# Proposed Wind Energy Facility on a site north of Oyster Bay, Eastern Cape Province

# Bird Impact Assessment Study

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# Executive summary

Renewable Energy Systems (RES) Southern Africa (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd to undertake an Environmental Impact Assessment (EIA) and to compile an Environmental Management Plan (EMP) for a proposed Wind Energy Facility on a site near Oyster Bay. The project consists of the establishment of a wind energy facility and associated infrastructure within a broader site of 23 km² located approximately 6km north of Oyster Bay in the Eastern Cape Province. The proposed facility will have a generating capacity of up to 160MW (current lay-out = 77 turbines) with a proposed 132kV grid connection of approximately 25km.

The principal areas of concern from a bird impact perspective are:

- Mortality due to collision with the wind turbines;
- Displacement due to disturbance;
- Habitat loss due to the footprint of the wind farm; and
- Mortalities from collisions with the associated power lines

**DATA SOURCES**

The **primary source** of information on bird occurrence, densities, flight patterns and habitat at the development site is a monitoring programme that commenced in May 2011 and is ongoing. The objective of the programme is to gather baseline data on bird usage of the site, and covers all four seasons over a 12-month period. To date 20.95km of transects have been surveyed, and 60 hours of vantage point observations have been completed. From the analysis of this data the following **preliminary** trends emerge:

**COLLISIONS WITH THE TURBINES**

The flight data collected so far for priority species over the proposed turbine area for the **winter** period show that:

- Of the priority species, Denham's Bustard and Jackal Buzzard are most often recorded flying at medium (rotor) height;
- Flights take place during all wind conditions, but most medium height flights were recorded during moderate winds ; and
- Most flights take place during south-westerly winds, followed by westerly winds.

Calculating an estimated collision rate (ECR) is a risky venture, because of the many assumptions that inevitably need to be made in order to arrive at a figure, due to the lack of actual data. In this instance, a preliminary ECR of 0.42 birds, or 0.005 birds per turbine for the winter season (= 77 turbines) was calculated with the available data, subject to several important qualifications. **It is imperative to approach this figure with caution, and see it at best as very rough indicator of collision risk.**

Due to the limited amount of monitoring that has been conducted to date, it would be risky to draw preliminary conclusions as far as priority species are concerned. At this stage of the investigations, the following management actions are recommended to reduce the risk of collisions by priority species:

- Pre-construction monitoring should continue for a 12-month period as planned, to establish an adequate baseline for comparative purposes.
- Once the turbines have been constructed, post-construction monitoring as per the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011) should be implemented to compare actual collision rates with predicted collision rates. If actual collision rates indicate unsustainable mortality levels, the following mitigation measures will have to be considered:

    - Negotiating appropriate off-set compensation for turbine related collision mortality;
    - As a last resort, halting operation of specific turbines during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality

**DISPLACEMENT DUE TO DISTURBANCE**

To date, a total of 56 species were recorded during transect drives. Judging from the results of the transect surveys completed to date, the following preliminary conclusions can be drawn:

- The survey area is particularly well suited for Denham's Bustard and White-winged Lapwing;
- So far agriculture and grassland are emerging as important habitat for priority species – it accounted for 92% of priority species records to date, although it only makes up approximately 26% of the habitat surveyed;
- Interestingly, no White-bellied Korhaans were recorded on the transect counts. However, this is almost certainly set to change as the monitoring

progresses, as the species was recorded during VP observations, and also by the author during previous site visits in the southern transect area.

At this stage, it can only be speculated about the impact of potential displacement on terrestrial birds in the study area, particularly Denham's Bustard, White-bellied Korhaan, Blue Crane and White-winged Lapwing as this will only become apparent once the post-construction monitoring commences. If the birds are displaced, this potentially could be the most significant impact of the wind farm on birds.

The following management actions are proposed to minimise the impact of displacement on birds:

- The pre-construction monitoring programme must continue as planned to provide baseline information for comparative purposes;
- Post-construction monitoring should be implemented to assess the impact of displacement, particularly on priority species. Initially, a 12-month period of post-construction monitoring should be implemented, using the same protocol as is currently implemented. Thereafter, the need for further monitoring will be informed by the results of the initial 12-month period;
- Should the results of the post-construction monitoring indicate significant displacement of priority species, appropriate off-set compensation should be negotiated with the developer to compensate for the loss of priority species habitat; and
- During the construction period, activity should be restricted to the construction footprint itself. Access to the rest of the properties must be strictly controlled to prevent unnecessary disturbance of birds.

**HABITAT CHANGE AND LOSS**

Direct habitat loss is not regarded as a major impact on avifauna compared to the potential impact of collisions with the turbines and, in particular, potential displacement due to disturbance. The infrastructure footprint must be restricted to the minimum in accordance with the recommendations of the ecological specialist study.

**ELECTRICITY TRANSMISSION LINES**

The proposed 132kV power line that will link the wind facility to the grid could pose a collision risk, particularly to Denham's Bustard and Blue Cranes irrespective of which of the proposed alignments is used.

From a potential avifaunal collision risk perspective, none of the proposed power line alignments emerge as a clear preferred alternative, as they all run through basically the same habitat. However, the **eastern alignment** is slightly preferred above the other for the following reasons:

- It is the shortest; and
- It runs next to an existing overhead power line for approximately 10km. Other transmission lines running parallel to the proposed alignments were treated as a risk reducing factor.

The following management actions are proposed to minimise the risk of collisions with the proposed line:

- The power line should be marked with Double Loop Bird Flight Diverters on the earth wire of the line, five metres apart, alternating black and white.

**CUMULATIVE IMPACTS**

It is impossible to say at this stage what the cumulative impact of all the proposed wind developments within the broader study area will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the latest version of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al* 2011), the first version which was released by the Endangered Wildlife Trust and Birdlife South Africa in March 2011. This will provide the data necessary to improve the assessment of the cumulative impact of wind development on priority species. At this stage, indications are that displacement may emerge as a significant impact, particularly for species such as Denham's Bustard, White-bellied Korhaan and (possibly) Secretarybird.

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# 1. INTRODUCTION

Renewable Energy Systems (RES) Southern Africa (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd to undertake an Environmental Impact Assessment (EIA) and to compile an Environmental Management Plan (EMP) for a proposed Wind Energy Facility on a site near Oyster Bay. Chris van Rooyen Consulting was appointed to assess the potential impacts the facility will have on birds.

The investigation of potential impacts on birds caused by wind farms is a new field of study in South Africa, and has only been the focus of much attention since the middle of 2010. The concept of wind energy suddenly and rapidly gained momentum in South Africa in the latter part of 2010, resulting in a plethora of proposed wind farm applications which caught the ornithological community completely by surprise. The pace of proposed new developments is such that both developers and specialist ornithological consultants struggled (and are still struggling) to come to grips with the enormity of the task ahead, namely to ensure that scientifically robust studies are implemented at all proposed development sites to assess the potential impact on avifauna. The basic approach to this study is to present findings and recommendations based on the knowledge which is currently available in a South African context, while acknowledging that there is still much to learn in this field. As the results of pre-and post-construction monitoring programmes which currently are being implemented become available, those results will be applied to future developments in order to predict with increasing confidence what the likely impact of a particular wind farm development will be on avifauna. At present it has to be acknowledged that there is much to be learnt and this situation is likely to continue for some time. This study should be seen as work in progress as the full results of the 12 month pre-construction monitoring programme will only become available in 2012 when the baseline monitoring has been completed.

## 1.1 Project components

The project consists of the establishment of a wind energy facility and associated infrastructure within a broader site of 23 km² located approximately 6 km north of Oyster Bay in the Eastern Cape Province. The proposed facility will have a generating capacity of up to 160MW and the following infrastructure:

- Up to 80 wind turbines (current lay-out provides for 77 turbines);
- Cabling between the turbines, to be placed underground where practical;
- On-site substation/s to facilitate the connection between the wind energy facility and the grid;

- A new overhead power line of approximately 25km to be connected to Eskom's existing Melkhout Substation;
- Internal access roads to each turbine; and
- Workshop area for maintenance and storage.

The wind energy facility is proposed on the following farm portions: Portion 3 of Farm Klein 713; Portion 1, 2, 3, 4 and the Remainder of Farm Rebok Rant 715; Portion 1 and 3 of Farm Ou Werf 738; Portion 5 of Farm Klippedrift 732; Portion 10 and Portion 12 of Farm Kruis Fontein 681.

For a detailed description of the project components, see Chapter 2 of the Impact Assessment Report

See Figures 1 and 2 below for a map of the study area, indicating the proposed turbine lay-out and position of the various power line alignments.

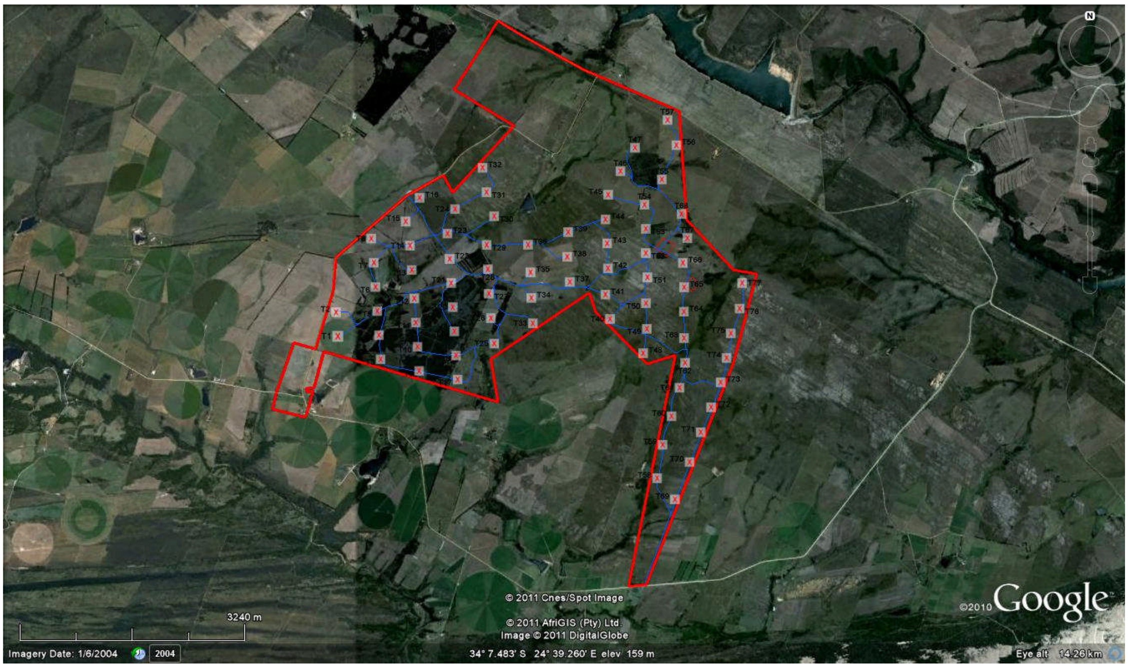


**Figure 1: Map of the study area indicating the proposed turbine lay-out**


**Figure 2: Map of the study area indicating the proposed western (yellow line), central (green line) and eastern (purple line) alternatives for the power line**

## 1.2 Terms of reference

The scope of the report comprises the assessment of the avifaunal impacts associated with the construction and operation of the proposed facility and the provision of appropriate mitigation measures to reduce such potential impacts. This report is therefore centred on the following specific terms of reference:

- Description of the receiving environment (habitat) from an avifaunal perspective;
- Identification of priority avifauna that might be impacted by the proposed facility;
- Identification of potential impacts on priority avifauna;
- The assessment of the potential impacts; and
- The provision of the mitigation measures to reduce the impacts.

## 1.3 Sources of information

The **primary source** of information on bird occurrence, densities, flight patterns and habitat at the development site is a monitoring programme that commenced in May 2011 and is ongoing. The monitoring programme is designed in accordance with *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"* (Jenkins *et al* 2011) by the Endangered Wildlife Trust (EWT) and BirdLife South Africa (BLSA). The objective of the programme is to gather baseline data on bird usage of the site, and covers all four seasons over a 12-month period. The seasons are defined as follows:

- Summer: Mid - November to Mid – March.
- Autumn: Mid – March to Mid-May
- Winter: Mid-May to Mid-August
- Spring: Mid-August to Mid – November.

The specific objectives are to record the following:

- The abundance and diversity of birds at the wind energy facility site and a suitable control site. The purpose of a control site is to make post-construction comparisons of potential displacement of birds at the wind energy facility site possible, by comparing pre- and post construction abundance at both sites.
- Flight patterns of priority species at the wind energy facility site.

Monitoring at the wind energy facility site is conducted in the following manner:

Three transects were identified totaling 20.95 km which covers the majority of the proposed turbine area (see Figure 3). This is referred in the report as the "survey area" and consist of a 1km buffer around each transect. Data is captured in the following manner:

- Two observers travelling slowly in a vehicle record all priority species along the transects. Each transect is travelled four times per season.
- In addition, point counts are conducted every 500m, where all birds are recorded for a 5 minute period.
- The following variables are recorded:
  - Species;
  - Number of birds;
  - Date;
  - Start time and end time;
  - Distance from transect or point (0-50 m, 50-100 m, >100 m);
  - Wind direction;
  - Wind strength (calm; moderate; strong);
  - Weather (sunny; cloudy; partly cloudy; rain; mist);
  - Temperature (cold; mild; warm; hot);
  - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground); and

- Co-ordinates (priority species only).

- Five vantage points were selected from which the majority of the proposed turbine area can be observed (the "VP area"), to record the flight altitude and patterns of priority species (see Figure 3). A total of 18 hours of observations per vantage point per season is being conducted. The following variables are recorded:

  - Species;
  - Number of birds;
  - Date;
  - Start time and end time;
  - Wind direction;
  - Wind strength (calm; moderate; strong);
  - Weather (sunny; cloudy; partly cloudy; rain; mist);
  - Temperature (cold; mild; warm; hot);
  - Flight altitude (high i.e app. >150m; medium i.e. app. 50-150 m; low i.e. app. <50 m);
  - Flight mode (soar; flap; glide ; kite; hover); and
  - Flight duration (in 15 second-intervals).

Focal point monitoring is also conducted at a major wetland, and for potential nests of priority species. Incidental sightings are also recorded.


**Figure 3: The transects (green lines), VP points (yellow circles) and focal points in the study area.**

The following information sources were also consulted for this report, as **supplementary** sources of data:

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al,* 1997) obtained from the Animal Demography Unit of the University of Cape Town, as a means to ascertain which species occur within the study area. A data set was obtained for the QDGC (quarter degree grid cell) within which the development will take place, namely 3424BA. A QDGC corresponds to the area shown on a 1:50 000 map (15' x 15') and is approximately 27 km long (north-south) and 23 km wide (east-west).
- The SABAP data were supplemented with SABAP2 data for the relevant QDGC. These data are much more recent, as SABAP2 was only launched in May 2007, and should therefore be more representative. For SABAP, QDGCs were the geographical sampling units. For SABAP2 the sampling unit has been reduced to pentad grid cells (or pentads); these cover 5 minutes of latitude

by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. This finer scale has been selected for SABAP2 to obtain more detailed information on the occurrence of species and to give a clearer and better understanding of bird distributions. There are nine pentads in a QDGC.

- Additional information on large terrestrial avifauna and habitat use that was collected for the Coordinated Avifaunal Roadcounts (CAR) project of the Animal Demography Unit (ADU) of the University of Cape Town (Young 2003), was obtained from the St. Francis Bay Bird Club.
- The conservation status of all bird species occurring in the aforementioned QDGC was determined with the use of the *Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland* (Barnes 2000).
- A classification of the vegetation types in the QDGC from an avifaunal perspective was obtained from SABAP1 and the Vegetation map of South Africa, Lesotho and Swaziland (SANBI 2006).
- Detailed satellite imagery from Google Earth was used in order to view the study area on a landscape level and to help identify bird habitat on the ground.
- Information on the micro habitat level was obtained through a two-day site visit in April 2011, before the monitoring commenced. An attempt was made to investigate the total study area as far as was practically possible, and to visit potentially sensitive areas identified from Google Earth imagery.
- Priority species were identified using the (draft) BLSA draft species list for the Avian Wind Farm Sensitivity Map for South Africa (Retief *et al* 2011).
- Personal observations by the author, who is familiar with the variety of birdlife and bird habitats due to his involvement in other wind farm developments in the Jeffreys Bay and Humansdorp area.

## 1.4 Assumptions

This study made the basic assumption that the sources of information used are reliable. However, it must be noted that there are certain limitations:

- At present (August 2011), one replicate of transect monitoring data have been completed, and a total of 60 hours of VP observations. It was planned to analyse one complete season of monitoring data (25%) for this report, but heavy rains prevented the completion of the winter monitoring in time for this report. In any event, the results presented in this report should be seen as preliminary. The final analysis will be conducted at the end of the 12-month monitoring period.

- With certain classes of birds, particularly cranes and bustards, very little research has been conducted on potential impacts with wind facilities worldwide. The precautionary principle was therefore applied throughout. The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle. The principle was implemented in an international treaty as early as the 1987 Montreal Protocol and, among other international treaties and declarations, is reflected in the 1992 Rio Declaration on Environment and Development. Principle 15 of the 1992 Rio Declaration states that: "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation."

- No comprehensive studies, and published, peer-reviewed scientific papers, are available on the impacts wind farms have on birds in South Africa. It is therefore inevitable that, because of the lack of any research on this topic in South Africa, an element of speculation will enter the conclusions in this report.

## 2. DESCRIPTION OF THE AFFECTED ENVIRONMENT

### 2.1 Vegetation types and bird habitats

Vegetation structure is more critical in determining bird habitat than actual plant composition (Harrison *et.al.* 1997). Therefore, the description of vegetation presented in this study concentrates on factors relevant to birds, and does not give an exhaustive list of plant species which occur in the study area.

The proposed development site is situated within the Fynbos Biome (Harrison *et.al.* 1997). The dominant natural vegetation in the study area is classified as Tsitsikamma Sandstone Fynbos (SANBI 2006). The Fynbos Biome is characterised by a high diversity of plant species composition and a high level of endemism. This diversity is not paralleled in its avifaunal composition, and fynbos is regarded as relatively poor in avifaunal diversity compared to other southern African biomes. However, whilst some of the distribution and abundance of the bird species in the study area is related to the occurrence of natural fynbos, it is more important to examine the micro-habitats available to birds, most of which are the result of human-induced transformation. The study area has been extensively transformed by agricultural activity, mostly by the cultivation of pastures for dairy farming. Little natural vegetation remains, and some remaining areas are degraded.

The following bird habitat classes were recorded within the survey area during the monitoring (see Appendix A for examples):

- Grassland: Open areas covered predominantly by grassland up to about 30m in height with very little scrub (2-3%), which is located on what is presumably old agricultural fields;
- Wetlands: Includes both man-made dams and natural seasonal wetlands which, when dry, consist of short grassland (< 30cm – to be confirmed by future monitoring);
- Scrub: Mostly natural (often degraded) fynbos of various densities up to one metre in height, some of which is situated on what are presumably old agricultural fields, but also against slopes which is unsuitable for cultivation.
- Agriculture: This consists mostly of dry-land pastures resembling very short grassland (up to 10cm in height) and irrigated pivots. A few lands with planted crops (maize) are also present, as well as a few stands of exotic trees.

See Figure 4 below for a habitat map of the study area, based on the habitat classes defined above.

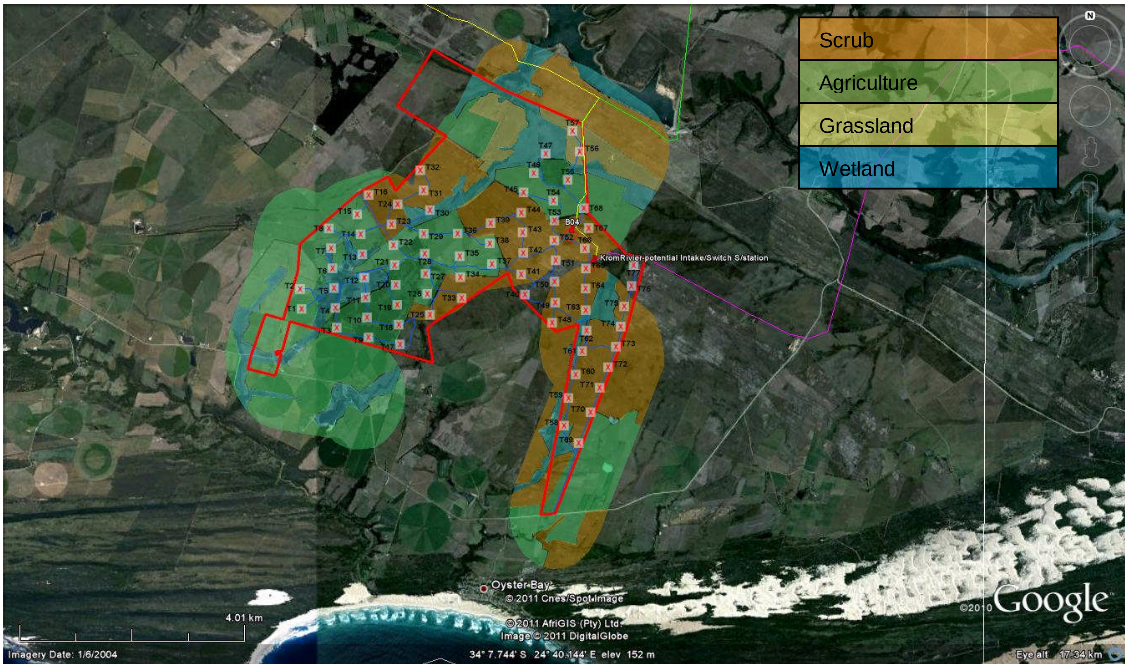


**Figure 4: Habitat recorded in the survey area (a 1km buffer zone around the survey transects).**

## 2.2 Avifauna in the study area

Within the survey area (see Figure 4 above) approximately 17% of the habitat is classified as wetland, 22% as agriculture, 35% as scrub and 4% as grassland.

The priority bird species that have been recorded on the site to date (transect counts and VP observations) are listed in Table 1 below. The non-priority species (transect counts) are listed in Table 2 below.

**Table 1: Priority bird species recorded during 1 replicate of winter transect surveys (20.95km) and 60 hours of vantage point (VP) observations**

| Priority Species | Birds per kilometre |
|---|---|
| Black-winged Lapwing | 0.76 |
| Denham's Bustard | 1.05 |
| Jackal Buzzard | 0.29 |
| Temminck's Courser | 0.29 |
| African Marsh-Harrier | Recorded at VPs only |
| White-bellied Korhaan | Recorded at VPs only |
| African Fish-Eagle | Recorded at VPs only |
| Blue Crane | Recorded at VPs only |
| Jackal Buzzard | Recorded at VPs only |
| Lanner Falcon | Recorded at VPs only |

## 3. IDENTIFICATION OF KEY IMPACTS PERTAINING TO AVIFAUNA

The effects of a wind farm on birds are highly variable and depend on a wide range of factors including the specification of the development, the topography of the surrounding land, the habitats affected and the number and species of birds present. With so many variables involved, the impacts of each wind farm must be assessed individually. Each of these potential effects can interact, either increasing the overall impact on birds or, in some cases, reducing a particular impact (for example where habitat loss causes a reduction in birds using an area which might then reduce the risk of collision). The principal areas of concern are:

- Mortality due to collision with the wind turbines;
- Displacement due to disturbance;
- Habitat loss due to the footprint of the wind farm; and
- Mortalities from collisions with the associated power lines

Internationally, it is widely accepted that bird mortalities from collisions with wind turbines contribute a relatively small proportion of the total mortality from all causes. The US National Wind Coordinating Committee (NWCC) conducted a comparison of wind farm bird mortality with that caused by other man-made structures in the USA (Anon. (b) 2000). The NWCC did not conduct its own study, but analyzed all of the research done to date on various causes of avian mortality, including commercial wind farm turbines. It reports that "data collected outside California indicate an average of 1.83 avian fatalities per turbine (for all species combined), and 0.006 raptor fatalities per turbine per year. Based on current projections of 3,500 operational wind turbines in the US by the end of 2001, excluding California, the total annual mortality was estimated at approximately 6,400 bird fatalities per year for all species combined". The NWCC report states that its intent is to "put avian mortality associated with windpower development into perspective with other significant sources of avian collision mortality across the United States". It further reports that: "Based on current estimates, windplant related avian collision fatalities probably represent from 0.01% to 0.02% (i.e. 1 out of every 5,000 to 10,000) of the annual avian collision fatalities in the United States". That is, commercial wind turbines cause the direct deaths of only 0.01% to 0.02% of all of the birds killed by collisions with man-made structures and activities in the USA.

Also in the USA, a Western EcoSystems Technology Inc. study found a range of between 100 million to 1 billion bird fatalities due to collisions with artificial structures such as vehicles, buildings and windows, power lines and communication towers, in comparison to 33,000 fatalities attributed to wind turbines. The study (see Anon. (a) 2003) reports that "windplant-related avian collision fatalities probably represent from 0.01% to 0.02% (i.e. one out of every 5,000 to 10,000 avian fatalities) of the annual avian collision fatalities in the United States, while some may perceive this level of mortality as small, all efforts to reduce avian mortality are important". A Finnish study reported 10 bird fatalities from turbines, and 820,000 birds killed annually from colliding with other structures such as buildings, electricity pylons and lines, telephone and television masts, lighthouses and floodlights (Anon. (a) 2003).

### 3.1 Collisions with the turbines

The majority of studies on collisions caused by wind turbines have recorded relatively low mortality levels (Madders & Whitfield 2006). This is perhaps largely a reflection of the fact that many of the studied wind farms are located away from large concentrations of birds. It is also important to note that many records are based only on finding corpses, with no correction for corpses that are overlooked or removed by scavengers (Drewitt & Langston, 2006).

Relatively high collision mortality rates have been recorded at several large, poorly-sited wind farms in areas where large concentrations of birds are present (including Important Bird Areas (IBAs)), especially among migrating birds, large raptors or other large soaring species, e.g. in the Altamont Pass in California, USA, and in Tarifa and Navarra in Spain. In these cases actual deaths resulting from collision are high, notably of Golden Eagle *Aquila chrysaetos* and Eurasian Griffon *Gyps fulvus*, respectively.

In a study in Spain, it was found that the distribution of collisions with wind turbines was clearly associated with the frequencies at which soaring birds flew close to rotating blades (Barrios & Rodriguez 2004). Patterns of risky flights and mortality included a temporal component (deaths concentrated in some seasons), a spatial component (deaths aggregated in space), a taxonomic component (a few species suffered most losses), and a migration component (resident populations were more vulnerable). Clearly, the risk is likely to be greater on or near areas regularly used by large numbers of feeding or roosting birds, or on migratory flyways or local flight paths, especially where these are intercepted by the turbines. Risk also changes with weather conditions, with evidence from some studies showing that more birds collide with structures when visibility is poor due to fog or rain, although this effect may to some extent be offset by lower levels of flight activity in such conditions (Madders & Whitfield 2005). Strong headwinds also affect collision rates and migrating birds in particular tend to fly lower when flying into the wind (Drewitt & Langston 2006). The same applies for Blue Cranes flying between roosting and foraging areas (pers. obs.).

Accepting that many wind farms may only cause low levels of mortality, even these levels of additional mortality may be significant for long-lived species with low productivity and slow maturation rates (e.g. Blue Crane, Denham’s Bustard, Black Harrier and Secretarybird), especially when rarer species of conservation concern are affected. In such cases there could be significant effects at the population level (locally, regionally or, in the case of rare and restricted species, nationally), particularly in situations where cumulative mortality takes place as a result of multiple installations (Carette *et. al.* 2009).

Large birds with poor manoeuvrability (such as cranes, korhaans, bustards and Secretarybirds) are generally at greater risk of collision with structures, and species that habitually fly at dawn and dusk or at night are perhaps less likely to detect and avoid turbines (e.g. cranes arriving at a roost site after sunset, or flamingos flying at night). Collision risk may also vary for a particular species, depending on age, behaviour and stage of annual cycle (Drewitt & Langston 2006). While the flight characteristics of cranes, flamingos and bustards make them obvious candidates for collisions with power lines, it is noted that these classes of birds (unlike raptors) do not feature prominently in literature as wind turbine collision victims. It may be that they avoid wind farms entirely, resulting in lower collision risks. However, this can only be verified through on-site post-construction monitoring.

The precise location of a wind farm site can be critical. Soaring species may use particular topographic features for lift (Barrios & Rodriguez 2004; De Lucas *et. al.* 2008) or such features can result in large numbers of birds being funnelled through an area of turbines (Drewitt & Langston 2006). For example, absence of thermals on cold, overcast days may force larger, soaring species (e.g. White Stork and Secretarybird) to use slopes for lift, which may increase their exposure to turbines. Birds also lower their flight height in some locations, for example when following the coastline or crossing a ridge, which might place them at greater risk of collision with rotors.

The size and alignment of turbines and rotor speed are likely to influence collision risk; however, physical structure is probably only significant in combination with other factors, especially wind speed, with moderate winds resulting in the highest risk (Barrios & Rodriguez 2004; Stewart *et. al.* 2007). Lattice towers are generally regarded as more dangerous than tubular towers because many raptors use them for perching and occasionally for nesting; however Barrios & Rodriguez (2004) found tower structure to have no effect on mortality, and that mortality may be directly related to abundance for certain species (e.g. Common Kestrel *Falco tinnunculus*). De Lucas *et. al.* (2008) found that turbine height and higher elevations may heighten the risk (taller/higher = higher risk), but that abundance was not directly related to collision risk, at least for Eurasian Griffon Vulture *Gyps fulvus*.

A review of available literature indicates that, where collisions have been recorded, the rates per turbine are highly variable with averages ranging from 0.01 to 23 bird collisions annually (the highest figure is the value, following correction for scavenger removal, for a coastal site in Belgium and relates to gulls, terns and ducks among other species) (Drewitt & Langston 2006). Although providing a helpful and standardised indication of collision rates, average rates per turbine must be viewed with some caution as they are often cited without variance and can mask significantly higher (or lower) rates for individual turbines or groups of turbines (Everaert *et. al.* 2001 as cited by Drewitt & Langston 2006).

Some of the highest mortality levels have been for raptors in the Altamont Pass in California (Howell & DiDonato 1991, Orloff & Flannery 1992 as cited by Drewitt & Langston 2006) and at Tarifa and Navarre in Spain (Barrios & Rodriguez unpublished data as cited by Drewitt & Langston 2006). These cases are of particular concern because they affect relatively rare and long-lived species such as Griffon Vulture *Gyps fulvus* and Golden Eagle *Aquila chrysaetos* that have low reproductive rates and are vulnerable to additive mortality. Golden Eagles congregate in Altamont Pass to feed on super-abundant prey which supports very high densities of breeding birds. In the Spanish cases, extensive wind farms were built in topographical bottlenecks where large numbers of migrating and local birds fly through a relatively confined area due to the nature of the surrounding landscape, for example through mountain passes, or use rising winds to gain lift over ridges (Barrios & Rodriguez 2004). Although the average numbers of annual fatalities per turbine (ranging from 0.02 to 0.15 collisions/turbine) were generally low in the Altamont Pass and at Tarifa, overall collision rates were high because of the large numbers of turbines involved (over 7 000 in the case of Altamont). At Navarre, corrected annual estimates ranging from 3.6 to 64.3 mortalities/turbine were obtained for birds and bats (unpublished data). Thus, a minimum of 75 Golden Eagles are killed annually in Altamont and over 400 Griffon Vultures are estimated (following the application of correction factors) to have collided with turbines at Navarre. Work on Golden Eagles in the Altamont Pass indicated that the population was declining in this area thought to be due, at least in part, to collision mortality (Hunt *et. al.* 1999, Hunt 2001 as cited by Drewitt & Langston 2006).

### 3.2 Displacement due to disturbance

The displacement of birds from areas within and surrounding wind farms due to visual intrusion and disturbance effectively can amount to habitat loss. Displacement may occur during both the construction and operational phases of wind farms, and may be caused by the presence of the turbines themselves through visual, noise and vibration impacts, or as a result of vehicle and personnel movements related to site maintenance. The scale and degree of disturbance will vary according to site- and species-specific factors and must be assessed on a site-by-site basis (Drewitt & Langston 2006).

Unfortunately, few studies of displacement due to disturbance are conclusive, often because of the lack of before-and-after and control-impact (BACI) assessments.

Onshore, disturbance distances (in other words the distance from wind farms up to which birds are absent or less abundant than expected) up to 800 m (including zero) have been recorded for wintering waterfowl (Pedersen & Poulsen 1991 as cited by Drewitt & Langston 2006), though 600 m is widely accepted as the maximum reliably recorded distance (Drewitt & Langston 2006). The variability of displacement distances is illustrated by one study which found lower post-construction densities of feeding European White-fronted Geese *Anser albifrons* within 600 m of the turbines at a wind farm in Rheiderland, Germany (Kruckenberg & Jaene 1999 as cited by Drewitt & Langston 2006), while another showed displacement of Pink-footed Geese *Anser brachyrhynchus* up to only 100–200 m from turbines at a wind farm in Denmark (Larsen & Madsen 2000 as cited by Drewitt & Langston 2006). Indications are that Great Bustard *Otis tarda* (a species related to the Denham's Bustard) are displaced by wind farms within one kilometre of the facility (Langgemach 2008).

Studies of breeding birds are also largely inconclusive or suggest lower disturbance distances, though this apparent lack of effect may be due to the high site fidelity and long life-span of the breeding species studied. This might mean that the true impacts of disturbance on breeding birds will only be evident in the longer term, when new recruits replace existing breeding birds. Few studies have considered the possibility of displacement for short-lived passerines (such as larks), although Leddy *et al* (1999) found increased densities of breeding grassland passerines with increased distance from wind turbines, and higher densities in the reference area than within 80 m of the turbines, indicating that displacement did occur at least in this case. The consequences of displacement for breeding productivity and survival are crucial to whether or not there is likely to be a significant impact on population size. A recent comparative study of nine wind farms in Scotland (Pearce-Higgens *et al* 2009) found unequivocal evidence of displacement: Seven of the 12 species studied exhibited significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with equivocal evidence of turbine avoidance in a further two. No species were more likely to occur close to the turbines. Levels of turbine avoidance suggest breeding bird densities may be reduced within a 500-m buffer of the turbines by 15–53%, with Common Buzzard *Buteo buteo*, Hen Harrier *Circus cyaneus*, Golden Plover *Pluvialis apricaria*, Snipe *Gallinago gallinago*, Curlew *Numenius arquata* and Wheatear *Oenanthe oenanthe* most affected.

Studies show that the scale of disturbance caused by wind farms varies greatly. This variation is likely to depend on a wide range of factors including seasonal and diurnal patterns of use by birds, location with respect to important habitats, availability of alternative habitats and perhaps also turbine and wind farm specifications. Behavioural responses vary not only between different species, but between individuals of the same species, depending on such factors as stage of life cycle (wintering, moulting, breeding), flock size and degree of habituation. The possibility that wintering birds in particular might habituate to the presence of turbines has been raised (Langston & Pullin 2003), though it is acknowledged that there is little evidence and few studies of long enough duration to show this, and at least one study has found that habituation may not happen (Altamont Pass Avian Monitoring Team 2008). A systematic review of the effects of wind turbines on bird abundance has shown that increasing time since operations commenced resulted in greater declines in bird abundance (Stewart *et al*. 2004 as cited by Drewitt & Langston 2006). This evidence that impacts are likely to persist or worsen with time suggests that habituation is unlikely, at least in some cases (Drewitt & Langston 2006, Altamont Pass Avian Monitoring Team 2008).

The effect of birds altering their migration flyways or local flight paths to avoid a wind farm is also a form of displacement. This effect is of concern because of the possibility of increased energy expenditure when birds have to fly further, as a result of avoiding a large array of turbines, and the potential disruption of linkages between distant feeding, roosting, moulting and breeding areas otherwise unaffected by the wind farm. The effect depends on species, type of bird movement, flight height, distance to turbines, the layout and operational status of turbines, time of day and wind force and direction, and can be highly variable, ranging from a slight 'check' in flight direction, height or speed, through to significant diversions which may reduce the numbers of birds using areas beyond the wind farm (Drewitt & Langston 2006).

A review of the literature suggests that none of the barrier effects identified so far have significant impacts on populations (Drewitt & Langston 2006). However, there are circumstances where the barrier effect might lead indirectly to population level impacts; for example where a wind farm effectively blocks a regularly used flight line between nesting and foraging areas, or where several wind farms interact cumulatively to create an extensive barrier which could lead to diversions of many tens of kilometres, thereby incurring increased energy costs.

### 3.3 Habitat change and loss

The scale of direct habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, generally speaking, is likely to be small per turbine base. Typically, actual habitat loss amounts to 2–5% of the total development area (Fox *et al*. 2006 as cited by Drewitt & Langston 2006), though effects could be more widespread where developments interfere with hydrological patterns or flows on wetland or peatland sites (unpublished data). Some changes could also be beneficial. For example, habitat changes following the development of the Altamont Pass wind farm in California led to increased mammal prey availability for some species of raptor (for example through greater availability of burrows for Pocket Gophers *Thomomys bottae* around turbine bases), though this may also have increased collision risk (Thelander *et al.* 2003 as cited by Drewitt & Langston 2006).

### 3.4 Management actions

Mitigation measures fall into two broad categories: best-practice measures which could be adopted by any wind farm development and should be adopted as an industry standard, and additional measures which are aimed at reducing an impact specific to a particular development (Drewitt & Langston 2006).

Examples of **generic** best practice measures are (Drewitt & Langston 2006):

- Ensuring that key areas of conservation importance and sensitivity are avoided;
- Implementing appropriate working practices to protect sensitive habitats;
- Providing adequate briefing for site personnel and, in particularly sensitive locations, employing an on-site ecologist during construction;
- Implementing an agreed post-development monitoring programme;
- Siting turbines close together to minimise the development footprint (subject to technical constraints such as the need for greater separation between larger turbines);
- Grouping turbines to avoid alignment perpendicular to main flight paths and to provide corridors between clusters, aligned with main flight trajectories, within large wind farms;
- Increasing the visibility of rotor blades – research indicates that high contrast patterns might help reduce collision risk, although this may not always be acceptable on landscape grounds. Another suggested, but untested possibility is to paint blades with UV paint, which may enhance their visibility to birds;
- Where possible, installing transmission cables underground (subject to habitat sensitivities and in accordance with existing best practice guidelines for underground cable installation);
- Marking overhead cables using deflectors and avoiding construction over areas of high bird concentrations, especially for species vulnerable to collision;
- Timing construction to avoid sensitive periods; and
- Implementing habitat enhancement for species using the site.

With respect to more site-specific mitigation, it may be necessary to prepare a site management plan designed to reduce or prevent harmful habitat changes following construction, and to provide habitat enhancement as appropriate. Other measures which may be suitable in some circumstances include the relocation of proposed or actual turbines responsible for particular problems, halting operation during peak migration periods, or reducing rotor speed. Again, post-construction monitoring is essential in order to test the effectiveness of such mitigation measures and research is needed to provide more information on specific impacts and novel mitigation measures that might reduce impacts.

Unfortunately, the record of mitigation management in the wind industry is not particularly encouraging. Despite the fact that wind power has been a feature of the energy industry in the developed world for more than a decade, best practices with regard to bird mitigation are still far from clear and universally accepted. In the USA, for example, best practices are sorely lacking (Smallwood 2008). Mitigation measures would be more effective if based on scientifically founded conclusions of factors affecting bird collisions with wind turbines. It is essential to perform scientifically rigorous pre- and post-construction monitoring of bird fatalities and flight behaviour in wind farms, as well as ecological investigations. These types of investigations have not been performed at most wind farms in the USA so the scientific basis for mitigation measures remains weak (Smallwood 2008). Avoidance and minimisation measures will be the most effective mitigation at wind farms, but these have yet to be implemented at USA wind farms. Adaptive management is often promised in environmental review documents, but in practice it seldom happens. Off-site compensation may be the only substantial means of mitigating impacts following wind farm development. A scientifically defensible nexus between project impacts and mitigation benefits still needs to be established for compensation ratios directed toward wind farms (Smallwood 2008).

It must be accepted that appropriate best practices and mitigation measures with regard to impacts on birds in a South African context will take a number of years to crystallise, and a measure of trial and error will inevitably be part of the process.

# 4 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

## 4.1 Mortalities from collisions with wind turbines

A total of 60 hours of vantage point observations has been completed to date in order to record flight patterns and altitudes of priority species. For purposes of the analysis, it was assumed that all flights of priority species within a 2 km radius of a vantage point were recorded during the observation periods. For purposes of this report, the combined area taken up by the five vantage points is termed "the VP area".

During the observation period, priority species were recorded flying over the VP area for a total of 1 hour 44 minutes and 15 seconds. A total of 65 individual flights (single birds and flocks) were recorded, involving 102 individual birds. Of these, 35 flights were at low altitude (below rotor height), 19 were at medium altitude (i.e. approximately within rotor height) and 10 were at high altitude (above rotor height). The passage rate for priority species over the VP area (all heights) was 1.71 birds/hour. For medium altitude flights only, the passage rate was 0.3 birds/hour. Figure 5 below provides a breakdown of the priority species at medium height recorded during the vantage point observations to date.

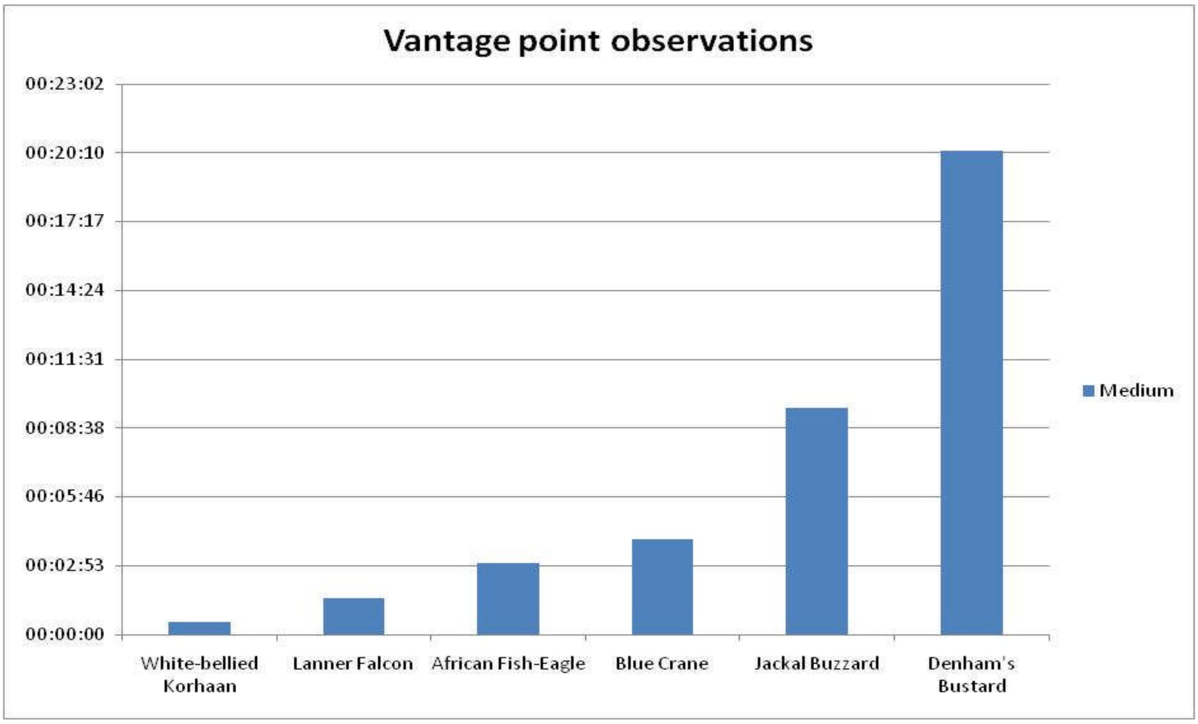


**Figure 5: Breakdown of priority species vantage point observations (medium height flights only) for the winter observations to date (60 hours). Time is hours: minutes: seconds.**

An indication of the influence of wind direction on the flight patterns of the priority species during the observation period is provided in Figure 6.

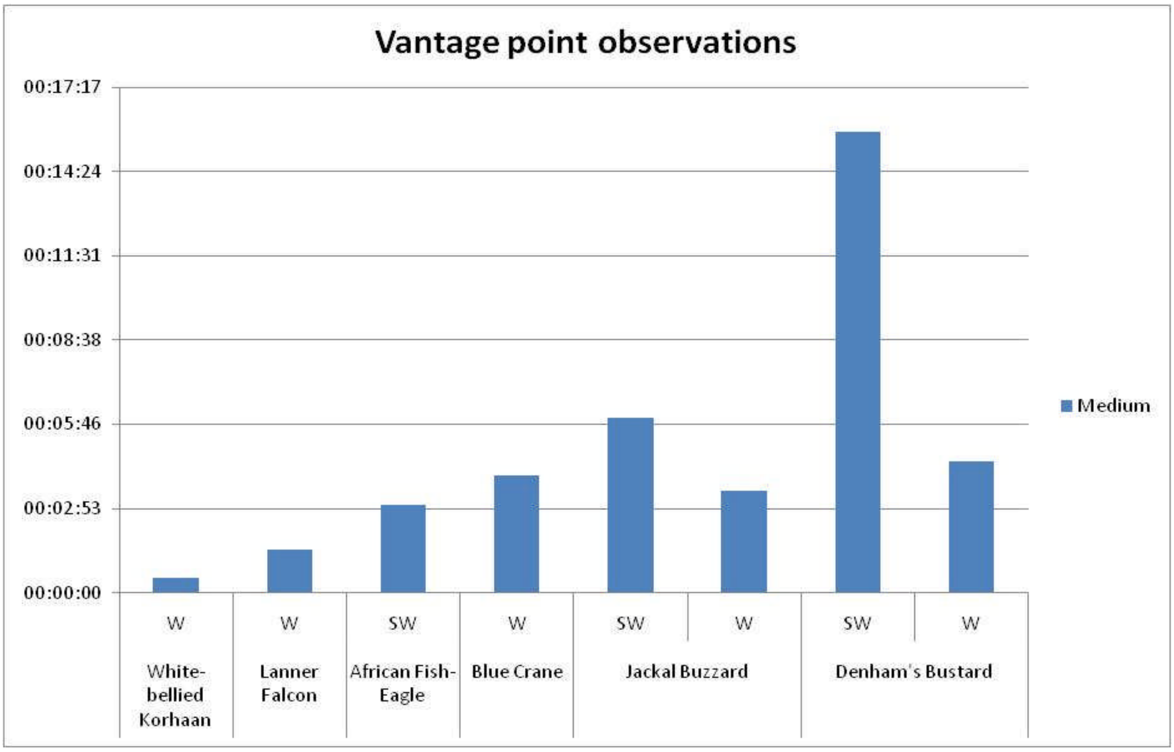


**Figure 6: Duration of medium flight heights of priority species in various wind directions during 60 hours of observations in winter.**

An indication of the influence of wind strength on the flight patterns of the priority species during the winter observation period is provided in Figure 7.

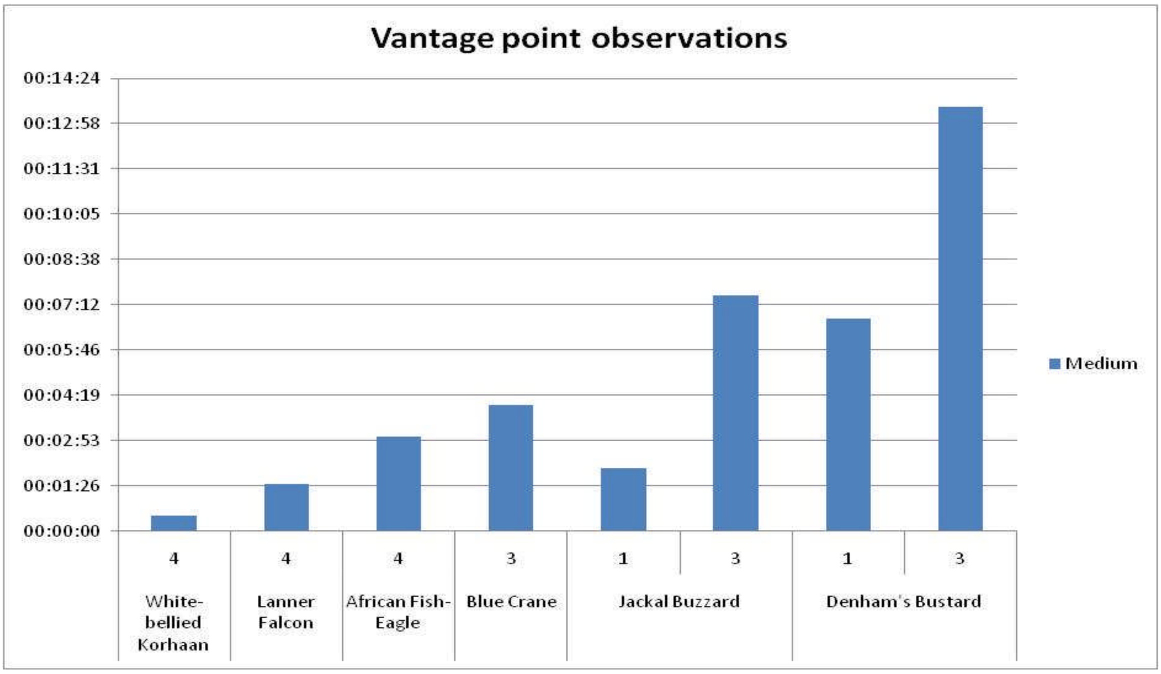


**Figure 7: Medium flight heights and duration of priority species in various wind strengths (1 = calm; 2 = light; 3 = moderate; 4 = strong) during 20 hours of winter observations.**

The flight data collected so far for priority species over the proposed turbine area for the **winter** period show that:

- Of the priority species, Denham's Bustard and Jackal Buzzard are most often recorded flying at medium height;
- Flights take place during all wind conditions, but most medium height flights were recorded during moderate winds ; and
- Most flights take place during south-westerly winds, followed by westerly winds.

Calculating an estimated collision rate (ECR) is a risky venture, because of the many assumptions that inevitably need to be made in order to arrive at a figure, due to the lack of actual data. In this instance, an ECR for priority species per turbine for winter was calculated in the following manner: The number of birds which could be flying at medium altitude in the VP area during the winter period (mid-May to mid-August) was estimated. This was done by multiplying the passage rate for medium altitude (0.3 birds/h) with the potential flying time available for that period, assuming that each day will have an average of 8 hours potential flying time. The following formula was used: (90 days x 8 hours) x 0.3 = 216 birds. The total surface area that is covered by the VP area comes to approximately 4852 hectares, and within this area, the total surface area covered by the turbine rotors footprint (taken as a 50 m radius around the centre column) amounts to approximately 60 hectares (.781ha x 77 turbines) i.e. about 1.2%, which means that 98.8% of the airspace in the VP area can be considered safe from a collision risk perspective. Based on this, it was conservatively assumed that at least 90% of all birds flying through the VP area at turbine height medium altitude would therefore be travelling through "safe" airspace, or conversely, it was assumed that no more than 21 birds (10%) would potentially collide with turbines, if they take no evasive action. This figure was then multiplied by 0.02, on the assumption that 98% of these birds will take evasive action to avoid the turbines (SNH 2010). This gives an ECR of 0.42 birds, or 0.005 birds per turbine for the winter season (= 77 turbines). This figure should be qualified in the following manner:

- It does not take into account variations in bird numbers from year to year, which is likely to be considerable, depending on rainfall;
- It does not take into account rainy weather conditions, when most birds, particularly soaring species, do not fly;
- It does not take into account the fact that all the turbines will not be operating for the full 8 hours every day;
- The figure includes flights of Denham's Bustard and Blue Crane which took place during calm conditions when the turbines will not be operating;
- It does not take into account that some species, e.g. Denham's Bustards, could be displaced from the area, therefore reducing the risk of collisions with the turbines;
- It does not take nocturnal species into account;
- It assumes that each turbine poses an equal risk of collision, which, based on actual observations (see Figure 8) may not be the case;
- The assumption that there is a linear relationship between air space taken up by rotors and the size of the collision risk may be too simplistic; and
- The figure is based on only 60 hours of observation in one season, which is not enough to make general assumptions (ultimately 360 hours of VP observations will be completed over 12 months).

Given the important qualifications above, it is imperative to approach this figure with caution, and see it at best as very rough indicator of collision risk.

In order to form a picture of the spatial distribution of priority species flights over the turbine area, a distribution map of flights was prepared. This was done by overlaying a 100 m x 100 m grid over the survey area. Each grid square was then given a weighting score taking into account the length of individual flight lines and the number of individual birds crossing the square (see Figure 8 for the map of medium altitude flights recorded during the winter observation period).

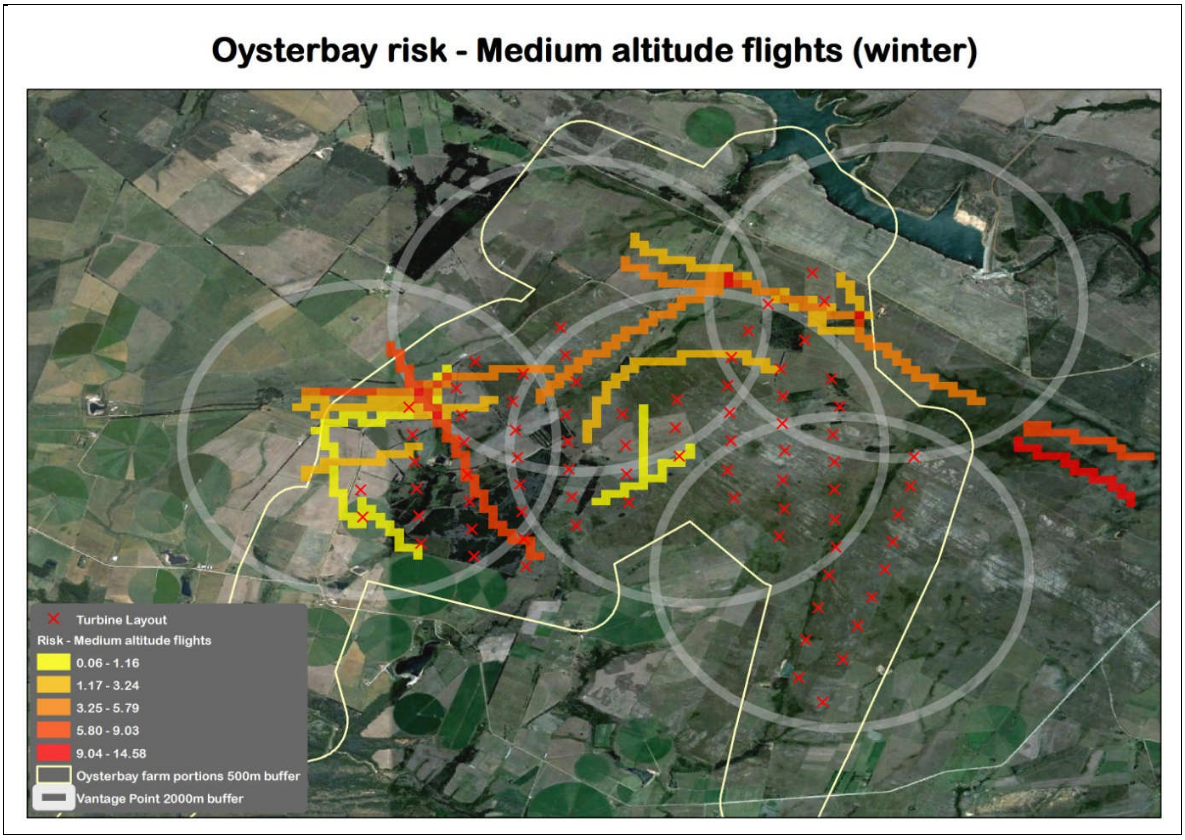


**Figure 8: Spatial distribution of recorded medium height flights (priority species) over the proposed turbine area (60 hours of observation)**

Due to the limited amount of monitoring that has been conducted to date, it would be risky to draw preliminary conclusions as far as priority species are concerned. At this stage of the investigations, the following management actions are recommended to reduce the risk of collisions by priority species:

- Pre-construction monitoring should continue for a 12-month period as planned, to establish an adequate baseline for comparative purposes.
- Once the turbines have been constructed, post-construction monitoring as per the latest version of *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al* 2011) should be implemented to compare actual collision rates with predicted collision rates. If actual collision rates indicate unsustainable mortality levels, the following mitigation measures will have to be considered:

- o Negotiating appropriate off-set compensation for turbine related collision mortality;
- o As a last resort, halting operation of specific turbines during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality

## 4.2 Displacement due to disturbance

The three transects were counted once during the winter season (4 counts were originally planned, but could not be performed due to heavy rain making the transects undriveable). A total of 56 species were recorded. Index of Kilometric Abundance (IKA = birds/km) was calculated for each species (see Table 2 below).

**Table 2: Species recorded during transect surveys (1 replicate)**

| **Priority Species** | **Total count** | **Length** | **IKA** |
|---|---|---|---|
| Black-winged Lapwing | 16.00 | 20.95 | 0.76 |
| Denham's Bustard | 22.00 | 20.95 | 1.05 |
| Jackal Buzzard | 6.00 | 20.95 | 0.29 |
| Temminck's Courser | 6.00 | 20.95 | 0.29 |
| | | | |
| **Non-Priority Species** | **Total count** | **Length** | **IKA** |
| African Hoopoe | 2.00 | 20.95 | 0.10 |
| African Pipit | 35.00 | 20.95 | 1.67 |
| African Quailfinch | 10.00 | 20.95 | 0.48 |
| African Sacred Ibis | 13.00 | 20.95 | 0.62 |
| African Stonechat | 30.00 | 20.95 | 1.43 |
| Black-collared Barbet | 1.00 | 20.95 | 0.05 |
| Black-headed Heron | 8.00 | 20.95 | 0.38 |
| Black-headed Oriole | 1.00 | 20.95 | 0.05 |
| Blacksmith Lapwing | 15.00 | 20.95 | 0.72 |
| Bokmakierie | 34.00 | 20.95 | 1.62 |
| Brimstone Canary | 5.00 | 20.95 | 0.24 |
| Brown-throated Martin | 7.00 | 20.95 | 0.33 |
| Cape Canary | 58.00 | 20.95 | 2.77 |
| Cape Crow | 18.00 | 20.95 | 0.86 |
| Cape Grassbird | 18.00 | 20.95 | 0.86 |
| Cape Longclaw | 31.00 | 20.95 | 1.48 |
| Cape Turtle-Dove | 13.00 | 20.95 | 0.62 |

| | | | |
|---|---|---|---|
| Cape Wagtail | 9.00 | 20.95 | 0.43 |
| Cape Weaver | 15.00 | 20.95 | 0.72 |
| Cattle Egret | 20.00 | 20.95 | 0.95 |
| Cloud Cisticola | 26.00 | 20.95 | 1.24 |
| Common Fiscal | 13.00 | 20.95 | 0.62 |
| Common Starling | 8.00 | 20.95 | 0.38 |
| Crowned Lapwing | 47.00 | 20.95 | 2.24 |
| Egyptian Goose | 21.00 | 20.95 | 1.00 |
| Fiscal Flycatcher | 3.00 | 20.95 | 0.14 |
| Fork-tailed Drongo | 8.00 | 20.95 | 0.38 |
| Greater Double-collared Sunbird | 1.00 | 20.95 | 0.05 |
| Grey-backed Cisticola | 13.00 | 20.95 | 0.62 |
| Hadeda Ibis | 29.00 | 20.95 | 1.38 |
| Karoo Prinia | 4.00 | 20.95 | 0.19 |
| Kelp Gull | 30.00 | 20.95 | 1.43 |
| Large-billed Lark | 1.00 | 20.95 | 0.05 |
| Little Rush-Warbler | 1.00 | 20.95 | 0.05 |
| Long-billed Pipit | 1.00 | 20.95 | 0.05 |
| Malachite Kingfisher | 2.00 | 20.95 | 0.10 |
| Malachite Sunbird | 12.00 | 20.95 | 0.57 |
| Neddicky | 4.00 | 20.95 | 0.19 |
| Orange-breasted Sunbird | 3.00 | 20.95 | 0.14 |
| Pied Starling | 17.00 | 20.95 | 0.81 |
| Plain-backed Pipit | 4.00 | 20.95 | 0.19 |
| Red-capped Lark | 14.00 | 20.95 | 0.67 |
| Red-eyed Dove | 21.00 | 20.95 | 1.00 |
| Reed Cormorant | 1.00 | 20.95 | 0.05 |
| Rufous-naped Lark | 6.00 | 20.95 | 0.29 |
| Sombre Greenbul | 1.00 | 20.95 | 0.05 |
| Southern Grey-headed Sparrow | 3.00 | 20.95 | 0.14 |
| Spotted Thick-knee | 1.00 | 20.95 | 0.05 |
| Spur-winged Goose | 20.00 | 20.95 | 0.95 |
| Yellow Bishop | 83.00 | 20.95 | 3.96 |
| Yellow-billed Duck | 2.00 | 20.95 | 0.10 |
| Zitting Cisticola | 3.00 | 20.95 | 0.14 |

The habitat in which birds were counted was also recorded, to get an indication of the relative importance of habitat classes from a bird usage perspective. An indication of habitat usage winter is given in Table 3 below. Within the survey area (defined as a 1km buffer around the transects – see Figure 3), approximately 17% of the habitat is classified as wetland, 22% as agriculture, 35% as scrub and 4% as grassland.

**Table 3: Habitat usage in the study area**

| Species | Agriculture | | Scrub | | Grassland | | Wetland | |
|---|---|---|---|---|---|---|---|---|
| | Total count | % | Total count | % | Total count | % | Total count | % |
| All spp (total) | 445 | 55.90% | 247 | 31.03% | 90 | 11.31% | 14 | 1.76% |
| Non-priority spp | 418 | 56.03% | 243 | 32.57% | 71 | 9.52% | 14 | 1.88% |
| Priority spp | 27 | 54.00% | 4 | 8.00% | 19 | 38.00% | 0 | 0.00% |
| | | | | | | | | |
| **Priority spp** | | | | | | | | |
| Black-winged Lapwing | 16 | 100.00% | 0 | 0.00% | 0 | 0.00% | 0 | 0.00% |
| Denham's Bustard | 4 | 18.18% | 4 | 18.18% | 14 | 63.64% | 0 | 0.00% |
| Jackal Buzzard | 4 | 66.67% | 0 | 0.00% | 2 | 33.33% | 0 | 0.00% |
| Temminck's Courser | 3 | 50.00% | 0 | 0.00% | 3 | 50.00% | 0 | 0.00% |

Judging from the results of the transect surveys completed to date, the following preliminary conclusions can be drawn:

- The survey area is particularly well suited for Denham’s Bustard and White-winged Lapwing;
- So far agriculture and grassland are emerging as important habitat for priority species – it accounted for 92% of priority species records to date, although it only makes up approximately 26% of the habitat surveyed;
- Interestingly, no White-bellied Korhaans were recorded on the transect counts. However, this is almost certainly set to change as the monitoring progresses, as the species was recorded during VP observations, and also by the author during previous site visits in the southern transect area.

At this stage, it can only be speculated about the impact of potential displacement on terrestrial birds in the study area, particularly Denham’s Bustard, White-bellied Korhaan, Blue Crane and White-winged Lapwing as this will only become apparent once the post-construction monitoring commences. If the birds are displaced, this potentially could be the most significant impact of the wind farm on birds. Very little published literature is available on the impact of wind farms on bustards, but the little that is available seems to indicate that displacement is likely (Langgemach 2008). The usual response of Denham's Bustards during the surveys is to flush in response to pedestrian and vehicle traffic. The potential for habituation is always there, but due to lack of research results, no unequivocal predictions can be made. As far as raptors are concerned, the chances of displacement are low, based on research results elsewhere (Madders and Whitfield 2008). This trend also seems to be supported by the results of the limited post-construction monitoring conducted at the existing four turbines at the Darling Wind Farm (Van Rooyen 2011). Blue Cranes might also be more tolerant, based on general observations in the study area where Blue Cranes breed and forage in close proximity to agricultural operations.

The following management actions are proposed to minimise the impact of displacement on birds:

- The pre-construction monitoring programme must continue as planned to provide baseline information for comparative purposes;
- Post-construction monitoring should be implemented to assess the impact of displacement, particularly on priority species. Initially, a 12-month period of post-construction monitoring should be implemented, using the same protocol as is currently implemented. Thereafter, the need for further monitoring will be informed by the results of the initial 12-month period;
- Should the results of the post-construction monitoring indicate significant displacement of priority species, appropriate off-set compensation should be negotiated with the developer to compensate for the loss of priority species habitat; and
- During the construction period, activity should be restricted to the construction footprint itself. Access to the rest of the properties must be strictly controlled to prevent unnecessary disturbance of birds.

## 4.3 Habitat change and loss

The scale of direct habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, generally speaking, is likely to be small per turbine base. Typically, actual habitat loss amounts to 2–5% of the total development area (Fox *et al*. 2006 as cited by Drewitt & Langston 2006). Direct habitat loss is not regarded as a major impact on avifauna compared to the potential impact of collisions with the turbines and, in particular, potential displacement due to disturbance.

The infrastructure footprint must be restricted to the minimum in accordance with the recommendations of the ecological specialist study.

### 4.4 Electricity transmission lines

The proposed 132kV power line that will link the wind facility to the grid could pose a collision risk, irrespective of which of the proposed alignments is used.

Because of their size and prominence, electrical infrastructures constitute an important interface between wildlife and man. Negative interactions between wildlife and electricity structures take many forms, but two common problems in southern Africa are electrocution of birds (and other animals) and birds colliding with power lines (Ledger & Annegarn 1981; Ledger 1983; Ledger 1984; Hobbs & Ledger 1986a; Hobbs & Ledger 1986b; Ledger *et.al.* 1992; Verdoorn 1996; Kruger & Van Rooyen 1998; Van Rooyen 1998; Kruger 1999; Van Rooyen 1999; Van Rooyen 2000). Electrocutions are not envisaged to be a problem on the proposed overhead power line network. Collisions, on the other hand, could be a major potential problem.

Collisions kill far more birds annually in southern Africa than electrocutions (Van Rooyen 2007). Most heavily impacted upon are bustards, storks, cranes and various species of water birds. These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with power lines (van Rooyen 2004, Anderson 2001). Unfortunately, many of the collision sensitive species are considered threatened in southern Africa - of the 2369 avian mortalities on distribution lines recorded by the EWT since August 1996, 1512 (63.8%) were Red Data species (Van Rooyen 2007).

Power line collisions have long been recorded as a major source of avian mortality (Van Rooyen 2007). In the Overberg region of the Western Cape, which has a comparable suite of power line sensitive species to the study area, most numerous amongst power line collision victims are Blue Crane and Denham's Bustard (Shaw 2009), both of which occur in large numbers in the area where the proposed power line is situated. It has been estimated that as many as 10% of the Blue Crane population in the Overberg are killed annually on power lines, and figure for Denham's Bustard might be as high as 30% of the Overberg population (Shaw 2009), although this figure requires further verification. These figures are extremely concerning, as it represents a possible unsustainable source of unnatural mortality. Data gathered by the St Francis Bay Bird Club between 1999 and 2010 for the CAR project on Route EH03 indicates healthy populations of Blue Crane and Denham's Bustard in the study area (see Table 4 and Figure 9 below).

**Table 4: CAR counts on route EH03 (St Francis Bay Bird Club 2011)**

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Blue Crane** | | | | | | | | | | | | | |
| Summer | 0 | 0 | 2 | 5 | 0 | 12 | 2 | 2 | 5 | 2 | 2 | 6 | 38 |
| Winter | 0 | 0 | 11 | 0 | 48 | 2 | 116 | 230 | 8 | 12 | 8 | 4 | 439 |
| **Denham's Bustard** | | | | | | | | | | | | | |
| Summer | 14 | 0 | 3 | 0 | 2 | 2 | 6 | 1 | 28 | 38 | 12 | 16 | 122 |
| Winter | 4 | 29 | 16 | 18 | 16 | 15 | 13 | 9 | 34 | 17 | 16 | 59 | 246 |


**Figure 8: Location of CAR route EH03 (blue line)**

Unfortunately, the dynamics of the collision problem is poorly understood. In the most recent study on this problem in the Overberg, Shaw (2009) identified cultivated land and region as the significant factors influencing power line collision risk for Blue Cranes. Lines that cross cultivated land pose a higher risk, as expected, as this is the preferred habitat of Blue Cranes in the Overberg. Interestingly, she also found that collision rates in the Bredasdorp region are much higher than those around Caledon, which might be a function of the higher proportion of flocks, and a greater number of large flocks (50+ birds) in Bredasdorp, as opposed to Caledon in the winter. Collision rates are higher for birds in flocks, as they may panic, or lack visibility and room for manoeuvre because of the close proximity of other birds (APLIC, 1994). Other factors, such as proximity to dams, wind direction and proximity to roads and dwellings did not emerge as significant factors, but she readily admits that her broad-scale analysis may have been too crude to demonstrate their effects. It is for example a well known fact that cranes are particularly vulnerable to power lines skirting water bodies used as roosts, as they often arrive there or leave again in low light conditions (pers. obs.).

From a potential avifaunal collision risk perspective, none of the proposed power line alignments emerge as a clear preferred alternative, as they all run through basically the same habitat. However, the **eastern alignment** is slightly preferred above the other for the following reasons:

- It is the shortest; and
- It runs next to an existing overhead power line for approximately 10km. Evidence suggests that placing a new line next to an existing line reduces the risk of collisions to birds. The reasons for that are two-fold namely it creates a more visible obstacle to birds and the resident birds, particularly breeding adults, are used to an obstacle in that geographic location and have learnt to avoid it (APLIC 1994; Sundar & Choudhury 2005). Other transmission lines running parallel to the proposed alignments were therefore treated as a risk reducing factor.

The following management actions are proposed to minimise the risk of collisions with the proposed line:

- The power line should be marked with Double Loop Bird Flight Diverters on the earth wire of the line, five metres apart, alternating black and white.

### 4.4 Cumulative impacts

It is impossible to say at this stage what the cumulative impact of all the proposed wind developments will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the latest version of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al* 2011), which was released by the Endangered Wildlife Trust and Birdlife South Africa in March 2011. This will provide the data necessary to improve the assessment of the cumulative impact of wind development on priority species. At this stage, indications are that displacement may emerge as a significant impact, particularly for species such as Denham's Bustard, White-bellied Korhaan and (possibly) Secretarybird.

# 5 IMPACT ASSESSMENT

The criteria for the assessment of impacts are fully explained in the Chapter ? of the Impact Assessment Report. The tables below provide a summary of the envisaged impacts.

## 5.1 Assessment criteria

The assessment of impact significance is based on the following convention:

- The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 is assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).

- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

**Table 5: Impacts table for bird collisions with the turbine**

| ***Nature:*** Bird collisions, particularly priority species, with the wind turbines | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | Low (1) | Low (1) |
| ***Duration*** | Long-term (4) | Long-term (4) |
| ***Magnitude*** | Moderate (6) | Low (4) |
| ***Probability*** | Probable (3) | Improbable (1) |
| ***Significance*** | **(1+4+6)x 3 = 33 (Medium)** | **(1+4+4)x 1 = 9 (Low)** |
| ***Status (positive or negative)*** | Negative | Negative |
| ***Reversibility*** | Low | High |

| | | |
|---|---|---|
| ***Irreplaceable loss of resources?*** | Yes | No |
| ***Can impacts be mitigated?*** | Yes | |
| ***Confidence*** | Low, due to lack of data | Low, due to lack of data |

**Mitigation**

- Pre-construction monitoring should continue for a 12-month period as planned, to establish an adequate baseline for comparative purposes.
- Once the turbines have been constructed, post-construction monitoring as per the latest version of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al* 2011) should be implemented to compare actual collision rates with predicted collision rates. If actual collision rates indicate unsustainable mortality levels, the following mitigation measures will have to be considered:

    - Negotiating appropriate off-set compensation for turbine related collision mortality;
    - As a last resort, halting operation of specific turbines during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality

***Cumulative impacts:*** It is impossible to say at this stage what the cumulative impact of all the proposed wind developments will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the latest version of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al* 2011, which was released by the Endangered Wildlife Trust and Birdlife South Africa in March 2011. This will provide the data necessary to improve the assessment of the cumulative impact of wind development on priority species.

***Residual Impacts:*** It is envisaged that mitigation will greatly reduce but not entirely eliminate collision mortality.

**Table 6: Impacts table for bird collisions with the power line**

| ***Nature:*** Bird collisions, particularly priority species, with the proposed power line | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | Low (1) | Low (1) |
| ***Duration*** | Long-term (4) | Long-term (4) |
| ***Magnitude*** | Moderate (6) | Low (6) |
| ***Probability*** | Highly Probable (4) | Probable (3) |
| ***Significance*** | **(1+4+6)x 4 = 44 (Medium)** | **(1+4+6)x 3= 33 (Medium)** |
| ***Status (positive or negative)*** | Negative | Negative |
| ***Reversibility*** | Low | Low |
| ***Irreplaceable loss of resources?*** | Yes | Yes |
| ***Can impacts be mitigated?*** | Yes, but not entirely | |
| ***Confidence*** | High | High |
| ***Mitigation:*** The power line should be marked with Double Loop Bird Flight Diverters on the earth wire of the line, five metres apart, alternating black and white. | | |
| ***Cumulative impacts:*** The power line network in the study area is well developed, and is almost certainly a source of unnatural mortality for large terrestrial species, specifically Blue Cranes and Denham's Bustard. This power line will further increase the cumulative risk posed by the network. | | |
| ***Residual Impacts:*** It is envisaged that mitigation will reduce but not entirely eliminate collision mortality. | | |

**Table 7: Impacts table for displacement of birds by the wind farm facility**

| ***Nature:*** Displacement due to disturbance | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | Low (1) | Low (1) |
| ***Duration*** | Long-term (4) | Long-term (4) |
| ***Magnitude*** | Moderate (6) | Moderate (6) |
| ***Probability*** | Probable (3) | Probable (3) |
| ***Significance*** | **(1+4+6)x 3 = 33 (Medium)** | **(1+4+6)x 3= 33 (Medium)** |
| ***Status (positive or*** | Negative | Negative |

| | | |
|---|---|---|
| ***negative)*** | | |
| ***Reversibility*** | Low | Low |
| ***Irreplaceable loss of resources?*** | Yes | Yes |
| ***Can impacts be mitigated?*** | Probably only through off-sets. Site specific mitigation options are limited | |

***Mitigation:***

- The pre-construction monitoring programme must continue as planned to provide baseline information for comparative purposes;
- Post-construction monitoring should be implemented to assess the impact of displacement, particularly on priority species. Initially, a 12 month period of post-construction monitoring should be implemented, using the same protocol as is currently implemented. Thereafter, the need for further monitoring will be informed by the results of the initial 12-month period;
- Should the results of the post-construction monitoring indicate significant displacement of priority species, appropriate off-set compensation should be negotiated with developer to compensate for the loss of priority species habitat; and
- During the construction period, activity should be restricted to the construction footprint itself. Access to the rest of the properties must be strictly controlled to prevent unnecessary disturbance of birds.

***Cumulative impacts:*** It is impossible to say at this stage what the cumulative impact of all the proposed wind developments will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the latest version of *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al* 2011), which was released by the Endangered Wildlife Trust and Birdlife South Africa in March 2011. This will provide the data necessary to improve the assessment of the cumulative impact of wind development on priority species. Indications are that Denham's Bustard might be displaced from the wind farm area.

***Residual Impacts:*** Strict access control during the construction phase will prevent some disturbance, but the main source of disturbance related displacement will be the wind farm activities itself.

**Table 8: Displacement due to habitat destruction**

| ***Nature:*** Displacement due to habitat destruction | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| ***Extent*** | Low (1) | Low (1) |
| ***Duration*** | Long-term (4) | Long-term (4) |
| ***Magnitude*** | Low (4) | Minor (2) |
| ***Probability*** | Highly Probable (4) | Probable (3) |
| ***Significance*** | **(1+4+4)x 4 = 36 (Medium)** | **(1+4+2)x 3= 21 (Low)** |
| ***Status (positive or negative)*** | Negative | Negative |
| ***Reversibility*** | Low | Low |
| ***Irreplaceable loss of resources?*** | Yes | Yes |
| ***Can impacts be mitigated?*** | Yes to some extent | |
| ***Mitigation:*** The infrastructure footprint must be restricted to the minimum in accordance with the recommendations of the ecological specialist study. | | |
| ***Cumulative impacts:*** It is impossible to say at this stage what the cumulative impact of all the proposed wind developments will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the latest version of *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al* 2011), which was released by the Endangered Wildlife Trust and Birdlife South Africa in March 2011. This will provide the data necessary to improve the assessment of the cumulative impact of wind development on priority species. Indications are that Denham's Bustard might be displaced from the wind farm area. | | |
| ***Residual Impacts:*** Some habitat destruction is inevitable in the areas where the wind farm infrastructure will be located. | | |

## 5. ENVIRONMENTAL MANAGEMENT PLAN

### 5.1 Objectives

The objectives of the Environmental Management Plan (EMP) is to gather baseline data over a period of 12 months before construction on the following aspects pertaining to avifauna:

- The abundance and diversity of birds at the wind farm site and a suitable control site;
- Flight patterns of priority species at the wind farm site; and
- To inform the management of the wind farm and specifically mitigation strategies on an ongoing basis, including the level and frequency of post-construction monitoring.

The pre-construction programme commenced in May 2011 and is ongoing.

### 5.2 Proposed monitoring protocols

The methodology for gathering of data, including the manner and frequency of sampling, is guided by the recently released *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"* Version 1 (Jenkins *et al* 2011), which is the current protocol endorsed by the Endangered Wildlife Trust (EWT) and Birdlife South Africa (BLSA). The methodology will be discussed on an ongoing basis with relevant NGO stakeholders as the project progresses, specifically the EWT and BirdLife SA, at the regular meetings of the Birds and Wind Energy Specialist Group (BAWESG). The priority species will be identified through the use of the following data sources:

- The BLSA list of priority species for wind farms (Retief 2011)
- Existing avifaunal data sources, e.g. the South African Bird Atlas 2 (SABAP2) and the Co-ordinated Avifaunal Road Count (CAR)
- The results of monitoring at several wind farm sites in the Jeffreys Bay area which commenced in 2011 and is currently ongoing.

### 5.3 Deliverables

A report will be produced at the end of the pre-construction programme which will contain an analysis of the results of the pre-construction monitoring. These outcomes will inform the final micro-siting of the turbines. Results will be presented in terms of the estimated density of priority (and non-priority) species (birds/km or if possible and/or required, birds/km$^2$), which will serve as the baseline for comparing potential displacement of birds during and after construction, and habitat associations. In addition, a Collision Risk Model (CMR), popularly known as the Band model, which is widely applied in the UK, will be used to predict collision rates of priority species if and when possible. If the Band model proves not to be suitable for these purposes, an alternative method of presenting the collision risk data will be found, in consultation with the client. The predominant flight patterns will be mapped and, where/if possible, coordinates of flight corridors will be provided. In addition, focal point monitoring will be conducted where necessary, i.e. any priority species nest sites that are discovered in the course of the monitoring, as well as wetlands that could serve as roost sites for priority species.

Interim reports will be provided to the client at the conclusion of each seasonal monitoring period. The interim report will contain a preliminary analysis of the data that has been gathered to date, and any potential issues that could influence the lay-out of the turbines will be flagged and discussed with the client.

### 5.4 Responsibilities and progress reports

The monitoring and data capturing will be conducted by Karoo Birding Safaris (Japie and Ralie Claassen) and supervised by Chris van Rooyen. The data analysis will be conducted by Chris van Rooyen, Albert Froneman (who will also do the GIS analysis) and Dr. Marietjie Froneman. Progress reports will be compiled at the end of each season's monitoring.

### 5.5 Post-construction monitoring

The primary aims of post-construction monitoring are to:

- Estimate the numbers/densities of birds regularly present or resident within the broader impact area of the operational wind facility;
- Compare this data with baseline figures and hence quantify the impacts of displacement and/or collision mortality; and
- Mitigate impacts of the development by informing ongoing management of the wind facility.

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

All methods used to estimate bird numbers and movements during baseline monitoring should be applied in exactly the same way to post-construction work in order to ensure the comparability of these two data sets. Further detail on any differences in field techniques and data requirements (e.g. the timing of commencement of post-construction monitoring, the duration over which data collection should be carried out, the need to record bird reactions to the presence of operational turbines) will be done according to the best practices which are valid at that point in time. For now, it is important to note that post-construction monitoring should be started as soon as possible after the first turbines become operational to ensure that the immediate effects of the facility on resident and passing birds are recorded, before they have time to adjust or habituate to the development, and should run over a period of at least 12 months.

The table below provides a summary of the pre-construction monitoring which is required.

| Mitigation: Action/control | Responsibility | Timeframe |
|---|---|---|
| Pre-construction monitoring must be implemented for a 12-month period, consisting of line transects counts and vantage point observations. The objective is to establish a baseline to use for comparison purposes once the wind energy facility has become operational. | RES Ornithological consultant | 12 months (4 x per year), starting in May 2011 |
| | | |
| | | |

| | |
|---|---|
| **Performance Indicator** | » Quarterly report presenting the results of the seasonal monitoring |
| **Monitoring** | » Four replicates per year (one replicate per season) |

The table below provides a summary of the construction mitigation and monitoring requirements.

| Mitigation: Action/control | Responsibility | Timeframe |
|---|---|---|
| • During the construction period, activity should be restricted to the construction footprint itself. Access to the rest of the properties must be strictly controlled to prevent unnecessary disturbance of birds.<br>• The infrastructure footprint must be restricted to the minimum in accordance with the recommendations of the ecological specialist study. | RES Environmental Control Officer | Duration of the construction period |
| | | |

| Mitigation: Action/control | Responsibility | Timeframe |
|---|---|---|
| | | |

| | |
|---|---|
| **Performance Indicator** | » N/A |
| **Monitoring** | » Regular spot-checks by the Environmental Control Officer to ensure compliance |

The table below provides a summary of the operational mitigation and monitoring requirements.

| Mitigation: Action/control | Responsibility | Timeframe |
|---|---|---|
| • Once the turbines have been constructed, post-construction monitoring as per the latest version of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al* 2011) should be implemented to compare actual collision rates with predicted collision rates. If actual collision rates indicate unsustainable mortality levels, the following mitigation measures will have to be considered:<br>o Negotiating appropriate off-set compensation for turbine related collision mortality;<br>o As a last resort, halting operation of specific turbines during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality<br>• Post-construction monitoring should be implemented to assess the impact of displacement, particularly on priority species. Initially, a 12 month period of post-construction monitoring should be implemented, using the same protocol as | RES Ornithological consultant | 12 months (4 x per year), starting as soon as possible after the wind energy facility becomes operational. |

| Mitigation: Action/control | Responsibility | Timeframe |
|---|---|---|
| is currently implemented. Thereafter, the need for further monitoring will be informed by the results of the initial 12-month period;<br>• Should the results of the post-construction monitoring indicate significant displacement of priority species, appropriate off-set compensation should be negotiated with the developer to compensate for the loss of priority species habitat;<br>• The power line should be marked with Double Loop Bird Flight Diverters on the earth wire of the line, five metres apart, alternating black and white. | | |
| | | |
| | | |

| | |
|---|---|
| **Performance Indicator** | » Quarterly report presenting the results of the monitoring. |
| **Monitoring** | » The required monitoring replicates and intervals should be established at the beginning of the post-construction monitoring period. |

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APPENDIX A BIRD HABITAT

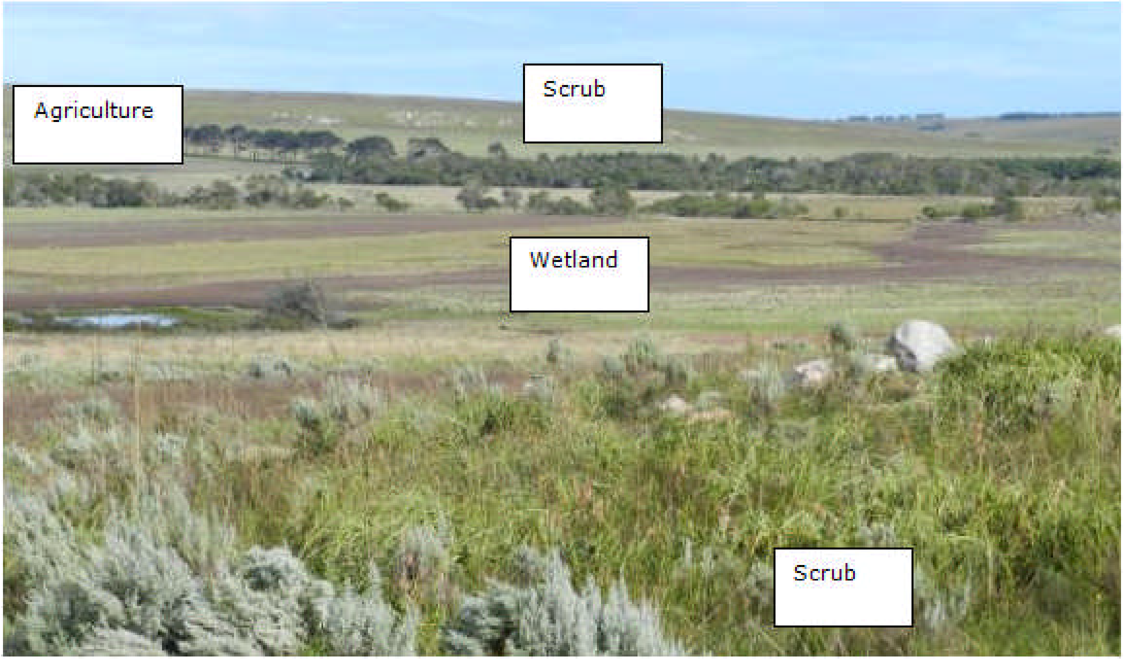


**Figure 1: A view of the study area illustrating different habitat types**


**Figure 2: An example of agriculture (pastures)**

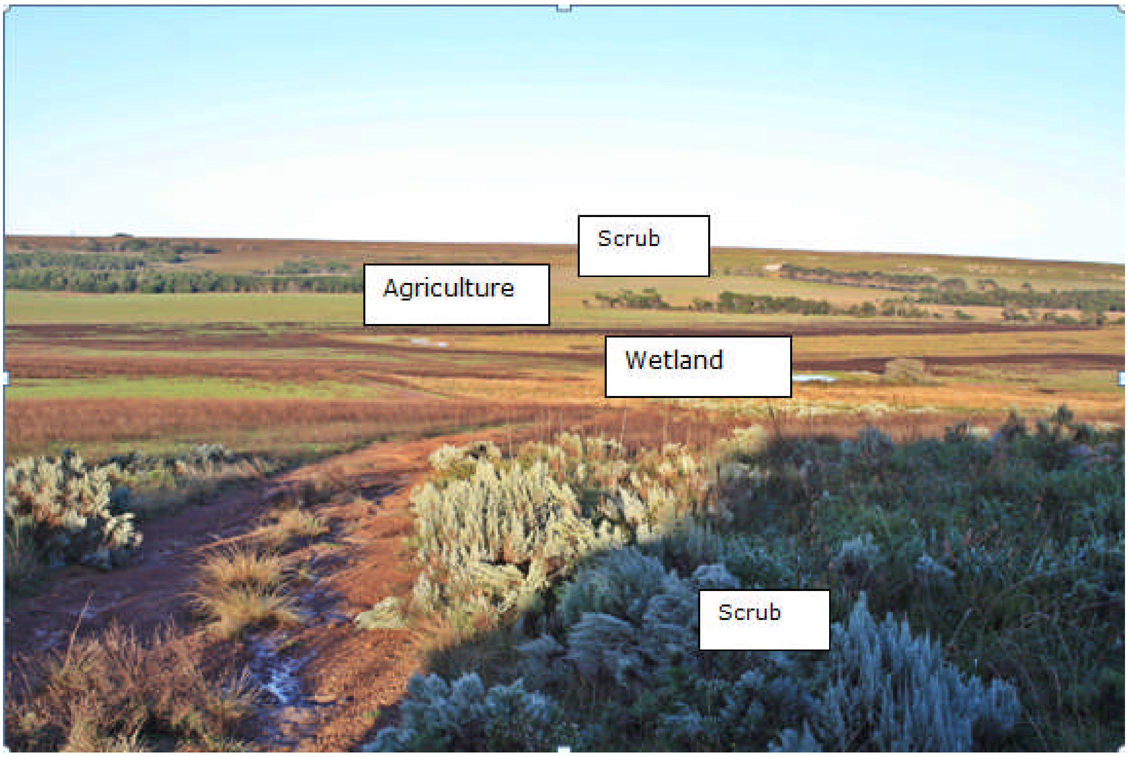


**Figure 3: Another view of the study area showing the different habitat types**


**Figure 4: An example of grassland**