

EXXARO WEST COAST WIND ENERGY FACILITY

Avian impact assessment



EXECUTIVE SUMMARY

This study contains an extensive review of relevant literature on wind energy impacts on birds, and identifies potential impacts of the proposed Exxaro West Coast Wind Energy Facility on the avifauna of the Brand se Baai area of the west coast of the Western Cape, South Africa. These expected impacts are: habitat destruction by construction of the facility itself and any ancillary infrastructure, disturbance and possible displacement of sensitive species by the operation of the facility, and mortality in collision with the blades of the wind turbines, or in collision or electrocution incidents associated with ancillary infrastructure.

The proposed wind energy facility is situated in an open, undulating area of coastal Strandveld, adjacent to the estuary of the ephemeral Sout River. The immediate area supports at least 150 bird species, and possibly >230 species, including up to 63 endemics or near-endemics, 22 red-listed species, and eight species which are both endemic and red-listed. Commuting flocks of Greater Flamingo *Phoenicopterus ruber* and Lesser Flamingo *Phoenicopterus minor*, sporadic influxes of Ludwig's Bustard *Neotis ludwigii*, resident and/or visiting raptor species – especially Black Harrier *Circus maurus* and Martial Eagle *Polemaetus bellicosus*, and flocks of shorebirds (including small but significant numbers of Chestnut-banded Plover *Charadrius pallidus*) are probably the species of greatest conservation significance which are most likely to be impacted by the wind energy facility, both in terms of the anticipated collision and disturbance impacts of the development.

The proposed Exxaro West Coast Wind Energy Facility could have a significant, long-term impact on components of the avifauna of the surrounding area. The most obvious and immediate negative impacts are likely to be on the flamingo's which visit the estuary, the salt pans and the slimes dams of the nearby heavy minerals mining area, and on the sometimes substantial numbers of Ludwig's Bustard which visit the area after good winter rains, and have been recorded breeding on the mining site. These red-listed (and in some cases endemic species) may be disturbed by the construction of the wind energy facility, and/or lose foraging habitat (in terms of the area covered by the construction footprint and by displacement from areas with operating turbines), and/or suffer energetic costs associated with routing around a barrier of wind turbines when commuting between resource areas, and/or sustain mortalities in collisions with the turbine blades.

These effects may be reduced to acceptable and sustainable levels by adherence to a proposed mitigation scheme. A comprehensive programme to fully monitor the actual impacts of the facility on the broader avifauna of the area is recommended and outlined, from pre-construction and into the operational phase of the project. Clarity on the environmental impact of this and at least one other facility planned for the same general area can only be reached once pre-construction monitoring has been completed.

CONSULTANT'S DECLARATION OF INDEPENDENCE

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

1. INTRODUCTION

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

2. TERMS OF REFERENCE

The terms of reference for this environmental impact study, as supplied by Savannah Environmental (Pty) Ltd, were to provide:

- An indication of the methods used in determining the significance of potential impacts.
- A description of all the environmental issues (pertaining to birds) identified during the EIA process.
- An assessment of the significance of each of the identified direct, indirect and cumulative impacts, in terms of the expected nature, extent, duration, probability and severity of each, as well as in terms of the reversibility of impacts, and the degree to which each can be mitigated.
- A description and comparative assessment of alternatives in the development plan.
- Recommendations on practical mitigation of potentially significant negative impacts for inclusion in the Environmental Management Plan, with an indication of the expected efficacy of such mitigation measures.
- A description of any assumptions, uncertainties or knowledge gaps affecting this assessment.
- An environmental impact statement with a summary of key findings, an assessment of positive and negative implications of the proposed development, and a comparative assessment of identified alternatives.

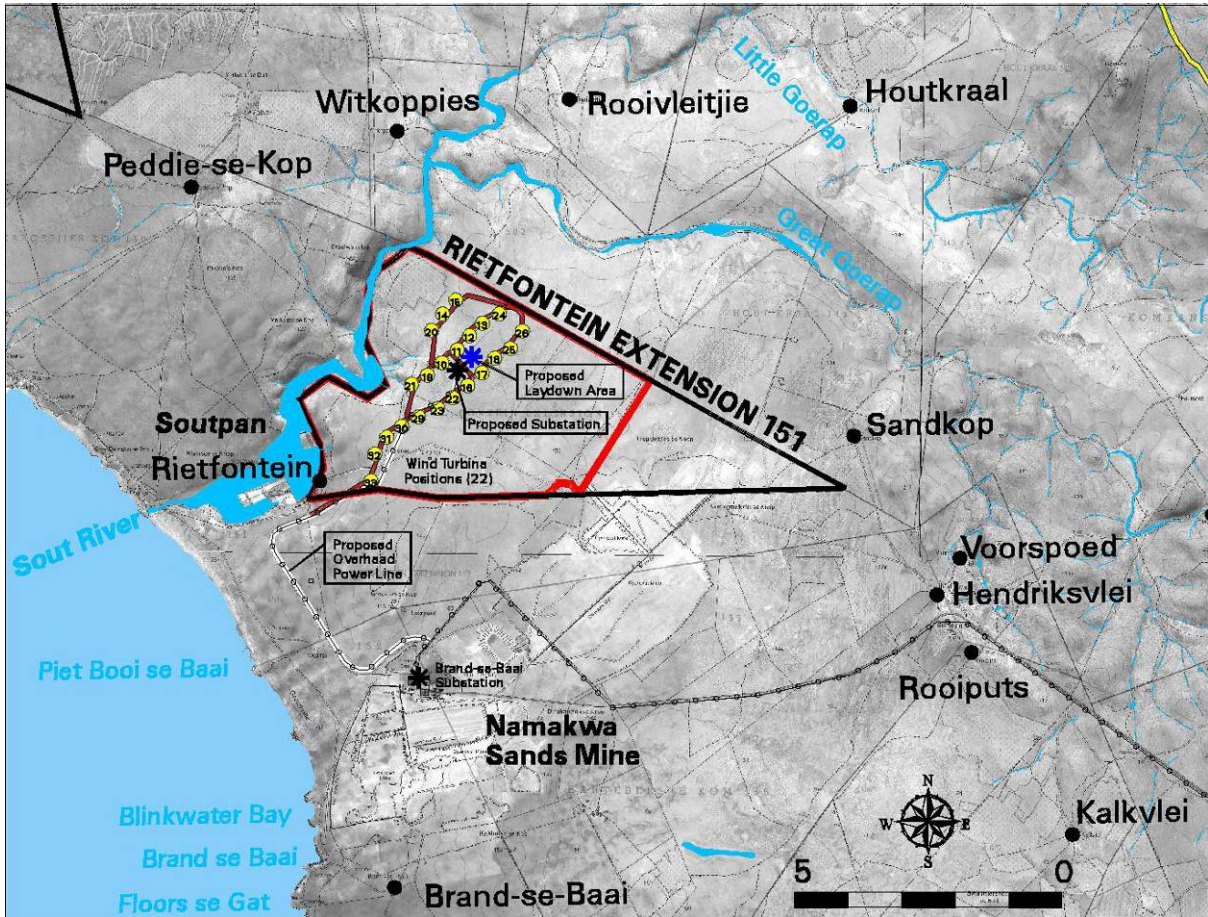


FIGURE 1. General location and layout of the proposed Exxaro West Coast Wind Energy Facility.

3. STUDY METHODS

3.1. Approach

The initial scoping study, which forms the background to this report, included the following steps:

- A review of available published and unpublished literature pertaining to bird interactions with wind energy facilities is provided summarising the issues involved and the current level of knowledge in this field. Various information sources (listed below), including data on the birdlife of the area and previous studies of bird interactions with wind energy facility and electricity infrastructure, were examined.
- An inclusive, annotated list of the avifauna likely to occur within the impact zone of the proposed wind energy facility was compiled using a combination of the

existing distributional data and previous experience/knowledge of the avifauna of the general area.

- A short-list of priority bird species (defined in terms of conservation status and endemism) which could possibly be impacted by the proposed wind energy facility was extracted from the total bird list. These species were subsequently considered as adequate surrogates for the local avifauna generally, and mitigation of impacts on these species was considered likely to accommodate any less important bird populations that may also potentially be affected.
- A summary of more likely and significant impacts of the wind energy facility on the local avifauna was drawn up, and a brief methodology was devised for the EIA phase for confirming these impacts and developing an effective mitigation strategy.

The present EIA report builds on the scoping study, with emphasis on the outcome of a site visit, made on 9 November 2010. While the scoping phase identified potential avifaunal issues associated with the proposed wind energy facility and its possible associated infrastructure, the EIA investigates these issues in more detail and includes:

- Field surveys of large terrestrial species, raptors and endemic passerines within the study area to determine the relative importance of local populations of these key taxa.
- Refinement of the expected species and priority species lists based on (i), and compilation of SABAP 2 atlas lists for the pentads visited during the site visit.
- Estimates of the extent and direction of possible movements of these species within/through the anticipated impact zone of the wind energy facility, in relation to the distribution of available resources – nesting or roosting sites (wetlands, stands of trees, existing power lines), foraging areas (croplands, wetlands), sources of lift for slope soaring birds (ridge lines).
- Identification of any sensitive/high risk areas to locate wind turbines within the broader study area, in terms of (i) to (iii) above.
- Recommendations on mitigation where necessary (particularly with reference to the siting of turbines).
- 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.

3.2. Data sources used

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

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al.* 1997) were obtained from the Animal Demography Unit website (<http://sabap2.adu.org.za/index.php>) for the relevant quarter-degree squares (SABAP 1: 3717BA & BB Ruitersvlei – 6 cards submitted over the atlas period, 98 species recorded; 3117 BD Baievlei – 6 cards, 78 species) or pentads (SABAP 2: 3110_1750, 3110_1755, 3115_1750, 3115_1755 – no cards submitted so far for all four pentads combined). A composite list of species likely to occur in the impact zone of the wind energy facility was drawn up as a combination of these data, refined by a more specific assessment of the actual habitats affected, based on general knowledge of the avifauna of the region (APPENDIX 1).
- Conservation status and endemism of all species considered likely to occur in the area was determined as per the most recent iteration of the national Red-list for birds (Barnes 2000), informed by a more recent revision for raptors (Jenkins 2008a), the most recent iteration of the global list of threatened species (<http://www.iucnredlist.org>), and the most recent and comprehensive summary of southern African bird biology (Hockey *et al.* 2005).
- Data from the Animal Demography Unit's Coordinated Avifaunal Roadcount project (CAR: <http://car.adu.org.za/>, Young *et al.* 2003), and Coordinated Waterbird Counts (CWAC: <http://cwac.adu.org.za/>, Taylor *et al.* 1999).
- Data from the Animal Demography Unit's Coordinated Avifaunal Roadcount project (CAR: <http://car.adu.org.za/>, Young *et al.* 2003).
- EIA and EMP reports for other developments in the same area (Allan & Jenkins 1990, Jenkins 1998).
- EIA reports and any subsequent monitoring reports on the potential impacts on birds of other proposed and/or constructed and operational wind energy facilities in South Africa (e.g. van Rooyen 2001a, Küyler 2004, Jenkins 2008b, 2009).

3.3. Limitations & assumptions

Any inaccuracies in the above sources of information could limit this study. The SABAP 1 data for this area are sparse (only 12 cards submitted for both quarter-degree squares over the atlas period) and are now >15 years old (Harrison *et al.* 1997). This problem is compounded by the lack of more recent, SABAP 2 data for the area, and in combination these two data sources are not sufficient to pronounce conclusively on the actual birdlife present. This deficiency was partially addressed by the short visit to the site. The availability of comprehensive information on the birds of the Olifant's River mouth, some

60 km to the south (Barnes 1998, Taylor *et al.* 1999) and featuring very similar habitat, also partly compensates for this deficiency, as does the compilation of previous reports on the avifauna of the Namakwa Sands mining area (Allan & Jenkins 1990, Jenkins 1998).

Given that there are currently only three, very small wind energy facilities operational in South Africa (totaling only 8 turbines between them), practical experience of the environmental effects of wind energy facilities in this country is extremely limited, and we must base our estimates of the possible impacts of new facilities largely on lessons learned internationally. While many of the established, general principles can probably be usefully applied here, care should be taken in adapting international knowledge and experience to uniquely South African birds and conditions.

4. BACKGROUND TO THE STUDY

4.1 Interactions between wind energy facilities and birds

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

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

4.1.1 Collisions with turbines

Collision rates

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

The National Wind Co-ordinating Committee (2004) estimates that 2.3 birds are killed per turbine per year in the US outside of California – correcting for searcher efficiency and scavenger rates. However, this index ranges from as low as 0.63 mortalities/turbine/year in Oregon, to as high as 10 mortalities/turbine/year in Tennessee (NWCC 2004), illustrating the wide variance in mortality rates between sites. Curry & Kerlinger (2000) found that only 13% of the >5000 turbines at Altamont Pass, California were responsible for all Golden Eagle *Aquila chrysaetos* and Red-tailed Hawk *Buteo jamaicensis* collisions, but the most recent aggregate casualty estimates for Altamont run to >1000 raptor mortalities/turbine/year, and nearly 3000 mortalities/turbine/year overall (Smallwood & Thelander 2008), including >60 Golden Eagles, and at a mean rate of about 2-4 mortalities/MW/year.

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

To date, only eight wind turbines have been constructed in South Africa at two pilot wind energy facilities at Klipheuwel and Darling in the Western Cape (van Rooyen 2001, Jenkins 2001, 2003) and, more recently, in the first phase of a bigger development at Coega in the Eastern Cape. An avian mortality monitoring program was established at the Klipheuwel facility once the turbines were operational, involving regular site visits to monitor both bird traffic through the area and detect bird mortalities (Küyler 2004). This study found that (i) 9-57% of 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 magirostris*, were thought to have been killed by collision with turbine blades, indicating a net collision rate for birds of about 1.00 mortality/turbine/year.

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

Causes of collision

Multiple factors influence the number of birds killed at wind energy facilities. These can be classified into three broad groupings: (i) avian variables, (ii) location variables, and (iii) facility-related variables. Although only one study has so far shown a direct relationship between the abundance of birds in an area and the number of collisions (Everaert 2003), it would seem logical to assume that the more birds there are flying through an array of turbines, the higher the chances of a collision occurring. The nature of the birds present in the area is also very important as some species are more vulnerable to collision with turbines than others, and feature disproportionately frequently in collision surveys (Drewitt & Langston 2006, 2008, de Lucas *et al.* 2008). Species-specific variation in behaviour, from general levels of activity to particular foraging or commuting strategies, also affect susceptibility to collision (Barrios & Rodríguez 2004, Smallwood *et al.* 2009). There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk.

Landscape features can potentially channel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Ridges and steep slopes are important factors in determining the extent to which an area is used by gliding and soaring birds (Barrios & Rodríguez 2004). High densities of prey will attract raptors, increasing the time spent hunting, and as a result reducing the time spent being observant. Poor weather affects visibility. Birds fly lower during strong headwinds (Hanowski & Hawrot 2000, Richardson 2000), so when the turbines are functioning at their maximum speed, birds are likely to be flying at their lowest, 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 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 1. Results of recent published studies of the effects of wind energy facilities on local avifauna.

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

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

Certain species are morphologically specialised for flying in open landscapes with high relief and strong prevailing winds, and are particularly dependent on slope soaring opportunities for efficient aerial foraging and travel. South African examples might include Bearded *Gypaetus barbatus* and Cape Vulture *Gyps coprotheres*, Verreaux's Eagle *Aquila verreauxii*, Jackal Buzzard *Buteo rufofuscus*, Rock Kestrel *Falco rupicolus*, Peregrine Falcon *Falco peregrinus*, Lanner Falcon *Falco biarmicus* and Black Stork *Ciconia nigra* and, to a lesser extent, most other open-country raptors. Such species are potentially threatened by wind energy developments where turbines are situated to exploit the wind shear created by hills and ridge-lines. In these situations, birds and industry are competing for the same wind resource, and the risk that slope soaring birds will collide with the turbine blades, or else be prevented from using foraging habitat critical for their survival, is greatly increased. Evidence of these effects has been obtained from several operational wind energy facilities in other parts of the world – for example relatively high mortality rates of large eagles, buzzards and kestrels at Altamont Pass, California (>1100 raptors killed annually or 1.9 raptor casualties/MW/year, Smallwood & Thelander 2008), and of vultures and kestrels at Tarifa, Spain (0.15-0.19 casualties/turbine/year, Barrios & Rodríguez 2004, de Lucas *et al.* 2008, Table 1), and displacement of raptors generally in southern Spain (Farfán *et al.* 2009) and of large eagles in Scotland (Walker *et al.* 2005) – and one study has shown that the additive impact of wind farm mortality on an already threatened raptor could theoretically cause its localised extinction (Carrete *et al.* 2009).

Mitigating collision risk

The only direct way to reduce the risk of birds colliding with turbine blades is to make the blades more conspicuous and hence easier to avoid. Blade 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 maximises the time between successive stimulations of the same retinal region, and (v) the easiest, cheapest and most visible blade pattern for this purpose, effective across the widest variety of backgrounds, is a single black blade in an array of white blades (McIsaac 2001, Hodos 2002). Hence blade marking may be an important means to reduce collision rates by making the rotating turbine blades as conspicuous as possible under the least favourable visual conditions, particularly at facilities where raptors are known or likely to be frequent collision casualties.

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

Effective mitigation can only be achieved with a commitment to rigorous pre- and post-construction monitoring (see below), ideally using a combination of occasional, direct observation of birds commuting or foraging through and around the wind energy facility, coupled with constant, remote tracking of avian traffic using specialised radar equipment (e.g. see <http://www.detect-inc.com/wind.html>). Such systems can be programmed to set the relevant turbines to idle as birds enter a pre-determined danger zone around the turbine array, and to re-engage those turbines once the birds have safely passed.

4.1.2 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.

4.1.3 Impacts of associated infrastructure

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

Electrocution on power infrastructure

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

4.2. Description of the proposed wind energy facility

The proposed wind energy facility will be located on portions of the farms Graauw Duinen 152, Hartebeeste Kom 156 and Rietfontein 151 and Rietfontein Extension 151 (Fig. 1), in an inclusive area of about 80 km², immediately adjacent to the coast and the mouth of the Sout River, and about 50 km west of the towns of Bitterfontein and Nuwerus, South Africa. The facility will comprise 22 wind turbines, and will include a dedicated substation,

a 132 kV power line link to the national grid (probably linking via a two parallel lines or double circuit line to an existing 132 kV line just east of the Brand se Baai substation – Fig. 1), and a network of new or upgraded access and service roads.

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1 Vegetation of the study area

The affected environment falls within the south-western extremity of the Succulent Karoo biome, and on the interface between the Namaqualand Sandveld (in the north) and the West Strandveld Bioregions (Mucina & Rutherford 2006). It features a combination of Namaqualand Strandveld over most of the proposed development area, Namaqualand Sand Fynbos in the interior, and Arid Estuarine Saltmarsh along the lower course of the Sout River, and Cape Seashore Vegetation along the coastal strip (Mucina & Rutherford 2006). Namaqualand Sand Fynbos features dry, undulating dune fields, covered by 1-1.5 m high shrubs, interspersed by restios, while Namaqualand Strandveld is a flatter, more open habitat, with a high diversity of low shrubs, and a propensity for spectacular annual and perennial flowering in good rainfall years (Mucina & Rutherford 2006).

5.2 Avian microhabitats

The area features open, undulating and largely unmodified succulent shrubland, grading into the fairly compact floodplain of the Sout River. The site is situated in a remote area, about 2 km north of the Exxaro Namakwa Sands mine, and about 3 km from the Atlantic coastline (Fig. 1). The local climate is temperate, featuring warm, dry, windy summers, and wetter, cooler winters. The Succulent Karoo is generally defined by a low, winter rainfall regime (20-290 mm per annum), although precipitation at the WEF site is almost certainly supplemented by coastal fog, which will be regular. Altitude averages about 60-80 m above sea level, rising to just over 140 m a.s.l. at 'Grouduin se kop' just to the south. Land use on site is mainly small stock farming, with a substantial saltworks established just upstream from the Sout River mouth. There are buildings at the saltworks and at Rietfontein, extensive infrastructural development (including a 132 kV transmission line) at the heavy minerals mine, and a popular summer holiday location at Brand se Baai, 8 km south of the proposed WEF.



FIGURE 2a. Undulating Strandveld on Soutvlei se Duin, south-east of the Sout River, where most of the Exxaro West Coast WEF turbines will be located.



FIGURE 2b. The edge of the Sout River floodplain



FIGURE 2c. The Sout River just upstream from the salt pans at Rietfontein. Most of the avian diversity in the WEF area is focused on the river mouth.

Avian habitats within the broader impact zone comprise (i) open Strandveld/Sand Fynbos (Figs 2a & b) - the dominant microhabitat, covering most of the footprint area of the wind farm itself and supporting the bulk of the terrestrial species diversity and the key endemics, (ii) permanent, seasonal and ephemeral wetlands - low-lying, open areas may form ephemeral pans or damp areas in good rainfall years, the course of the Sout River features extensive pools and channels (Fig. 2c), with an expanse of saltmarsh closer to the mouth, and there are impoundments (slimes dams) associated with mining activities in the area to the south of the proposed turbine arrays, (iii) rocky coastline - runs to the west of the WEF area, and includes some areas of open beach, and (iv) cultivated lands - these occur only as old areas of cultivation within the Strandveld.

5.3 Avifauna of the impact area

The broader impact zone of the WEF and its associated infrastructure could support up to 236 bird species (APPENDIX 1), although only 140-150 species may be considered as regulars on site. Of the inclusive list, 22 species are red-listed, 63 species are regional endemics or near-endemics, and eight species - Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus*, African Black Oystercatcher *Haematopus moquini*, Damara Tern *Sterna balaenarum*, Black Harrier *Circus maurus*, Crowned Cormorant *Phalacrocorax coronatus*, Bank Cormorant *Phalacrocorax neglectus* and Cape Cormorant *Phalacrocorax capensis* - are red-listed endemics (Barnes 2000, Hockey *et al.* 2005).

The site provides a limited diversity of habitats for birds. The open Strandveld that covers most of the study area supports good populations of otherwise quite widespread endemic passerines (e.g. Karoo Lark *Calendulauda albescens*, Cape Long-billed Lark *Certhilauda curvirostris*, Black-headed Canary *Serinus alario*) as well as regionally significant numbers of key red-listed species (e.g. Ludwig's Bustard, Kori Bustard *Ardeotis kori*, and Martial Eagle *Polemaetus bellicosus*). Much of the species richness sustained by the site occurs in association with the Sout River floodplain, and the associated saltmarsh and salt pans. The study area is located about 60 km north of the Olifant's River Mouth, which is a national Important Bird Area (Barnes 1998, Fig. 2) chiefly because of its wetland and coastal avifauna. Unlike the Olifants, the Sout River is an ephemeral system and is probably not as productive as a result. Nevertheless, when the river is not flowing and the mouth and saltmarsh are largely under the saline influence of tidal flows into the estuary, the site probably supports significant numbers of both migratory and resident shorebirds and, together with the slimes dams at the heavy minerals mine, is an important staging point for Greater Flamingo *Phoenicopterus ruber* and Lesser Flamingo *Phoenicopterus minor* moving between bigger coastal resource areas to the south (Langebaan Lagoon, Berg River wetlands, Verloren Vlei, Olifant's River mouth) and north (Orange River mouth) (Barnes 1998). It may also serve a similar function for smaller numbers of Great White Pelican *Pelecanus onocrotalus*.

If and when the river does flow and the wetlands become temporarily more extensive and less saline, the system is likely to attract a greater diversity of wetland birds. In such wet years, the saltmarsh area could also hold breeding pairs of Black Harrier (Curtis *et al.* 2004, R.E. Simmons, pers. comm.).

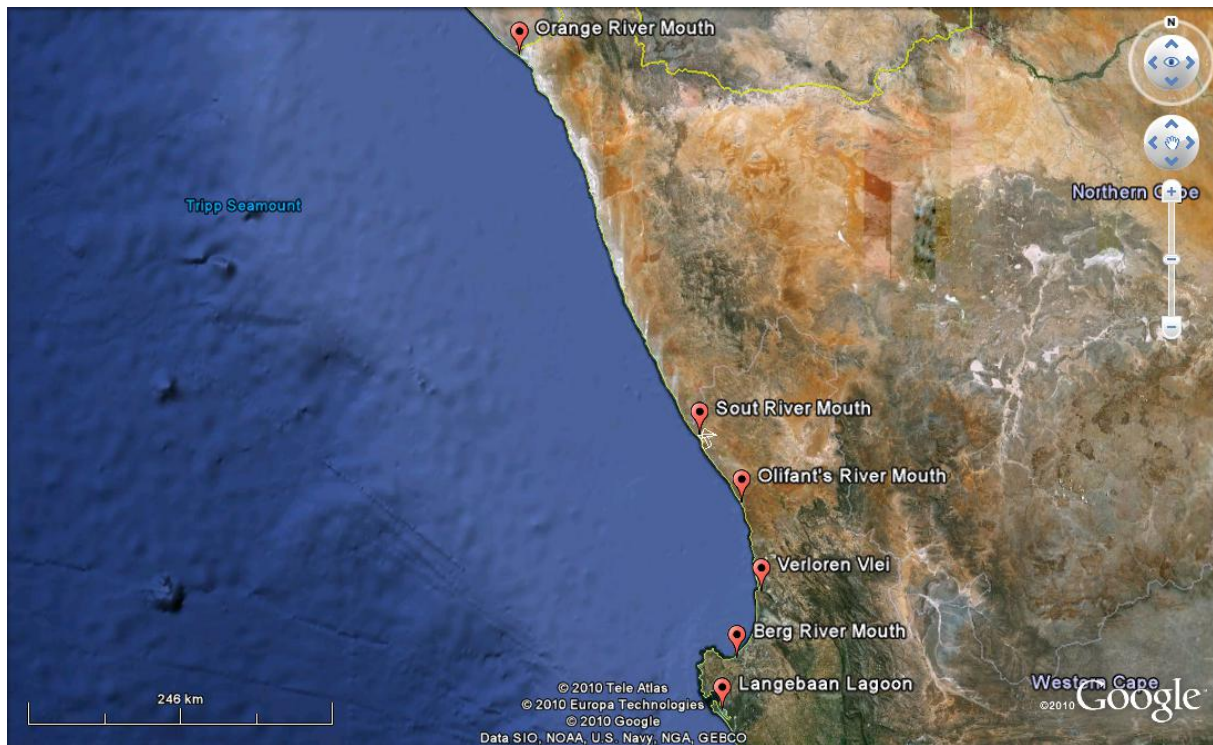


FIGURE 3. Location of the proposed Exxaro West Coast Wind Energy Facility in relation to nearby coastal Important Bird Areas (Barnes 1998).

Sixty-four species were seen during a site visit on November 10 2010 (Appendix 1). Although the visit was short, coverage of the area was good (Fig. 4), and some important birds were seen. Most significantly, there was about 400 flamingo's present in the area (at the slimes dams and at the salt pans and estuary), both Greater and Lesser (at a ratio of about 1:2). Also noted on the estuary was a relatively large number (10s) of Chestnut-banded Plover *Charadrius pallidus* – a red-listed species closely tied with availability of saline waterbodies. Single Ludwig's Bustards were seen at three locations along the ridge east of the river (directly within or adjacent to the proposed turbine arrays), and an adult Lanner Falcon *Falco biarmicus* was seen hunting shorebirds on the edge of the estuary, near Rietfontein. Another scarce and threatened species known to occur in the general area is Martial Eagle – a pair may be resident on power pylons somewhere to the east of the proposed WEF (C. Strydom and M. Vlok pers. comm.), but this could not be confirmed.



FIGURE 4. Area coverage (blue lines) and the distribution of significant sightings made during the November site visit, in relation to the proposed turbine array (white circles).

On the basis of these on-site observations, and in combination with the available SABAP atlas data for the general area, 9 priority species are recognised as key in the assessment of avian impacts of the proposed Exxaro West Coast Wind Energy Facility (Table 2), and as suitable surrogates for impacts on other species. These are mostly nationally and/or globally threatened species which are known to occur, or could occur in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the wind energy project. Some (in particular Ludwig's Bustard, Chestnut-banded Plover, Black Harrier, Martial Eagle, Lanner Falcon) are either known or likely to breed in the general area, while others (flamingo spp., Great White Pelican) occur as visitors only. All are likely to be sporadic in their occurrence, with influxes correlated with good rains.

Given that the proposed WEF is set back from and raised above the relatively linear coastline, impacts on purely coastal species are not considered likely.

Table 2. Priority bird species considered central to the avian impact assessment process for the Exxaro West Coast Wind Energy Facility, selected on the basis of South African (Barnes 2000) or global conservation status (www.iucnredlist.org or <http://www.birdlife.org/datazone/species/>), level of endemism, relative abundance on site (SABAP reporting rates, direct observation), and estimated conservation or ecological significance of the local population. Red-listed endemic species are shaded in grey.

Common name	Scientific name	SA conservation status/ (Global conservation status)	Regional endemism	Average SABAP reporting rate (N = 12 cards)	Estimated importance of local population	Preferred habitat	Risk posed by		
							Collision	Electro-cution	Disturbance / habitat loss
Ludwig's Bustard	<i>Neotis ludwigii</i>	Vulnerable (Endangered)	-	16.6	High	Strandveld	High	-	Moderate
Chestnut-banded Plover	<i>Charadrius pallidus</i>	Near-threatened (Near-threatened)	-	33.3	High	Saltmarsh and pans			
Black Harrier	<i>Circus maurus</i>	Near-threatened (Vulnerable)	Endemic	0.0	Moderate	Saltmarsh, Strandveld	Moderate	-	High
Martial Eagle	<i>Polemaetus bellicosus</i>	Vulnerable (Near-threatened)	-	0.0	Moderate	Strandveld	High	High	Moderate
Secretarybird	<i>Sagittarius serpentarius</i>	Near-threatened	-	33.3	Moderate	Strandveld, croplands	High	-	Moderate
Lanner Falcon	<i>Falco biarmicus</i>	Near-threatened	-	0.0	Low	Strandveld, croplands	High	Moderate	High
Greater Flamingo	<i>Phoenicopterus ruber</i>	Near-threatened	-	8.3	Moderate	Estuary, slimes dams, fly over	High	-	Moderate
Lesser Flamingo	<i>Phoenicopterus minor</i>	Near-threatened	-	8.3	Moderate	Estuary, slimes dams, fly over	High	-	Moderate
Great White Pelican	<i>Pelecanus onocrotalus</i>	Near-threatened	-	0.0	Low	Wetlands, fly over	High	-	High

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

- (i) Flocks of overflying wetland and coastal birds, numbering from 10s to 100s of birds, commuting between resource areas north/south of the wind energy facility. Species of particular concern are Greater Flamingo, Lesser Flamingo, Great White Pelican, and possibly large flocks of migratory palaeartic shorebirds. These are all collision prone and possibly displacement prone species. Also included here is Chestnut-banded Plover, which is less likely to be affected in numbers by turbine collisions, but may be displaced from the estuary by the action and noise of the wind farm.
- (ii) Large terrestrial species, especially Ludwig's Bustard, which can occur in large numbers in the general area after heavy winter rains (Allan 1994). This is a nationally and globally threatened, endemic species, highly susceptible to collision mortality on power lines (Anderson 2001, Jenkins *et al.* 2009, 2010), probably susceptible to turbine collision mortality, and possibly susceptible to disturbance and displacement by the operating wind farm.
- (iii) Resident and breeding and/or visiting raptors - Black Harrier (likely to occur regularly on site, and may breed within it in wet years – Curtis *et al.* 2004), Martial Eagle, Secretarybird *Sagittarius serpentarius* and Lanner Falcon.

6. IMPACT ASSESSMENT

Impacts of the proposed Wind Energy Facility are most likely to be manifest in the following ways (Tables 3 & 4):

- (i) Disturbance and displacement of flamingo's, Great White Pelicans and other shore or wetland birds from foraging areas by construction and/or operation of the facility, and /or mortality of these birds in collisions with the turbine blades or the new power lines while commuting between resource areas and roost sites.
- (ii) Disturbance and displacement of resident/breeding or non-breeding Ludwig's Bustard from nesting and/or foraging areas by construction and/or operation of the facility, and /or mortality of these birds in collisions with the turbine blades or the new power lines while commuting between resource areas and roost sites.
- (iii) Disturbance and displacement of resident/breeding or visiting raptors (especially Black Harrier, Martial Eagle) 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 the new power lines, while hunting in the Strandveld, or by electrocution when perched on power infrastructure.

Table 3. Assessment tables for construction impacts of the proposed Exxaro West Coast Wind Energy Facility on the local avifauna.

(A) Disturbance

Nature: Noise, movement and temporary occupation of habitat during the building process. Likely to impact all birds in the area to some extent, but sensitive, sedentary and/or habitat specific species will most adversely affected.

	Without mitigation	With mitigation
Extent	Low-Medium (2)	Low-Medium (2)
Duration	Short (1)	Short (1)
Magnitude	Medium-Low (4)	Low (3)
Probability	Definite (5)	Definite (5)
Significance	35 (Medium-Low)	30 (Low-Medium)
Status	Negative	Negative
Reversibility	Medium	High
Irreplaceable loss?	Possible	Probably not
Can impacts be mitigated?	Yes	

Mitigation: Abbreviating construction time, scheduling activities around avian breeding and/or movement schedules (timing to be determined after pre-construction monitoring), lowering levels of associated noise, and reducing the size of the inclusive development footprint.

Cumulative impacts: Possible, although nearest known WEF development site at least 30 km to the south.

Residual impacts: Some priority species may move away regardless of mitigation.

(B) Habitat loss

Nature: Destruction of habitat for priority species, either temporary – resulting from construction activities peripheral to the built area, or permanent - the area occupied by the completed development.

	Without mitigation	With mitigation
Extent	Low (1)	Low (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Low (2)	Low (1)
Probability	Definite (5)	Definite (5)
Significance	40 (Medium)	35 (Medium-Low)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Possible	Probably not
Can impacts be mitigated?	Yes	

Mitigation: Minimising habitat destruction caused by the construction of the facility by keeping the lay-down areas as small as possible, building as few temporary roads as possible, and reducing the final extent of developed area to a minimum.

Cumulative impacts: Yes, more wind energy developments in the area will increase habitat losses exponentially. None known at present.

Residual impacts: Some species may be permanently lost to the area regardless of mitigation.

Table 4. Assessment tables for operational impacts of the proposed Exxaro West Coast Wind Energy Facility on the local avifauna.

(A) Disturbance

Nature: Noise and movement generated by operating turbines and maintenance activities is sufficient to disturb priority species, causing displacement from the area, adjustments to commute routes with energetic costs, or otherwise affecting nesting success or foraging efficiency.

	Without mitigation	With mitigation
Extent	Low-Medium (2)	Low-Medium (2)
Duration	Lifetime of the facility (4)	Lifetime of the facility (4)
Magnitude	Medium (6)	Medium (6)
Probability	Highly probable (4)	Highly probable (4)
Significance	48 (Medium)	48 (Medium)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Possible	Possible
Can impacts be mitigated?	Slightly	

Mitigation: Abbreviating maintenance times, scheduling activities in relation to avian breeding and/or movement schedules (timing to be determined after pre-construction monitoring), and lowering levels of associated noise.

Cumulative impacts: Considerable. Any additional wind energy facilities proposed for the same general area will substantially raise disturbance levels, and extend the displacement or barrier effect across a broader front. The Eskom West Coast WEF may be a factor but is situated quite far to the south.

Residual impacts: Some priority species may be permanently lost from the area.

(B) Mortality

Nature: Collision of priority species with the wind turbine blades lines, or electrocution of the same on new power infrastructure.

	Without mitigation	With mitigation
Extent	Medium (3)	Low-Medium (2)
Duration	Lifetime of the facility (4)	Lifetime of the facility (4)
Magnitude	Medium-High (7)	Low-Medium (6)
Probability	Highly probable (4)	Probable (3)
Significance	56 (Medium-High)	36 (Medium)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss?	Yes	Possibly not
Can impacts be mitigated?	Yes	

Mitigation: Careful siting of turbines, painting turbine blades, bird friendly power hardware, monitoring priority bird movements and collisions, turbine management sensitive to these data – radar assisted if necessary.

Cumulative impacts: Yes, if more turbines are built in the same general area, more collision hot-spots are likely, and mortality rates may increase exponentially.

Residual impacts: Some casualties may be incurred regardless of mitigation.

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

- (i) Minimising the disturbance impacts associated with the construction of the facility, by abbreviating construction time, scheduling activities around avian breeding and/or movement schedules (actual timing to be refined by the results of pre-construction monitoring), and lowering levels of associated noise.
- (ii) Minimising habitat destruction caused by the construction of the facility by keeping the lay-down areas as small as possible, building as few temporary roads as possible, and reducing the final extent of developed area to a minimum.
- (iii) Minimising the disturbance impacts associated with the operation of the facility, by abbreviating maintenance times, scheduling activities in relation to avian breeding and/or movement schedules (actual timing to be refined by the results of pre- and post-construction monitoring), and lowering levels of associated noise.
- (iv) Painting one blade of each turbine black to maximise 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) 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.
- (vii) Ensuring that all new power infrastructure (pylons, conductors, transformers, substations) is adequately insulated and bird friendly in configuration (Lehman *et al.* 2007).

- (viii) Carefully monitoring the local avifauna both 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 (flamingo's, bustards, 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.
- (ix) Ensuring that the results of pre-construction monitoring are applied to project-specific impact mitigation in a way that allows for the potential cumulative effects on the local/regional avifauna of any other wind energy projects proposed for this area, including the larger 100 MW Eskom facility at Skaapvlei, about 30-40 km to the south. Viewed in isolation, each of these projects may pose only a limited threat to the avifauna of the Namaqualand coastal region. 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 repeated arrays of 10s of turbines spread across an important coastal flight path (Madsen *et al.* 2010).
- (x) 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.

6.1 Impact statement

This is a small to medium-sized wind energy project, proposed for a site with some conflicting issues in terms of its avifauna. The development area may impinge on the Sout River Estuary, and may affect the fly-way for wetland and shorebirds between this estuary and other resources north and south along the coast. The proposed development may affect populations of regionally or nationally threatened (and impact susceptible) birds (both wetland and terrestrial species) likely to occur within or close to the proposed turbine arrays. The facility will probably have a detrimental impact on these birds, particularly during its operational phase, unless significant commitment is made to mitigating these effects. Careful and responsible implementation of the required mitigation measures should reduce construction and operational phase impacts to tolerable and sustainable levels, especially if every effort is made to monitor impacts

throughout and to learn as much as possible about the effects of wind energy developments on South Africa avifauna. The impacts of this development must be viewed in the context of the potential cumulative effects generated by at least one other wind energy project proposed for the same general area.

7. PROPOSED MONITORING PROGRAMME

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

- (i) Determine the densities of birds resident or sporadically present (e.g. Ludwig's Bustard, Black Harrier, Chestnut-banded Plover, flamingo spp.) within the impact area of the wind energy facility 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 wind energy facility before construction, and afterwards, once the facility is operational.
- (iii) Identify sensitive and no-go areas for turbine placement to inform the final layout of the facility and the environmental management plan for both the construction and operational phases of the project.
- (iv) 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 facility is commissioned.
- (v) Register and as far as possible document the circumstances surrounding all avian collisions with the turbines for at least a full calendar year after the facility becomes operational.

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 2, Appendix 1). Ultimately, the study should provide much needed quantitative information on the effects of the facility 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 wind energy 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 the Birds & Wind Energy Specialist Group. Once the latter protocols have been finalised, they should supplement, and where necessary supercede, the measures stipulated here, as determined by the specialist advising the monitoring programme.

7.1 Monitoring protocols

7.1.1 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 development site. Each of these should be walked at least once every two months over at least six months immediately preceding construction, and at least once every two months over the same calendar period, at least six months after the facility 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, any cliff-lines or quarry faces within the broader development area (for e.g. the small, sandstone faces on the south side of the Sout River floodplain) should be surveyed for cliff-nesting raptors at least once every six months using documented protocols (Malan 2009), all sightings of key species (Table 2) 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).

7.1.2 Bird activity monitoring

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

- (i) Half-day counts of all priority species flying over or past the impact area (see passage rates below)
- (ii) Opportunistic surveys of large terrestrial species and raptors seen when travelling around the site.

7.1.3 Passage rates of priority bird species

Counts of bird traffic over and around the proposed/operational facility 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 site), 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 facility. 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 wind energy facility. The time and weather conditions should again be noted at the end of each count.

7.2 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.

7.2.1 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 carcasses 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 maximise 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.

7.2.2 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 facility, 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 labeled, 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 any new lengths of power line associated with the development should also be surveyed for collision victims using established protocols (see Jenkins *et al.* 2009, Jenkins *et al.* 2010, Shaw *et al.* 2010 a & b).

7. INPUTS TO THE ENVIRONMENTAL MANAGEMENT PLAN

OBJECTIVE:	A wind energy facility that is sustainable in terms of its impacts on local avifauna
Project components	<p>Conducting comprehensive pre- and post-construction monitoring of local avifauna (as per 7. Above)</p> <p>Getting the monitoring protocols right</p> <p>Securing the strategic use of radar</p> <p>Selecting and training a good monitoring team</p> <p>Collecting and collating sufficient accurate survey data pre-construction</p> <p>Analysing the pre-construction survey data to inform the final layout and the construction schedule</p> <p>Collecting and collating sufficient accurate survey data post-construction</p> <p>Analysing the post-construction survey data to inform the sustainable management of the facility</p>
Activity/risk source	<p>Starting pre-construction monitoring too late</p> <p>Appointment of unqualified personnel to do the monitoring</p> <p>Results of pre-construction monitoring not integrated into the final layout and/or the mitigation scheme</p> <p>Lack of clear communication between the scientist analysing the monitoring data and the client</p> <p>Misinterpretation of either the pre- or post-construction monitoring data</p>
Mitigation: Target/Objective	The delivery of an effective impact mitigation scheme for the facility, informed initially by influence of pre-construction monitoring on final construction plans, and refined by post-construction monitoring of actual impacts, and resulting adjustments in management practices and mitigation measures applied

Mitigation: Action/control	Responsibility	Timeframe
Appoint advising scientist and agency to conduct pre- and post-construction monitoring	Client	As soon as possible / practical
Refine monitoring protocol and determine the extent of radar deployment required	Advising scientist, in negotiation with the client	As soon as possible / practical
Appoint radar technologists to service the project, and acquire/hire hardware, software and relevant expertise, IF radar use is approved	Advising scientist, in negotiation with the client	As soon as possible / practical
Start pre-construction monitoring	Monitoring agency	1 year before construction is due to start

Mitigation: Action/control	Responsibility	Timeframe
Periodically collate and analyse pre-construction monitoring data	Advising scientist and radar specialist (if applicable)	Every 3 months of monitoring
Review report on the 6-12 months of pre-construction monitoring, and integrate findings into construction EMP and broader mitigation scheme	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	After a year of pre-construction monitoring
Ensure construction EMP is applied	Relevant Environmental Control Officer	During construction
Refine post-construction monitoring protocol in terms of results pre-construction, and determine the extent of radar deployment required	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	As soon as possible / practical after construction completed
Start post-construction monitoring	Monitoring agency	6 months after construction is completed
Periodically collate and analyse post-construction monitoring data	Advising scientist and radar specialist (if applicable)	Every 3 months of monitoring
Review report on the full year of post-construction monitoring, and integrate findings into operational EMP and broader mitigation scheme	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	1 year post-construction
Review the need for further post-construction monitoring	Advising scientist, monitoring agency and radar specialist (if applicable), in negotiation with the client	1 year post-construction

Performance indicator	<p>Regular provision of clearly worded, logical and objective information on the interface between the local avifauna and the proposed/operating wind energy facility</p> <p>Clear and logical recommendations on why, how and when to institute mitigation measures to reduce avian impacts of the development, from pre-construction to operational phase</p> <p>Quantifiable reductions in avian impacts once the facility is operational</p>
Monitoring	3-monthly and annual reports produced by the scientist advising the monitoring project

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Appendix 1. Annotated list of the bird species considered likely to occur within the impact zone of the proposed Exxaro West Coast Wind Energy Facility. Species seen during the July site visit appear in **bold**.

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

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Red-billed Teal	<i>Anas erythrorhyncha</i>	-	-		X			Moderate	-	-
Southern Pochard	<i>Netta erythrophthalma</i>	-	-		X			Moderate	-	-
Greater Honeyguide	<i>Indicator indicator</i>	-	-					-	-	Moderate
Ground Woodpecker	<i>Geocolaptes olivaceus</i>	-	Endemic	X		X		-	-	Moderate
Acacia Pied Barbet	<i>Tricholaema leucomelas</i>	-	Near-endemic	X				-	-	Moderate
African Hoopoe	<i>Upupa africana</i>	-	-				X	-	-	Moderate
Malachite Kingfisher	<i>Alcedo cristata</i>	-	-		X			-	-	Moderate
Giant Kingfisher	<i>Megaceryle maximus</i>	-	-		X			-	-	Moderate
Pied Kingfisher	<i>Ceryle rudis</i>	-	-		X			-	-	Moderate
European Bee-eater	<i>Merops apiaster</i>	-	-	X	X			-	-	Moderate
White-backed Mousebird	<i>Colius colius</i>	-	Endemic	X				-	-	Moderate
Red-faced Mousebird	<i>Urocolius indicus</i>	-	-	X				-	-	Moderate
Klaas's Cuckoo	<i>Chrysococcyx klaas</i>	-	-	X				-	-	-
Diderick Cuckoo	<i>Chrysococcyx caprius</i>	-	-	X				-	-	-
Alpine Swift	<i>Tachymarptis melba</i>	-	-	X		X		-	-	-
Common Swift	<i>Apus apus</i>	-	-	X	X	X	X	-	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
African Black Swift	<i>Apus barbatus</i>	-	-	X		X		-	-	-
Little Swift	<i>Apus affinis</i>	-	-				X	-	-	-
Horus Swift	<i>Apus horus</i>	-	-	X	X			-	-	-
White-rumped Swift	<i>Apus caffer</i>	-	-		X		X	-	-	-
Barn Owl	<i>Tyto alba</i>	-	-	X		X	X	-	Moderate	Moderate
Cape Eagle-Owl	<i>Bubo capensis</i>	-	-			X		-	High	Moderate
Spotted Eagle-Owl	<i>Bubo africanus</i>	-	-	X		X	X	-	High	Moderate
Fiery-necked Nightjar	<i>Caprimulgus pectoralis</i>	-	-	X	X			-	-	Moderate
Freckled Nightjar	<i>Caprimulgus tristigma</i>	-	-			X		-	-	Moderate
Rufous-cheeked Nightjar	<i>Caprimulgus rufigena</i>	-	-	X				-	-	Moderate
Rock Dove	<i>Columba livia</i>	-	-			X	X	-	-	-
Speckled Pigeon	<i>Columba guinea</i>	-	-			X	X	-	-	-
Laughing Dove	<i>Streptopelia senegalensis</i>	-	-	X			X	-	-	Moderate
Cape Turtle-Dove	<i>Streptopelia capicola</i>	-	-	X			X	-	-	Moderate
Namaqua Dove	<i>Oena capensis</i>	-	-	X			X	-	-	Moderate
Ludwig's Bustard	<i>Neotis ludwigii</i>	Vulnerable	Near-endemic	X			X	High	-	Moderate
Kori Bustard	<i>Ardeotis kori</i>	Vulnerable	-	X				High	-	Moderate

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Southern Black Korhaan	<i>Afrotis afra</i>	-	Endemic	X			X	Moderate	-	Moderate
Karoo Korhaan	<i>Eupodotis vigorsii</i>	-	Endemic	X				Moderate	-	Moderate
Blue Crane	<i>Anthropoides paradiseus</i>	Vulnerable	Endemic	X	X		X	High	-	Moderate
Red-chested Flufftail	<i>Sarothrura rufa</i>	-	-		X			-	-	Moderate
African Rail	<i>Rallus caerulescens</i>	-	-		X			-	-	-
Black Crake	<i>Amaurornis flavirostris</i>	-	-		X			-	-	-
Common Moorhen	<i>Gallinula chloropus</i>	-	-		X			-	-	-
Red-knobbed Coot	<i>Fulica cristata</i>	-	-		X			-	-	-
Namaqua Sandgrouse	<i>Pterocles namaqua</i>	-	Near-endemic	X			X	-	-	-
African Snipe	<i>Gallinago nigripennis</i>	-	-		X			-	-	Moderate
Bar-tailed Godwit	<i>Limosa lapponica</i>	-	-		X			-	-	-
Common Whimbrel	<i>Numenius phaeopus</i>	-	-		X	X		-	-	-
Eurasian Curlew	<i>Numenius arquata</i>	-	-		X	X		-	-	-
Marsh Sandpiper	<i>Tringa stagnatilis</i>	-	-		X			-	-	-
Common Greenshank	<i>Tringa nebularia</i>	-	-		X			-	-	-
Wood Sandpiper	<i>Tringa glareola</i>	-	-		X			-	-	-

Common name	Scientific name	Conservation status	Regional endemity	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Terek Sandpiper	<i>Xenus cinereus</i>	-	-		X			-	-	-
Common Sandpiper	<i>Actitis hypoleucos</i>	-	-		X			-	-	-
Ruddy Turnstone	<i>Arenaria interpres</i>	-	-		X	X		-	-	-
Red Knot	<i>Calidris canutus</i>	-	-		X	X		-	-	-
Sanderling	<i>Calidris alba</i>	-	-		X	X		-	-	-
Little Stint	<i>Calidris minuta</i>	-	-		X	X		-	-	-
Curlew Sandpiper	<i>Calidris ferruginea</i>	-	-		X	X		-	-	-
Ruff	<i>Philomachus pugnax</i>	-	-		X			-	-	-
Wilson's Phalarope	<i>Steganopus tricolor</i>	-	-		X			-	-	-
Red-necked Phalarope	<i>Phalaropus lobatus</i>	-	-		X			-	-	-
Red Phalarope	<i>Phalaropus fulicaria</i>	-	-		X			-	-	-
Greater Painted-snipe	<i>Rostratula benghalensis</i>	Near-threatened	-		X			-	-	Moderate
Water Thick-knee	<i>Burhinus vermiculatus</i>	-	-		X			Moderate	-	Moderate
Spotted Thick-knee	<i>Burhinus capensis</i>	-	-	X			X	Moderate	-	Moderate
African Black Oystercatcher	<i>Haematopus moquini</i>	Near-threatened	Endemic		X	X		Moderate	-	-
Black-winged Stilt	<i>Himantopus himantopus</i>	-	-		X			Moderate	-	-
Pied Avocet	<i>Recurvirostra avosetta</i>	-	-		X			Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Grey Plover	<i>Pluvialis squatarola</i>	-	-		X	X		Moderate	-	-
Common Ringed Plover	<i>Charadrius hiaticula</i>	-	-		X	X		-	-	-
Kittlitz's Plover	<i>Charadrius pecuarius</i>	-	-		X		X	-	-	-
Three-banded Plover	<i>Charadrius tricollaris</i>	-	-		X			-	-	-
Chestnut-banded Plover	<i>Charadrius pallidus</i>	Near-threatened	-		X			-	-	-
White-fronted Plover	<i>Charadrius marginatus</i>	-	-		X	X		-	-	-
Lesser Sand Plover	<i>Charadrius mongolus</i>	-	-		X			-	-	-
Greater Sand Plover	<i>Charadrius leschenaultii</i>	-	-		X			-	-	-
Blacksmith Lapwing	<i>Vanellus armatus</i>	-	-		X			Moderate	-	-
Crowned Lapwing	<i>Vanellus coronatus</i>	-	-				X	Moderate	-	Moderate
Double-banded Courser	<i>Rhinoptilus africanus</i>	-	-				X	Moderate	-	Moderate
Kelp Gull	<i>Larus dominicanus</i>	-	-			X		Moderate	Moderate	-
Grey-headed Gull	<i>Larus cirrocephalus</i>	-	-		X	X		Moderate	-	-
Hartlaub's Gull	<i>Larus hartlaubii</i>	-	Endemic		X	X		Moderate	-	-
Caspian Tern	<i>Sterna caspia</i>	Near-threatened	-		X			Moderate	-	-
Swift Tern	<i>Sterna bergii</i>	-	-		X	X		Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemicity	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Sandwich Tern	<i>Sterna sandvicensis</i>	-	-		X	X		Moderate	-	-
Common Tern	<i>Sterna hirundo</i>	-	-		X	X		Moderate	-	-
Arctic Tern	<i>Sterna paradisaea</i>	-	-			X		Moderate	-	-
Antarctic Tern	<i>Sterna vittata</i>	-	-			X		Moderate	-	-
Little Tern	<i>Sterna albifrons</i>	-	-		X	X		Moderate	-	-
Damara Tern	<i>Sterna balaenarum</i>	Endangered	Breeding endemic			X		Moderate	-	-
White-winged Tern	<i>Chlidonias leucopterus</i>	-	-		X			Moderate	-	-
Osprey	<i>Pandion haliaetus</i>	-	-		X			Moderate	Moderate	-
Black-shouldered Kite	<i>Elanus caeruleus</i>	-	-	X			X	Moderate	-	Moderate
Black Kite	<i>Milvus migrans</i>	-	-	X			X	Moderate	-	-
African Fish-Eagle	<i>Haliaeetus vocifer</i>	-	-		X			Moderate	High	-
Black-chested Snake-Eagle	<i>Circaetus pectoralis</i>	-	-	X				Moderate	Moderate	Moderate
African Marsh-Harrier	<i>Circus ranivorus</i>	Vulnerable	-	X	X		X	Moderate	-	Moderate
Black Harrier	<i>Circus maurus</i>	Near-threatened	Endemic	X	X		X	High	-	Moderate
African Harrier-Hawk	<i>Polyboroides typus</i>	-	-					Moderate	-	-
Southern Pale Chanting Goshawk	<i>Melierax canorus</i>	-	Near-endemic	X				Moderate	Moderate	Moderate

Common name	Scientific name	Conservation status	Regional endemicy	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Steppe Buzzard	<i>Buteo vulpinus</i>	-	-	X			X	Moderate	Moderate	-
Jackal Buzzard	<i>Buteo rufofuscus</i>	-	Endemic	X		X	X	Moderate	Moderate	Moderate
Verreaux's Eagle	<i>Aquila verreauxii</i>	-	-			X		High	High	-
Booted Eagle	<i>Aquila pennatus</i>	-	-	X			X	Moderate	-	-
Martial Eagle	<i>Polemaetus bellicosus</i>	Vulnerable	-	X				High	High	Moderate
Secretarybird	<i>Sagittarius serpentarius</i>	Near-threatened	-	X			X	High	-	Moderate
Lesser Kestrel	<i>Falco naumanni</i>	Vulnerable	-	X			X	-	-	Moderate
Rock Kestrel	<i>Falco rupicolus</i>	-	-	X		X	X	-	-	Moderate
Greater Kestrel	<i>Falco rupicoloides</i>	-	-	X				-	-	Moderate
Lanner Falcon	<i>Falco biarmicus</i>	Near-threatened	-	X		X	X	High	Moderate	Moderate
Peregrine Falcon	<i>Falco peregrinus</i>	Near-threatened	-	X		X	X	High	Moderate	-
Little Grebe	<i>Tachybaptus ruficollis</i>	-	-		X			-	-	-
Great Crested Grebe	<i>Podiceps cristatus</i>	-	-		X			Moderate	-	-
Black-necked Grebe	<i>Podiceps nigricollis</i>	-	-		X			Moderate	-	-
African Darter	<i>Anhinga rufa</i>	-	-		X			Moderate	-	-
Reed Cormorant	<i>Phalacrocorax africanus</i>	-	-		X			Moderate	-	-
Crowned Cormorant	<i>Phalacrocorax coronatus</i>	Near-threatened	Endemic			X		Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemism	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
White-breasted Cormorant	<i>Phalacrocorax lucidus</i>	-	-		X	X		Moderate	Moderate	-
Bank Cormorant	<i>Phalacrocorax neglectus</i>	Vulnerable	Endemic			X		Moderate	-	-
Cape Cormorant	<i>Phalacrocorax capensis</i>	Near-threatened	Breeding endemic			X		Moderate	-	-
Little Egret	<i>Egretta garzetta</i>	-	-		X	X		-	-	-
Yellow-billed Egret	<i>Egretta intermedia</i>	-	-		X			-	-	-
Great Egret	<i>Egretta alba</i>	-	-		X			-	-	-
Grey Heron	<i>Ardea cinerea</i>	-	-		X			Moderate	Moderate	-
Black-headed Heron	<i>Ardea melanocephala</i>	-	-		X		X	Moderate	Moderate	Moderate
Purple Heron	<i>Ardea purpurea</i>	-	-		X			-	-	-
Cattle Egret	<i>Bubulcus ibis</i>	-	-		X		X	-	-	-
Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>	-	-		X			-	-	-
Little Bittern	<i>Ixobrychus minutus</i>	-	-		X			-	-	-
Hamerkop	<i>Scopus umbretta</i>	-	-		X			-	-	-
Greater Flamingo	<i>Phoenicopterus ruber</i>	Near-threatened	-		X			High	-	-
Lesser Flamingo	<i>Phoenicopterus minor</i>	Near-threatened	-		X			High	-	-
Glossy Ibis	<i>Plegadis falcinellus</i>	-	-		X			-	-	-
Hadedda Ibis	<i>Bostrychia hagedash</i>	-	-		X		X	Moderate	-	-

Common name	Scientific name	Conservation status	Regional endemicy	Preferred habitat				Risk posed by		
				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
African Sacred Ibis	<i>Threskiornis aethiopicus</i>	-	-		X		X	Moderate	-	-
African Spoonbill	<i>Platalea alba</i>	-	-		X			Moderate	-	-
Great White Pelican	<i>Pelecanus onocrotalus</i>	Near-threatened	-		X			High	-	-
Black Stork	<i>Ciconia nigra</i>	Near-threatened	-		X		X	High	Moderate	-
White Stork	<i>Ciconia ciconia</i>	-	-	X	X		X	High	High	-
Fork-tailed Drongo	<i>Dicrurus adsimilis</i>	-	-					-	-	Moderate
Bokmakierie	<i>Telophorus zeylonus</i>	-	Near-endemic	X				-	-	Moderate
Pirit Batis	<i>Batis pririt</i>	-	Near-endemic	X				-	-	Moderate
Cape Crow	<i>Corvus capensis</i>	-	-	X			X	-	-	Moderate
Pied Crow	<i>Corvus albus</i>	-	-	X			X	-	-	Moderate
White-necked Raven	<i>Corvus albicollis</i>	-	-	X		X	X	-	-	-
Red-backed Shrike	<i>Lanius collurio</i>	-	-	X				-	-	-
Common Fiscal	<i>Lanius collaris</i>	-	-	X			X	-	-	Moderate
Cape Penduline-Tit	<i>Anthoscopus minutus</i>	-	Near-endemic	X				-	-	Moderate
Grey Tit	<i>Parus afer</i>	-	Endemic	X				-	-	Moderate
Sand Martin	<i>Riparia riparia</i>	-	-		X			-	-	-
Brown-throated Martin	<i>Riparia paludicola</i>	-	-		X			-	-	Moderate

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				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Banded Martin	<i>Riparia cincta</i>	-	-	X	X			-	-	-
Barn Swallow	<i>Hirundo rustica</i>	-	-	X	X		X	-	-	-
White-throated Swallow	<i>Hirundo albigularis</i>	-	-		X			-	-	Moderate
Pearl-breasted Swallow	<i>Hirundo dimidiata</i>	-	-	X	X			-	-	Moderate
Greater Striped Swallow	<i>Hirundo cucullata</i>	-	-	X	X		X	-	-	Moderate
Rock Martin	<i>Hirundo fuligula</i>	-	-			X		-	-	Moderate
Cape Bulbul	<i>Pycnonotus capensis</i>	-	Endemic	X				-	-	Moderate
Fairy Flycatcher	<i>Stenostira scita</i>	-	Endemic	X				-	-	Moderate
Cape Grassbird	<i>Sphenoeacus afer</i>	-	Endemic	X				-	-	Moderate
Long-billed Crombec	<i>Sylvietta rufescens</i>	-	-	X				-	-	Moderate
Yellow-bellied Eremomela	<i>Eremomela icteropygialis</i>	-	-	X				-	-	Moderate
Karoo Eremomela	<i>Eremomela gregalis</i>	-	Endemic	X				-	-	Moderate
Little Rush-Warbler	<i>Bradypterus baboecala</i>	-	-		X			-	-	Moderate
African Reed-Warbler	<i>Acrocephalus baeticatus</i>	-	-		X			-	-	Moderate
Greater Swamp-Warbler	<i>Acrocephalus rufescens</i>	-	-		X			-	-	Moderate

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				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Lesser Swamp-Warbler	<i>Acrocephalus gracilirostris</i>	-	-		X			-	-	Moderate
Layard's Tit-Babbler	<i>Parisoma layardi</i>	-	Endemic	X				-	-	Moderate
Chestnut-vented Tit-Babbler	<i>Parisoma subcaeruleum</i>	-	Near-endemic	X				-	-	Moderate
Cape White-eye	<i>Zosterops virens</i>	-	Endemic	X				-	-	Moderate
Grey-backed Cisticola	<i>Cisticola subruficapilla</i>	-	Near-endemic	X				-	-	Moderate
Levaillant's Cisticola	<i>Cisticola tinniens</i>	-	-	X	X			-	-	Moderate
Zitting Cisticola	<i>Cisticola juncidis</i>	-	-				X	-	-	Moderate
Karoo Prinia	<i>Prinia maculosa</i>	-	Endemic	X				-	-	Moderate
Namaqua Warbler	<i>Phragmacia substriata</i>	-	Endemic		X			-	-	Moderate
Rufous-eared Warbler	<i>Malcorus pectoralis</i>	-	Endemic	X				-	-	Moderate
Cape Clapper Lark	<i>Mirafrapa apiata</i>	-	Endemic	X			X	-	-	Moderate
Karoo Lark	<i>Calendulauda albescens</i>	-	Endemic	X			X	-	-	Moderate
Spike-heeled Lark	<i>Chersomanes albofasciata</i>	-	-	X			X	-	-	Moderate
Cape Long-billed Lark	<i>Certhilauda curvirostris</i>	-	Endemic	X			X	-	-	Moderate
Grey-backed Sparrowlark	<i>Eremopterix verticalis</i>	-	Near-endemic	X			X	-	-	Moderate

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				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Red-capped Lark	<i>Calandrella cinerea</i>	-	-	X			X	-	-	Moderate
Large-billed Lark	<i>Galerida magnirostris</i>	-	Endemic	X			X	-	-	Moderate
Cape Rock-Thrush	<i>Monticola rupestris</i>	-	Endemic			X		-	-	Moderate
Karoo Thrush	<i>Turdus smithi</i>	-	Endemic					-	-	Moderate
Chat Flycatcher	<i>Bradornis infuscatus</i>	-	Near-endemic	X				-	-	Moderate
Fiscal Flycatcher	<i>Sigelus silens</i>	-	Endemic	X				-	-	Moderate
Cape Robin-Chat	<i>Cossypha caffra</i>	-	-	X				-	-	Moderate
Karoo Scrub-Robin	<i>Cercotrichas coryphoeus</i>	-	Endemic	X				-	-	Moderate
African Stonechat	<i>Saxicola torquatus</i>	-	-	X	X		X	-	-	Moderate
Mountain Wheatear	<i>Oenanthe monticola</i>	-	Near-endemic	X		X		-	-	Moderate
Capped Wheatear	<i>Oenanthe pileata</i>	-	-				X	-	-	Moderate
Sickle-winged Chat	<i>Cercomela sinuata</i>	-	Endemic	X				-	-	Moderate
Karoo Chat	<i>Cercomela schlegelii</i>	-	Near-endemic	X				-	-	Moderate
Tractrac Chat	<i>Cercomela tractrac</i>	-	Near-endemic	X				-	-	Moderate
Familiar Chat	<i>Cercomela familiaris</i>	-	-	X			X	-	-	Moderate
Ant-eating Chat	<i>Myrmecocichla formicivora</i>	-	Endemic	X				-	-	Moderate

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				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Red-winged Starling	<i>Onychognathus morio</i>	-	-	X		X	X	-	-	Moderate
Pied Starling	<i>Spreo bicolor</i>	-	Endemic	X			X	-	-	Moderate
Wattled Starling	<i>Creatophora cinerea</i>	-	-	X			X	-	-	Moderate
Common Starling	<i>Sturnus vulgaris</i>	-	-				X	-	-	Moderate
Malachite Sunbird	<i>Nectarinia famosa</i>	-	-	X				-	-	Moderate
Southern Double-collared Sunbird	<i>Cinnyris chalybeus</i>	-	Endemic	X				-	-	Moderate
Dusky Sunbird	<i>Cinnyris fuscus</i>	-	Near-endemic	X				-	-	Moderate
Cape Weaver	<i>Ploceus capensis</i>	-	Endemic	X	X		X	-	-	Moderate
Southern Masked-Weaver	<i>Ploceus velatus</i>	-	-	X	X		X	-	-	Moderate
Red-billed Quelea	<i>Quelea quelea</i>	-	-	X	X		X	-	-	Moderate
Southern Red Bishop	<i>Euplectes orix</i>	-	-	X	X		X	-	-	Moderate
African Quailfinch	<i>Ortygospiza atricollis</i>	-	-				X	-	-	Moderate
Common Waxbill	<i>Estrilda astrild</i>	-	-		X		X	-	-	Moderate
Pin-tailed Whydah	<i>Vidua macroura</i>	-	-		X		X	-	-	Moderate
House Sparrow	<i>Passer domesticus</i>	-	-				X	-	-	Moderate

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				Strandveld & Sand Fynbos	Wetlands	Rocky coastline	Cultivated lands	Collision	Electro-cution	Disturbance and habitat loss
Cape Sparrow	<i>Passer melanurus</i>	-	Near-endemic	X			X	-	-	Moderate
Cape Wagtail	<i>Motacilla capensis</i>	-	-	X	X	X	X	-	-	Moderate
Cape Longclaw	<i>Macronyx capensis</i>	-	Endemic	X			X	-	-	Moderate
African Pipit	<i>Anthus cinnamomeus</i>	-	-	X			X	-	-	Moderate
Plain-backed Pipit	<i>Anthus leucophrys</i>	-	-				X	-	-	Moderate
Long-billed Pipit	<i>Anthus similis</i>	-	-				X	-	-	Moderate
Cape Canary	<i>Serinus canicollis</i>	-	Endemic	X				-	-	Moderate
Black-headed Canary	<i>Serinus alario</i>	-	Endemic	X				-	-	Moderate
Black-throated Canary	<i>Crithagra atrogularis</i>	-	-	X			X	-	-	Moderate
Yellow Canary	<i>Crithagra flaviventris</i>	-	Near-endemic	X			X	-	-	Moderate
White-throated Canary	<i>Crithagra albogularis</i>	-	Near-endemic				X	-	-	Moderate
Lark-like Bunting	<i>Emberiza impetuani</i>	-	Near-endemic				X	-	-	Moderate
Cape Bunting	<i>Emberiza capensis</i>	-	Near-endemic	X			X	-	-	Moderate