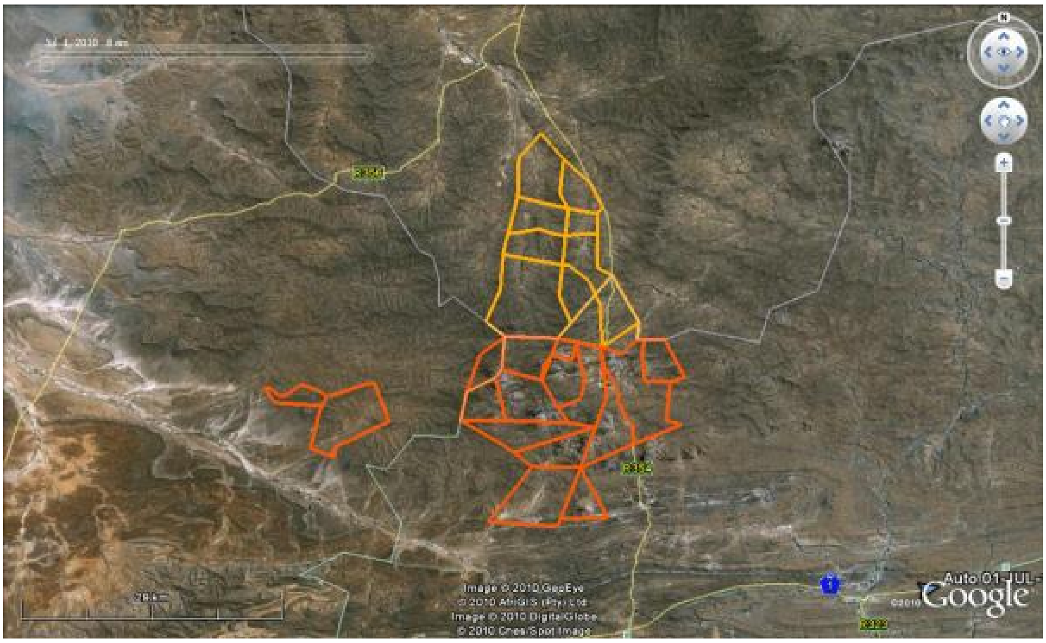

Figure 2.1 ***Location of the proposed Roggeveld WEF in relation to the affected properties and the surrounding landscape. The towns of Sutherland and Matjiesfontein are situated about 40 km to the north-east and 30 km to the south-east respectively.***

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 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.

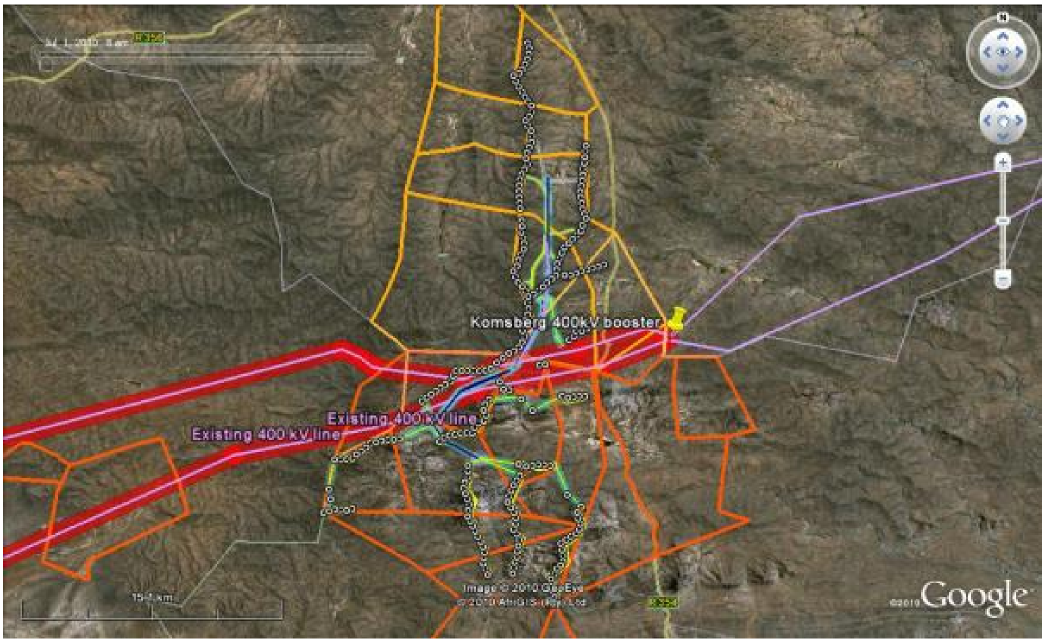

Figure 2.2 Layout and proposed power line link between the Roggeveld WEF and the Komsberg substation.

4.2 SITE VISITS

The site visit was conducted on October 21-22 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.

(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. 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 (3220CD Oliviersberg – 9 cards submitted over the atlas period, 3220DC

Swartland – 17 cards submitted, 3320AB Tweedside – 12 cards submitted, 3320BA Matjiesfontein – 24 cards submitted, Total = 62 cards for the area, note that the SABAP 1 data are now >15 years old), and for the relevant SABAP 2 pentads (3245_2025, 3250_2025, 3255_2025, 3300_2025, 3245_2030, 3250_2030, 3255_2030, 3300_2030 – two cards submitted so far for this area combined). A composite list of species likely to occur in the impact zone of the WEF was drawn up as a combination of these data and the information sources listed below, refined by a more specific assessment of the actual habitats affected and general knowledge of birds in the region (Appendix 1).

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

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

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

(v) EIA reports and any subsequent monitoring reports on the potential impacts on birds of other proposed and/or constructed and operational wind energy facilities in South Africa (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 seven 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). 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).

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

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

Certain species are morphologically 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.

Comment [M2]: Regulations such as the aviation control determine if the painting of one blade with a different colour is permissible .

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).

5.3.1 *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).

5.3.2 *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).

5.3.3 *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 junction of the Fynbos and Succulent Karoo biomes, and more specifically, at the interface between the Karoo Renosterveld and Rainshadow Valley Karoo bioregions (Mucina & Rutherford 2006). The natural vegetation is dominated by Central Mountain Shale Renosterveld (tall shrubland, dominated by renosterbos) in the southern two-thirds of the site, and Koedoesberge-

Moordenaars Karoo (low succulent scrub with scattered tall shrubs) in its northern reaches (Mucina & Rutherford 2006).

The site features areas of high topographic relief, as it includes ouliers of the Klein Roggeveld Mountains (Snydersberg, Rooiberg, Spitskop, Skurweberg), as well as the lower-lying areas of the Wilgebos and Tankwa River valleys to the west and east respectively. Altitude ranges from about 850 m above sea level to >1400 m a.s.l.. The climate is quite severe, with about 170 mm of rain per annum, falling mostly in winter, with mean winter minimum and summer maximum temperatures of 0°C and 29°C respectively.

6.2 *THE ALTERED ENVIRONMENT*

The area is presently used mainly for small stock (sheep) farming, with very limited cultivation of crops, mostly confined the immediate vicinity of occupied farmhouses. There are at least ten farmsteads within the development area, and a liberal scattering of farm dams of varying sizes (most notably those at Rietfontein and Klipbanksfontein along the Wilgebos River. The area is crossed by the R354 runing north/south between Matjiesfontein and Sutherland, by a number of smaller gravel roads connecting adjoining properties, and by a network of farm tracks. It is also traversed by Eskom's Droërivier-Muldersvlei and Bachus-Droërivier 400 kV transmission lines, aligned east/west through the southern half of the development area (Fig. 2.2).

6.3 *AVIAN HABITATS*

While the development area is large, and the altitude range it encompasses considerable, the habitat on site from an avian perspective is relatively uniform, dominated by open, rocky, undulating or montane Renosterveld or Karoo in places (Fig. 6.1a), with steep, rocky slopes, ridges and cliffs associated with the escarpment edge (Fig. 6.1b), denser, woody vegetation along the bigger drainage lines (and stands of alien trees), and both natural and artificial wetlands - river courses, vleis and dams (Fig. 6.1c).

The larger artificial impoundments in the area probably support good numbers of waterbirds in wet years, and the Eskom power pylons are used as roosting, hunting and/or nesting habitat by certain species (e.g. raptors and corvids).

The site is not located within 50 km of any of the currently registered national Important Bird Areas (Barnes 1998).

Figure 6.1a Open, undulating or montane Renosterveld – the dominant avian habitat type at the Roggeveld WEF site. The Eskom 400 kV transmission lines provide nesting habitat in the area for Martial Eagle.

Figure 6.1b Rocky ridges and small cliff-lines – habitat for montane and cliff-nesting birds.

Figure 6.1c Farm dams are the major wetland type within the Roggeveld WEF development area.

Figure 6.1 ***Areas of the Roggeveld WEF covered during the October site visit (blue lines) and important locations for birds in relation to the proposed turbine layout for the project (white circles).***

6.4 THE AVIFAUNA

More than 210 bird species could possibly occur on the site (Appendix 1), including up to 14 red-listed species, 69 endemics or near-endemics, and three red-listed endemics (Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus* and Black Harrier *Circus maurus*).

Sixty-three species were seen during the October site visit (Appendix 1), although none of these were red-listed species. The cliff lines, which are restricted either to the high ridges or to the steeply incised valleys of the larger watercourses, are small and broken, but hold at least one resident, breeding pair of Verreaux's Eagle *Aquila verreauxii* within the development area (nest site at 32°52.035 S, 20°30.216 E; Fig. 6.2), and at least one other just off the R354 to the south-east, and may also support multiple breeding pairs of Rock Kestrel *Falco tinnunculus*, Jackal Buzzard *Buteo rufofuscus*, Booted Eagle *Aquila pennatus* and Cape Eagle Owl *Bubo capensis,* and possibly pairs of Peregrine Falcon *Falco peregrinus* and Lanner Falcon *Falco biarmicus*.

Table 6.1 Priority bird species considered central to the avian impact assessment process for the Roggeveld 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 reporting rate (*n* = 64 cards)**	**Estimated importance of local population**	**Preferred habitat**	**Risk posed by**		
							Collision	**Electro-cution**	**Disturbance / habitat loss**
Cape Eagle Owl	*Bubo capensis*	-	-	0.0	Moderate	Rocky ridges	Moderate	Moderate	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	Near-endemic	4.8	Low	Open Karoo	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	-	0.0	Low	Open Karoo, wooded drainage lines	High	-	Moderate
Blue Crane	*Anthropoides paradiseus*	Vulnerable (Vulnerable)	Endemic	0.0	Low	Open Renosterveld, wetlands	High	-	Moderate
Black Harrier	*Circus maurus*	Near-threatened (Vulnerable)	Endemic	3.2	Moderate	Open Renosterveld, wetlands	Moderate	-	Moderate
Verreaux's Eagle	*Aquila verreauxii*	-	-	9.6	High	Rocky ridges	High	High	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	-	1.6	High	Open Karoo/Renosterveld	High	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	0.0	Moderate	Open Karoo/Renosterveld	High	-	Moderate
Black Stork	*Ciconia nigra*	Near-threatened	-	1.6	Low	Wetlands, rocky ridges	High	Moderate	-

Three pairs of Martial Eagle *Polemaetus bellicosus* nest on pylons on the Droërivier-Muldersvlei (DRO-MVL tower 542; 32º54.950 S, 20º37.140) and Bachus-Droërivier (BA-DRO towers 530 and 50; 32º58.720 S, 20º24.945 and 32º59.430 S, 20º19.440 respectively – Fig. 6.2) 400 kV transmission lines, although none of these sites has been occupied and active in recent years (Jenkins *et al.* 2007). Also notable is the location of a known Black Harrier nesting area along the upland watercourse in the Kabeltou/Brand Valley area (Fig. 6.2). At least two pairs of this threatened endemic have been recorded as breeding in this area simultaneously in the last 5-10 years, presumably in particularly wet years. None were seen during the site visit which should have coincided with the late breeding season in this species (Curtis *et al.* 2004).

Additional important restricted range and/or endemic species which certainly or probably occur in the area include Karoo Korhaan *Eupodotis vigorsii*, Karoo Long-billed Lark *Certhilauda subcoronata*, Black-eared Sparrowlark *Eremopterix australis*, Layard's Titbabbler *Parisoma layardii*, Namaqua Warbler *Phragmacia substriata*, African Rock Pipit *Anthus crenatus* and Black-headed Canary *Serinus alario* (Appendix 1).

Nine priority species are recognized as key in the assessment of avian impacts of the proposed Roggeveld 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 development area and which are likely to be, or could be, negatively affected by the WEF project. Five species – Cape Eagle Owl *Bubo capensis*, Kori Bustard *Ardeotis kori*, Blue Crane and Secretarybird *Sagittarius serpentarius* were included despite the fact that they were not recorded in either SABAP 1 or SABAP 2 data for the area because the habitat on the site looks suitable. Verreaux's Eagle and Cape Eagle Owl are not Red-listed (although see Jenkins 2008c) or endemic, but they are included because they are uncommon species and, with Martial Eagle, probably fulfil important ecological roles as apex predators in the area.

Comment [M3]: ?? How far can we include species not found on site in the assessment?

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

(i) Resident and breeding raptors, in particular Verreaux's Eagle, Martial Eagle and Black Harrier (likely to occur regularly on site, and definitely breeds within it in wet years – Curtis *et al.* 2004), and possibly Cape Eagle-Owl *Bubo capensis*. All are scarce or threatened species, potentially susceptible to collision with and displacement from the area by the turbine arrays. Perhaps the main threat to raptors is the risk of exposure to turbine collisions when gliding along the most prominent ridge-lines. Such locations are likely to attract and concentrate the activities of all slope soaring species in the area, and turbines should be placed well back from the edge of steep slopes to minimise this potential negative impact.

(ii) Seasonal influxes of Ludwig's Bustard. This is a nomadic, nationally 'Vulnerable' and globally 'Endangered', near-endemic species, highly susceptible to collision mortality on power lines (Jenkins *et al.* 2010, Jenkins *et al.* 2010 in prep.), probably susceptible to turbine collision mortality, and possibly susceptible to disturbance and displacement by the wind farm. As a plains species it is not likely to frequent the high relief areas of the site, but could occur in the flatter, more open northern section and/or along the wider sections of the river valleys.

7. *IMPACT ASSESSMENT*

This proposal is for a large wind energy installation, sited in an area where there are limited conflicting issues with local avifauna. There are no regionally or nationally critical populations of impact susceptible species within or close to the development area, and the proposed site does not impinge significantly on any rare or threatened habitats for birds. However, it is likely to affect local populations a short-list of threatened and/or ecologically valuable bird species. The proposed WEF will probably have a detrimental effect on these birds, during both the construction and operational phases of the development. The scale of the development renders these impacts potentially significant.

The worst affected taxa are likely to be large eagles and harriers killed or disturbed in the vicinity of nesting areas, and these and other raptors using the ridge lines for slope soaring (although raptor densities in the area generally do not appear to be overly high). Another possible impact of the facility will be displacement effects on, and (in particular) collision mortality of Ludwig's Bustard. This species is prone to erratic influxes to areas of the Karoo, apparently in response to past rainfall, but these factors are not well understood (Allan 1994). Compounding this unpredictability, recent studies of power line collisions by this bird (Jenkins *et al.* 2009, Jenkins *et al.* in prep.) have shown no detectable pattern in collisions in relation to landscape features. Hence, while bustards are likely to occur on the site in numbers, it is not possible to predict when such influxes are most likely to happen, or where these birds will be most susceptible to turbine collisions, precluding any useful input on where, and where not, to place turbines at this stage. Pre- and post-construction monitoring will be vital to improve understanding of the risk posed by the WEF on local bustards, and how best to mitigate this risk.

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/breeding / visiting raptors (especially Verreaux's Eagle, Martial Eagle and Black Harrier) from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of these species in collisions with the turbine blades or associated new power lines while slope-soaring or hunting, or by electrocution when perched on power infrastructure.

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

Table 7.1 Impact characteristics: Roggeveld 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 area 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) All birds on site; key species Verreaux's Eagle, Martial Eagle, Black Harrier, Cape Eagle-Owl, Ludwig's Bustard. (ii) Ludwig's Bustard, Martial Eagle, Black Harrier, Cape Eagle-Owl.	(i) All birds on site; key species: Verreaux's Eagle, Martial Eagle, Black Harrier, Ludwig's Bustard, Cape Eagle-Owl. (ii) All birds on site; key species Verreaux's Eagle, Martial Eagle, Black Harrier, Ludwig's Bustard, Cape Eagle-Owl.

Box 7.1 Construction Impact: Roggeveld 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 **local**.
- **Duration**: The duration would be **medium-term** as the ecology of the area would be altered beyond the completion of the project.
- **Intensity**: Loss of habitat for priority species will be considerable, 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-HIGH

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 – Medium

- **Extent**: The extent of the impact is **local**.
- **Duration**: The duration would be **short-term** as this effect will not extend beyond the life of the project.
- **Intensity**: Some biome/range restricted and/or threatened species will severely 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) – MEDIUM-HIGH

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

Box 7.2 Operation Impact: Roggeveld 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

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

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

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MEDIUM

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 **local**.
- **Duration**: The duration would be **long-term** as the ecology of the area would be affected at least until the project stops operating.
- **Intensity**: Some 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.

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

(iii) Excluding development from:

(a) Within 500 m of the edge of the most prominent ridge-lines within the development area to reduce collision risk for slope soaring raptors.

(b) Within 1500 m of any Verreaux's Eagle nest sites located within the development area (at least one site is directly affected - Fig. 6.2) to reduce disturbance and collision risk for this species.

(c) Within 2500 m of any Martial Eagle nest sites located within the development area (at least one site is directly affected - Fig. 6.2) to reduce disturbance and collision risk for this species.

(d) Within 1000 m of the outer perimeter of the wetland/watercourse designated as a Black Harrier nesting area (Fig. 6.2) to reduce disturbance and collision risk for this species.

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

(v) 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.

(vi) Minimizing the length of any new power lines installed, and ensuring that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010), and that all new power infrastructure is adequately insulated and bird friendly in configuration (Lehman *et al.* 2007). Note that current understanding of power line collision risk in birds precludes any guarantee of successfully distinguishing high risk from medium or low risk sections of a new line

Comment [M4]: Pre-construction monitoring should be part of further assessment of whether the nests are used and the extent that the various eagles of interest frequent those nests.

Comment [M5]: Depending on CAA requirements. It might not be possible to paint one blade black.

Comment [M6]: CAA also determines the lighting requirements for the turbines.

(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.

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

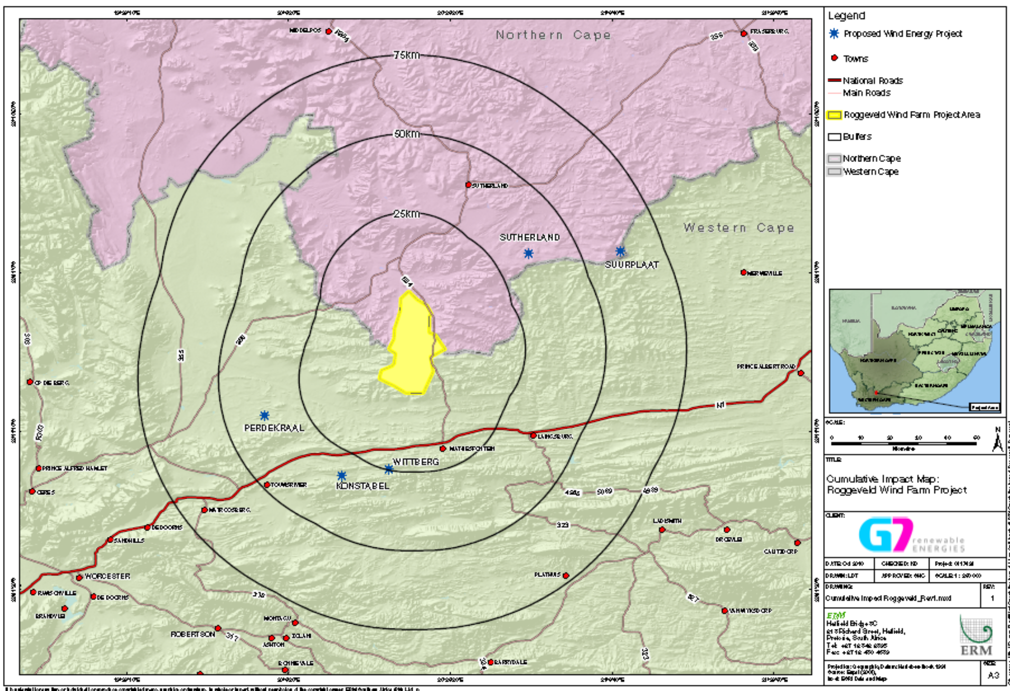

Figure 7.1 ***Roggeveld WEF site in the context of other WEF developments planned within a 75 km radius. Note that there are five such projects at present.***

(viii) Ensuring that the results of pre-construction monitoring are applied to project-specific impact mitigation in a way that allows for the potential cumulative effects on the local/regional avifauna of any other wind energy projects proposed for this area (of which there are five with a 75 km radius – Fig. 7.1), including the Sutherland Renewable Energy Facility and the Suurplaat Wind Farm, both proposed for properties along the Klein Roggeveld escarpment to the north-east, and the G7 Witberg project, some 20 km to the south (Fig. 7.1). Viewed in isolation, each of these projects may pose only a limited threat to the avifauna of the area. However, in combination they 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 a substantial array of many 100s of turbines (Masden *et al.* 2010).

(ix) 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, or installing a 'DeTect' or similar radar tracking system to monitor bird movements and institute temporary shut-downs as and when required.

Comment [M7]: We suggest that this section be removed as it will not be possible. Connection and supply agreements are subject to specific construction and capacity schedules which need to be strictly adhered to. Delivery of agreed power to Eskom will also limit the ability to shut down certain seasons of the year.

Table 7.1 ***Pre- and Post- Mitigation Significance: Roggeveld WEF - Birds***

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

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

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 six 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.

In addition, the cliff-lines and/or power lines within the development area should be surveyed for nesting raptors at least every 6-12 months using documented protocols (Malan 2009), and all sightings of key species (Table 6.1) on site should carefully plotted and documented, and the major waterbodies on and close to the development area should be surveyed for wetland species on each visit to the study area, using the standard protocols set out by the CWAC initiative (Taylor *et al.* 1999).

8.1.2 Bird activity monitoring

Monitoring of bird activity in the vicinity of the WEF 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 6-12 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)
(ii) Opportunistic surveys of bustards, cranes 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, or installing a DeTect or similar radar tracking system to monitor bird movements and institute temporary shut-downs as and when required.

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).

In tandem with surveys of the wind farm for collision casualties, sample sections of the new power line should be walked or driven (if the attendant servitude allows a driven survey of the whole length of line this would be preferable to a walked sample), and the area under the line searched for collision (and electrocution victims) using accepted protocols (Jenkins *et al.* 2007, Shaw *et al.* 2010a & b, Jenkins *et al.* in prep.).

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

Common name	Scientific name	Conservation status	Regional endemism	Local status					Susceptibility to		
					Cliff-lines and rocky ridges	Open Renosterveld or Karoo	Wooded drainage lines and alien plantations	Wetlands	Collision	Electrocution	Disturbance / habitat loss
Cape Spurfowl	***Pternistis capensis***	**-**	**Endemic**	**Common resident**	**X**	**X**			**Moderate**	**-**	**High**
Common Quail	*Coturnix coturnix*	-	-	Common visitor		X			-	-	High
Grey-winged Francolin	*Scleroptila africanus*	-	Endemic	Uncommon resident		X			Moderate	-	High
Helmeted Guineafowl	*Numida meleagris*	-	-	Common resident		X	X		Moderate	-	High
Egyptian Goose	***Alopochen aegyptiaca***	**-**	**-**	**Common resident**				**X**	**High**	**High**	**-**
South African Shelduck	***Tadorna cana***	**-**	**Endemic**	**Common resident**				**X**	**High**	**-**	**-**
Spur-winged Goose	*Plectropterus gambensis*	-	-	Common resident				X	High	Moderate	-
Cape Teal	*Anas capensis*	-	-	Uncommon resident				X	Moderate	-	-
African Black Duck	*Anas sparsa*	-	-	Uncommon resident				X	Moderate	-	-
Yellow-billed Duck	***Anas undulata***	**-**	**-**	**Common resident**				**X**	**Moderate**	**-**	**-**

Common name	Scientific name	Conservation status	Regional endemism	Local status					Susceptibility to		
					Cliff-lines and rocky ridges	Open Renosterveld or Karoo	Wooded drainage lines and alien plantations	Wetlands	Collision	Electrocution	Disturbance / habitat loss
Cape Shoveler	*Anas smithii*	-	Endemic	Common resident				X	Moderate	-	-
Red-billed Teal	*Anas erythrorhyncha*	-	-	Common resident				X	Moderate	-	-
Southern Pochard	*Netta erythropthalma*	-	-	Uncommon visitor				X	Moderate	-	-
Greater Honeyguide	*Indicator indicator*	-	-	Uncommon visitor			X		-	-	-
Lesser Honeyguide	*Indicator minor*	-	-	Uncommon visitor			X		-	-	Moderate
Ground Woodpecker	*Geocalaptes olivaceus*	-	Endemic	Uncommon resident	X				-	-	Moderate
Cardinal Woodpecker	*Dendropicos fuscescens*	-	-	Uncommon visitor			X		-	-	Moderate
Acacia Pied Barbet	***Tricholaema leucomelas***	**-**	**Near-endemic**	**Common resident**			**X**		**-**	**-**	**Moderate**
African Hoopoe	*Upupa africana*	-	-	Common resident			X		-	-	Moderate
Malachite Kingfisher	*Alcedo cristata*	-	-	Uncommon resident				X	-	-	-
Pied Kingfisher	*Ceryle rudis*	-	-	Uncommon resident				X	-	-	-
Giant Kingfisher	*Megaceryle maximus*	-	-	Uncommon resident				X	-	-	-
European Bee-eater	***Merops apiaster***	**-**	**-**	**Uncommon migrant**		**X**	**X**	**X**	**-**	**-**	**-**

Common name	Scientific name	Conservation status	Regional endemism	Local status					Susceptibility to		
					Cliff-lines and rocky ridges	Open Renosterveld or Karoo	Wooded drainage lines and alien plantations	Wetlands	Collision	Electrocution	Disturbance / habitat loss
White-backed Mousebird	***Colius colius***	**-**	**Endemic**	**Common resident**			**X**		**-**	**-**	**Moderate**
Red-faced Mousebird	***Urocolius indicus***	**-**	**-**	**Common resident**			**X**		**-**	**-**	**Moderate**
Red-chested Cuckoo	*Cuculus solitarius*	-	-	Uncommon migrant			X		-	-	-
Klaas Cuckoo	*Chrysococcyx klaas*	-	-	Uncommon resident			X		-	-	-
Diderick Cuckoo	*Chrysococcyx caprius*	-	-	Uncommon visitor			X		-	-	Moderate
Burchell's Coucal	*Centropus burchelli*	-	-	Uncommon resident				X	-	-	Moderate
Alpine Swift	*Tachymarptis melba*	-	-	Common resident	X	X			Moderate	-	-
Common Swift	*Apus apus*	-	-	Uncommon migrant	X	X			Moderate	-	-
African Black Swift	*Apus barbatus*	-	-	Common resident	X	X			Moderate	-	-
Little Swift	***Apus affinis***	**-**	**-**	**Uncommon visitor**		**X**			**Moderate-**	**-**	**-**
White-rumped Swift	*Apus caffer*	-	-	Common visitor	X	X			Moderate	-	-
Horis Swift	*Apus horus*	-	-	Uncommon visitor	X	X			Moderate	-	-
Barn Owl	*Tyto alba*	-	-	Common resident		X	X		-	Moderate	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status					Susceptibility to		
					Cliff-lines and rocky ridges	Open Renosterveld or Karoo	Wooded drainage lines and alien plantations	Wetlands	Collision	Electrocution	Disturbance / habitat loss
Cape Eagle-Owl	*Bubo capensis*	-	-	Uncommon resident	X	X			-	High	Moderate
Spotted Eagle-Owl	*Bubo africanus*	-	-	Common resident		X	X		-	High	Moderate
Freckled Nightjar	*Caprimulgus tristigma*	-	-	Uncommon resident	X				-	-	Moderate
Rufous-cheeked Nightjar	*Caprimulgus rufigena*	-	-	Uncommon resident		X	X				
Rock Dove	*Columba livia*	-	-	Common visitor		X			-	-	Moderate
Speckled Pigeon	***Columba guinea***	**-**	**-**	**Common resident**	**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		-	-	Moderate
Namaqua Dove	*Oena capensis*	-	-	Common resident		X	X		-	-	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable	Near-endemic	Uncommon visitor		X			High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	-	Rare visitor		X			High	-	Moderate
Southern Black Korhaan	*Afrotis afra*	-	Endemic	Common resident		X			Moderate	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Local status					Susceptibility to		
					Cliff-lines and rocky ridges	Open Renosterveld or Karoo	Wooded drainage lines and alien plantations	Wetlands	Collision	Electrocution	Disturbance / habitat loss
Karoo Korhaan	*Eupodotis vigorsii*	-	Endemic	Common resident		X			Moderate	-	Moderate
Blue Crane	*Anthropoides paradiseus*	Vulnerable	Endemic	Uncommon visitor		X		X	High	-	Moderate
Common Moorhen	*Gallinula chloropus*	-	-	Uncommon resident				X	Moderate-	-	-
Red-knobbed Coot	*Fulica cristata*	-	-	Common resident				X	Moderate-	-	-
Namaqua Sandgrouse	***Pterocles namaqua***	**-**	**Near-endemic**	**Common visitor**		**X**		**X**	**Moderate**	**-**	**-**
African Snipe	*Gallinago nigripennis*	-	-	Uncommon visitor				X	-	-	-
Marsh Sandpiper	*Tringa stagnatilis*	-	-	Uncommon visitor				X	Moderate	-	-
Common Greenshank	***Tringa nebularia***	**-**	**-**	**Common visitor**				**X**	**Moderate**	**-**	**-**
Wood Sandpiper	*Tringa glareola*	-	-	Uncommon visitor				X	Moderate	-	-
Common Sandpiper	*Actitis hypoleucos*	-	-	Uncommon visitor				X	Moderate	-	-
Little Stint	*Calidris minuta*	-	-	Uncommon visitor				X	Moderate	-	-
Curlew Sandpiper	*Calidris ferruginea*	-	-	Common visitor				X	Moderate	-	-
Ruff	*Philomachus pugnax*	-	-	Uncommon visitor				X	Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemism	Local status					Susceptibility to		
					Cliff-lines and rocky ridges	Open Renosterveld or Karoo	Wooded drainage lines and alien plantations	Wetlands	Collision	Electrocution	Disturbance / habitat loss
Water Thick-knee	*Burhinus vermiculatus*	-	-	Uncommon resident				X	Moderate	-	-
Spotted Thick-knee	*Burhinus capensis*	-	-	Uncommon resident		X	X		Moderate	-	-
Black-winged Stilt	***Himantopus himantopus***	**-**	**-**	**Common resident**				**X**	**Moderate**	**-**	**-**
Pied Avocet	***Recurvirostra avosetta***	**-**	**-**	**Common resident**				**X**	**Moderate**	**-**	**-**
Kittlitz's Plover	*Charadrius pecuarius*	-	-	Common resident				X	Moderate	-	-
Three-banded Plover	***Charadrius tricollaris***	**-**	**-**	**Common resident**				**X**	**Moderate**	**-**	**-**
Blacksmith Lapwing	***Vanellus armatus***	**-**	**-**	**Common resident**				**X**	**Moderate**	**-**	**-**
Crowned Lapwing	***Vanellus coronatus***	**-**	**-**	**Common resident**		**X**			**Moderate**	**-**	**-**
Double-banded Courser	*Rhinoptilus africanus*	-	-	Uncommon visitor		X			Moderate	-	-
Burchell's Courser	*Cursorius rufus*	-	Near-endemic	Rare visitor		X			Moderate	-	-
Whiskered Tern	*Chlidonias hybrida*	-	-	Uncommon visitor				X	Moderate	-	-
White-winged Tern	*Chlidonias leucopterus*	-	-	Uncommon visitor				X	Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemism	Local status					Susceptibility to		
					Cliff-lines and rocky ridges	Open Renosterveld or Karoo	Wooded drainage lines and alien plantations	Wetlands	Collision	Electrocution	Disturbance / habitat loss
Black-shouldered Kite	*Elanus caeruleus*	-	-	Uncommon resident		X	X		Moderate	-	Moderate
Black Kite	*Milvus migrans*	-	-	Uncommon migrant		X			-	-	-
African Fish-Eagle	*Haliaeetus vocifer*	-	-	Uncommon resident				X	-	High	-
Black-chested Snake-Eagle	***Circaetus pectoralis***	**-**	**-**	**Uncommon visitor**		**X**			**-**	**Moderate**	**Moderate**
African Marsh Harrier	*Circus ranivorus*	Vulnerable	-	Rare visitor				X	Moderate	-	-
Black Harrier	*Circus maurus*	Near-threatened	Endemic	Uncommon visitor	X	X		X	Moderate	-	Moderate
African Harrier-Hawk	*Polyboroides typus*	-	-	Uncommon visitor	X		X		-	-	Moderate
Southern Pale Chanting Goshawk	***Melierax canorus***	**-**	**Near-endemic**	**Common resident**		**X**	**X**		**-**	**Moderate**	**Moderate**
Gabar Goshawk	*Melierax gabar*	-	-	Uncommon resident			X		-	-	Moderate
Rufous-chested Sparrowhawk	***Accipiter rufiventris***	**-**	**-**	**Uncommon visitor**			**X**		**-**	**-**	**Moderate**
Black Sparrowhawk	*Accipiter melanoleucus*	-	-	Uncommon visitor			X		Moderate	-	Moderate
Steppe Buzzard	*Buteo vulpinus*	-	-	Common migrant	X	X			-	Moderate	Moderate

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Jackal Buzzard	***Buteo rufofuscus***	**-**	**Endemic**	**Common resident**	**X**	**X**			**-**	**Moderate**	**Moderate**
Verreaux's Eagle	***Aquila verreauxii***	**-**	**-**	**Uncommon resident**	**X**	**X**			**Moderate**	**High**	**Moderate**
Booted Eagle	*Aquila pennatus*	-	-	Uncommon resident	X	X			-	-	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable	-	Uncommon resident	X	X	X		Moderate	High	Moderate
Secretarybird	*Sagittarius serpentarius*	Near-threatened	-	Uncommon resident		X	X		High	-	Moderate
Lesser Kestrel	*Falco naumanni*	Vulnerable	-	Uncommon migrant		X	X		Moderate	-	Moderate
Rock Kestrel	***Falco rupicolus***	**-**	**-**	**Common resident**	**X**	**X**			**-**	**-**	**Moderate**
Greater Kestrel	*Falco rupicoloides*	-	-	Uncommon resident		X			-	-	Moderate
Lanner Falcon	*Falco biarmicus*	Near-threatened	-	Uncommon resident		X			High	Moderate	-
Peregrine Falcon	*Falco peregrinus*	Near-threatened	-	Uncommon visitor		X			High	Moderate	-
Great-crested Grebe	***Podiceps cristata***	**-**	**-**	**Uncommon visitor**				**X**	**Moderate**	**-**	**-**
Little Grebe	***Tachybaptus ruficollis***	**-**	**-**	**Common resident**				**X**	**-**	**-**	**-**
African Darter	*Anhinga rufa*	-	-	Common visitor				X	-	-	-

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Reed Cormorant	*Phalacrocorax africanus*	-	-	Common visitor				X	-	-	-
White-breasted Cormorant	***Phalacrocorax lucidus***	**-**	**-**	**Common visitor**				**X**	**Moderate**	**-**	**-**
Little Egret	*Egretta garzetta*	-	-	Common visitor				X	-	-	-
Grey Heron	***Ardea cinerea***	**-**	**-**	**Common visitor**				**X**	**Moderate**	**Moderate**	**-**
Black-headed Heron	*Ardea melanocephala*	-	-	Common resident		X		X	Moderate	Moderate	-
Cattle Egret	*Bubulcus ibis*	-	-	Common visitor				X	-	-	-
Hamerkop	*Scopus umbretta*	-	-	Uncommon resident			X	X	Moderate	-	-
Greater Flamingo	*Phoenicopterus ruber*	Near-threatened	-	Uncommon visitor				X	High	-	-
Lesser Flamingo	*Phoenicopterus minor*	Near-threatened	-	Rare visitor				X	High	-	-
Glossy Ibis	*Plegadis falcinella*	-	-	Uncommon visitor				X	Moderate	-	-
Hadeda Ibis	***Bostrychia hagedash***	**-**	**-**	**Common resident**			**X**		**Moderate**	**-**	**-**
African Sacred Ibis	*Threskiornis aethiopicus*	-	-	Common visitor				X	Moderate	-	-

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African Spoonbill	***Platalea alba***	**-**	**-**	**Common visitor**				**X**	**Moderate**	**-**	**-**
Black Stork	*Ciconia nigra*	Near-threatened	-	Rare visitor	X			X	High	Moderate	-
White Stork	*Ciconia ciconia*	-	-	Uncommon migrant				X	High	High	-
Fork-tailed Drongo	*Dicrurus adsimilis*	-	-	Uncommon resident			X		-	-	Moderate
African Paradise-Flycatcher	*Terpsiphone viridis*	-	-	Uncommon migrant			X		-	-	Moderate
Southern Tchagra	*Tchagra tchagra*	-	Endemic	Uncommon resident			X		-	-	Moderate
Southern Boubou	*Laniarius ferrugineus*	-	Endemic	Uncommon resident			X		-	-	Moderate
Bokmakierie	***Telophorus zeylonus***	**-**	**Near-endemic**	**Common resident**		**X**	**X**		**-**	**-**	**Moderate**
Pririt Batis	*Batis pririt*	-	Near-endemic	Uncommon resident		X			-	-	Moderate
Cape Crow	*Corvus capensis*	-	-	Common resident	X	X	X		-	-	Moderate
Pied Crow	***Corvus albus***	**-**	**-**	**Common resident**	**X**	**X**	**X**		**-**	**-**	**Moderate**
White-necked Raven	*Corvus albicollis*	-	-	Common resident	X	X			-	-	Moderate

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Red-backed Shrike	*Lanius collurio*	-	-	Rare migrant		X			-	-	-
Common Fiscal	***Lanius collaris***	-	-	**Common resident**		**X**	**X**		-	-	**Moderate**
Cape Penduline-Tit	***Anthoscopus minutus***	-	**Near-endemic**	**Uncommon resdient**		**X**			-	-	**Moderate**
Grey Tit	***Parus afer***	-	**Endemic**	**Common resident**		**X**			-	-	**Moderate**
Brown-throated Martin	***Riparia paludicola***	-	-	**Common resident**				**X**	-	-	**Moderate**
Barn Swallow	***Hirundo rustica***	-	-	**Common migrant**		**X**		**X**	-	-	**Moderate**
White-throated Swallow	*Hirundo albigularis*	-	-	Uncmmon resident				X	-	-	Moderate
Pearl-breasted Swallow	*Hirundo dimidiata*	-	-	Uncommon visitor			X		-	-	Moderate
Greater Striped Swallow	***Hirundo cucullata***	-	-	**Common migrant**		**X**	**X**	**X**	-	-	**Moderate**
Rock Martin	***Hirundo fuligula***	-	-	**Common resident**				**X**	-	-	**Moderate**
African Red-eyed Bulbul	*Pycnonotus nigricans*	-	Near-endemic	Uncommon resident			X		-	-	Moderate
Cape Bulbul	***Pycnonotus capensis***	-	**Endemic**	**Common resident**			**X**		-	-	**Moderate**

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Fairy Flycatcher	***Stenostira scita***	**-**	**Endemic**	**Uncommon visitor**			**X**		**-**	**-**	**Moderate**
Long-billed Crombec	*Sylvietta rufescens*	-	-	Common resident			X		-	-	Moderate
Yellow-bellied Eremomela	*Eremomela icteropygialis*	-	-	Common resident		X	X		-	-	Moderate
Karoo Eremomela	*Eremomela gregalis*	-	Endemic	Ccommon resident		X			-	-	Moderate
Little Rush-Warbler	*Bradypterus baboecala*	-	-	Uncommon resident				X	-	-	-
African Reed-Warbler	*Acrocephalus baeticatus*	-	-	Uncommon resident				X	-	-	Moderate
Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	-	-	Uncommon resident				X	-	-	Moderate
Willow Warbler	*Phylloscopus trochilus*	-	-	Uncommon migrant			X		-	-	Moderate
Layard's Tit-Babbler	*Parisoma layardi*	-	Endemic	Uncommon resident		X	X		-	-	Moderate
Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*	-	Near-endemic	Uncommon resident			X		-	-	Moderate
Cape White-eye	*Zosterops virens*	-	Endemic	Common resident			X		-	-	Moderate
Orange River White-eye	*Zosterops pallidus*	-	Endemic	Common resident			X		-	-	Moderate

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Grey-backed Cisticola	***Cisticola subruficapilla***	**-**	**Near-endemic**	**Common resident**	**X**	**X**			**-**	**-**	**Moderate**
Levaillant's Cisticola	*Cisticola tinniens*	-	-	Common resident				X	-	-	Moderate
Neddicky	*Cisticola fulvicapilla*	-	-	Common resident		X			-	-	Moderate
Zitting Cisticola	*Cisticola juncidis*	-	-	Common resident				X	-	-	Moderate
Karoo Prinia	***Prinia maculosa***	**-**	**Endemic**	**Common resident**	**X**	**X**			**-**	**-**	**Moderate**
Namaqua Warbler	***Phragmacia substriata***	**-**	**Endemic**	**Common resident**		**X**		**X**	**-**	**-**	**Moderate**
Rufous-eared Warbler	***Malcorus pectoralis***	**-**	**Endemic**	**Common resident**		**X**			**-**	**-**	**Moderate**
Cinnamon-breasted Warbler	*Euryptila subcinnamomea*	-	Endemic	Uncommon resident	X				-	-	Moderate
Bar-throated Apalis	*Apalis thoracica*	-	-	Uncommon resident		X	X		-	-	Moderate
Cape Clapper Lark	*Mirafra apiata*	-	Endemic	Common resident		X			-	-	Moderate
Sabota Lark	*Calendulauda sabota*	-	Near-endemic	Uncommon resident		X			-	-	Moderate
Karoo Lark	*Calendulauda albescens*	-	Endemic	Common resident		X			-	-	Moderate

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Spike-heeled Lark	*Chersomanes albofasciata*	-	-	Common resident		X			-	-	Moderate
Karoo Long-billed Lark	***Certhilauda subcoronata***	**-**	**Endemic**	**Common resident**		**X**			**-**	**-**	**Moderate**
Black-eared Sparrowlark	*Eremopterix australis*	-	Endemic	Uncommon visitor		X			-	-	Moderate
Grey-backed Sparrowlark	*Eremopterix verticalis*	-	Near-endemic	Common visitor		X			-	-	Moderate
Red-capped Lark	*Calandrella cinerea*	-	-	Common resident		X			-	-	Moderate
Sclater's Lark	*Spizocorys sclateri*	Near-threatened	Endemic	Uncommon resident		X			-	-	Moderate
Large-billed Lark	***Galerida magnirostris***	**-**	**Endemic**	**Common resident**		**X**			**-**	**-**	**Moderate**
Cape Rock Thrush	*Monticola rupestris*	-	Endemic	Common resident	X	X			-	-	Moderate
Sentinel Rock Thrush	*Monticola explorator*	-	Endemic	Uncommon resident	X				-	-	Moderate
Olive Thrush	***Turdus olivaceous***	**-**	**Endemic**	**Uncommon resident**			**X**		**-**	**-**	**Moderate**
Chat Flycatcher	*Bradornis infuscatus*	-	Near-endemic	Uncommon resident		X			-	-	Moderate
Fiscal Flycatcher	*Sigelus silens*	-	Endemic	Common resident			X		-	-	Moderate
Spotted Flycatcher	*Muscicapa striata*	-	-	Uncommon visitor			X				

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African Dusky Flycatcher	*Muscicapa adusta*	-	-	Uncommon resident			X		-	-	Moderate
Cape Robin-Chat	***Cossypha caffra***	**-**	**-**	**Common resident**			**X**		**-**	**-**	**Moderate**
Karoo Scrub-Robin	***Cercotrichas coryphoeus***	**-**	**Endemic**	**Common resident**		**X**	**X**		**-**	**-**	**Moderate**
African Stonechat	*Saxicola torquatus*	-	-	Common resident		X			-	-	Moderate
Mountain Wheatear	*Oenanthe monticola*	-	Near-endemic	Common resident		X			-	-	Moderate
Capped Wheatear	*Oenanthe pileata*	-	-	Common resident		X			-	-	Moderate
Sickle-winged Chat	***Cercomela sinuata***	**-**	**Endemic**	**Common resident**		**X**			**-**	**-**	**Moderate**
Karoo Chat	***Cercomela schlegelii***	**-**	**Near-endemic**	**Common resident**		**X**			**-**	**-**	**Moderate**
Familiar Chat	*Cercomela familiaris*	-	-	Common resident	X	X			-	-	Moderate
Tractrac Chat	*Cercomela tractrac*	-	Near-endemic	Uncommon resident		X			-	-	Moderate
Ant-eating Chat	*Myrmecocichla formicivora*	-	Endemic	Common resident		X			-	-	Moderate
Pale-winged Starling	*Onychognathus nabouroup*	-	Near-endemic	Common visitor	X		X		-	-	Moderate
Red-winged Starling	*Onychognathus morio*	-	-	Common resident	X		X		-	-	Moderate

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Pied Starling	***Spreo bicolor***	**-**	**Endemic**	**Common resident**		**X**			**-**	**-**	**Moderate**
Wattled Starling	*Creatophora cinerea*	-	-	Uncommon visitor		X			-	-	Moderate
Common Starling	*Sturnus vulgaris*	-	-	Common resident			X		-	-	Moderate
Orange-breasted Sunbird	*Anthobaphes violacea*	-	Endemic	Unommon visitor	X				-	-	Moderate
Malachite Sunbird	***Nectarinia famosa***	**-**	**-**	**Common resident**	**X**	**X**	**X**		**-**	**-**	**Moderate**
Southern Double-collared Sunbird	***Cinnyris chalybeus***	**-**	**Endemic**	**Common resident**		**X**	**X**		**-**	**-**	**Moderate**
Dusky Sunbird	*Cinnyris fuscus*	-	Near-endemic	Common resident		X			-	-	Moderate
Cape Weaver	*Ploceus capensis*	-	Endemic	Common resident			X	X	-	-	Moderate
Southern Masked-Weaver	***Ploceus velatus***	**-**	**-**	**Common resident**			**X**	**X**	**-**	**-**	**Moderate**
Southern Red Bishop	*Euplectes orix*	-	-	Common resident				X	-	-	Moderate
Yellow Bishop	*Euplectes capensis*	-	-	Common resident	X			X			

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Common Waxbill	*Estrilda astrild*	-	-	Common resident			X	X	-	-	Moderate
Pin-tailed Whydah	*Vidua macroura*	-	-	Common resident			X		-	-	Moderate
House Sparrow	*Passer domesticus*	-	-	Common resident			X		-	-	Moderate
Cape Sparrow	***Passer melanurus***	**-**	**Near-endemic**	**Common resident**		**X**	**X**		**-**	**-**	**Moderate**
Cape Wagtail	***Motacilla capensis***	**-**	**-**	**Common resident**		**X**		**X**	**-**	**-**	**Moderate**
African Rock Pipit	*Anthus cinnamomeus*	-	Endemic	Common resident	X	X			-	-	Moderate
Plain-backed Pipit	*Anthus leucophyrs*	-	-	Uncommon resident		X			-	-	Moderate
African Pipit	***Anthus cinnamomeus***	**-**	**-**	**Common resident**		**X**			**-**	**-**	**Moderate**
Long-billed Pipit	*Anthus similis*	-	-	Uncommon resident	X	X			-	-	Moderate
Cape Canary	*Serinus canicollis*	-	Endemic	Common resident		X			-	-	Moderate
Black-headed Canary	*Serinus alario*	-	Endemic	Uncommon resident		X			-	-	Moderate
Black-throated Canary	*Crithagra atrogularis*	-	-	Uncommon resident		X			-	-	Moderate
Yellow Canary	***Crithagra flaviventris***	**-**	**Near-endemic**	**Common resident**		**X**			**-**	**-**	**Moderate**

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Brimstone Canary	*Crithagra sulphuratus*	-	-	Uncommon visitor			X		-	-	Moderate
White-throated Canary	***Crithagra albogularis***	**-**	**Near-endemic**	**Common resident**		**X**			**-**	**-**	**Moderate**
Streaky-headed Seedeater	*Crithagra gularis*	-	-	Uncommon resident		X			-	-	Moderate
Lark-like Bunting	***Emberiza impetuani***	**-**	**Near-endemic**	**Common visitor**		**X**			**-**	**-**	**Moderate**
Cape Bunting	***Emberiza capensis***	**-**	**Near-endemic**	**Common resident**	**X**	**X**			**-**	**-**	**Moderate**