Environmental Impact Assessment for the proposed Banna Ba Pifhu Wind Energy Project near Humansdorp, Eastern Cape: Final Environmental Impact Assessment Report

Chapter 6:

Impact on Birds

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CHAPTER 6. IMPACT ON BIRDS

6.1 INTRODUCTION

6.1.1 Background and approach to the study

The investigation of potential impacts on birds caused by wind farms is a new field of study in South Africa, and has only been receiving 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, resulted in a plethora of proposed wind farm applications which caught the ornithological community completely by surprise. The pace of 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. In circumstances where there is uncertainty and the precautionary principle may be relevant, evidence, expert opinion, best practice guidance and professional judgement was applied to evaluate what is ornithologically likely to occur if the development is authorised.

The report focuses on the potential site-specific, negative impacts of the development on birds. The benefits to birds at the development site stemming from the contribution made by the wind farm towards countering climate change through renewable energy generation cannot yet be quantified at a local scale. Nevertheless it is clear that a large wind farm will potentially make a beneficial contribution to reducing CO_2 emissions. Climate change is widely perceived to be the single most important long-term threat to the global environment, particularly to birds. Thus, the continued rise in mean global temperatures could ultimately affect the size, distribution, survival and breeding productivity of many bird species (Huntley *et al.* 2007). Therefore, these clearly important beneficial effects have been recognized but are not considered further within this study.

This report presents results of the pre-construction monitoring programme that commenced in March 2011 and continued until March 2012. The results of this programme were used to inform the final layout of the turbines.

On 8 October 2012 the layout for the Banna Ba Pifhu wind project was changed to accommodate recommendations from the bat specialists following the completion of the 12-month bat monitoring, after the bird impact assessment report was finalised. The positions of 8 turbines have been changed-turbines namely 5, 8, 12, 15, 16 and 17. The positions were changed slightly to move them further from wetlands and other high-risk areas as identified by the bat specialists. These minor changes do not affect the conclusions and recommendations of the bird impact assessment report.

6.1.2 Terms of Reference

The **scope** of the avifaunal assessment report comprises the assessment of the avifaunal impacts associated with the construction and operation of the proposed plant 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.

The assessment methodology applied in this chapter is fully described in Chapter 4 of the EIR and is therefore not repeated here.

6.1.3 Information 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 March 2011 and continued for a year. The objective of the pre-construction programme was to gather baseline data on bird usage of the site. The protocol for the monitoring programme was designed according to the *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"* (Jenkins *et al.* 2011). Data was gathered in the following periods:

- Summer: 8-12 March 2011;
- Winter/early Spring: 28 June, 1-2 July 2011; 24-27 September 2011;
- Late spring: 17-20 November 2011; and
- Autumn: 27 March-2 April 2012

The specific objectives of the monitoring programme were to record the following:

- The abundance and diversity of birds at the turbine site; and
- Flight patterns of priority species at the turbine site.

For transect monitoring and data analysis purposes, priority species were identified using the BLSA list of priority species for wind farms (Retief 2011a). The list was updated in September 2011 (Retief 2011b) which added a few additional species, and modified the ranking of the species. In January 2012, a new list was released as part of the Avian Wind Farm Sensitivity Map (Retief *et al.* 2012). This list was used for the analyses in this report.

Monitoring at the turbine site is conducted in the following manner:

- A transect was identified totalling 15 km which covers the majority of the proposed turbine area (see Figure 6.1). This is referred to in the report as the “survey area”, and comprises a 1 km buffer on both sides of the transect.
- Two observers travelling slowly (± 10km/h) in a vehicle recorded all priority species on both sides of the transect. The observers stopped at regular intervals (every 500 m) to scan the environment with binoculars. The transect was counted four times per sampling session (see also 6.1.4 Assumptions and limitations).
- In addition, point counts were conducted every 500m, where all species were recorded for a 5 minute period.
- The following variables were 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).

- Two vantage points (VPs) were selected from which the majority of the proposed turbine area could be observed, to record the flight altitude and patterns of priority species. A total of 18 hours of observations per vantage point per season was conducted. The following variables were recorded:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Wind direction;
    - Wind strength (Beaufort scale, wind data obtained from proponent);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);
    - Flight altitude (high i.e >150 m; medium i.e. 50-150 m; low i.e. <50 m);
    - Flight mode (soar; flap; glide ; kite; hover); and
    - Flight duration (in 15 second-intervals).

The following information sources were also consulted for this report, as **background information**:

- Bird distribution data of the Southern African Bird Atlas Project (SABAP1 – 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 QDGCs (quarter degree grid cells) within which the development will take place, namely 3424BA and 3424BB. 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 SABAP1 data were supplemented with SABAP2 data for the relevant QDGCs. These data are much more recent, as SABAP2 was only launched in May 2007, and should therefore be more representative. For SABAP1, QDGCs were the geographical sampling units. For SABAP2 the sampling unit has been reduced in size 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 distribution. There are nine pentads in a QDGC.
- Additional information on large terrestrial avifauna and habitat use was obtained from the Coordinated Avifaunal Roadcounts (CAR) project of the Animal Demography Unit (ADU) of the University of Cape Town (Young 2003; 2008; 2009a; 2009b; 2010a; 2010b; Young 2011a; Young 2011b).
- The conservation status of all bird species occurring in the aforementioned QDGCs was determined with the use of the *Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland* (Barnes 2000) and the most recent and comprehensive summary of southern African bird biology "Roberts VII"(Hockey *et al.* 2005).
- A classification of the vegetation types in the QDGC from an avifaunal perspective was obtained from SABAP1.
- 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 before the monitoring commenced through several site visits in the course of 2010 and 2011. An attempt was made to investigate the total study area as far as was practically possible, and to visit potentially sensitive areas identified from the Google Earth imagery.
- Supplementary data on avifaunal diversity was obtained from the St Francis Bay Bird Club (Langlands 2012a; Langlands & Craig 2012b).

See Figure 6.1 below for a map of the transects, vantage points and proposed turbine layouts.

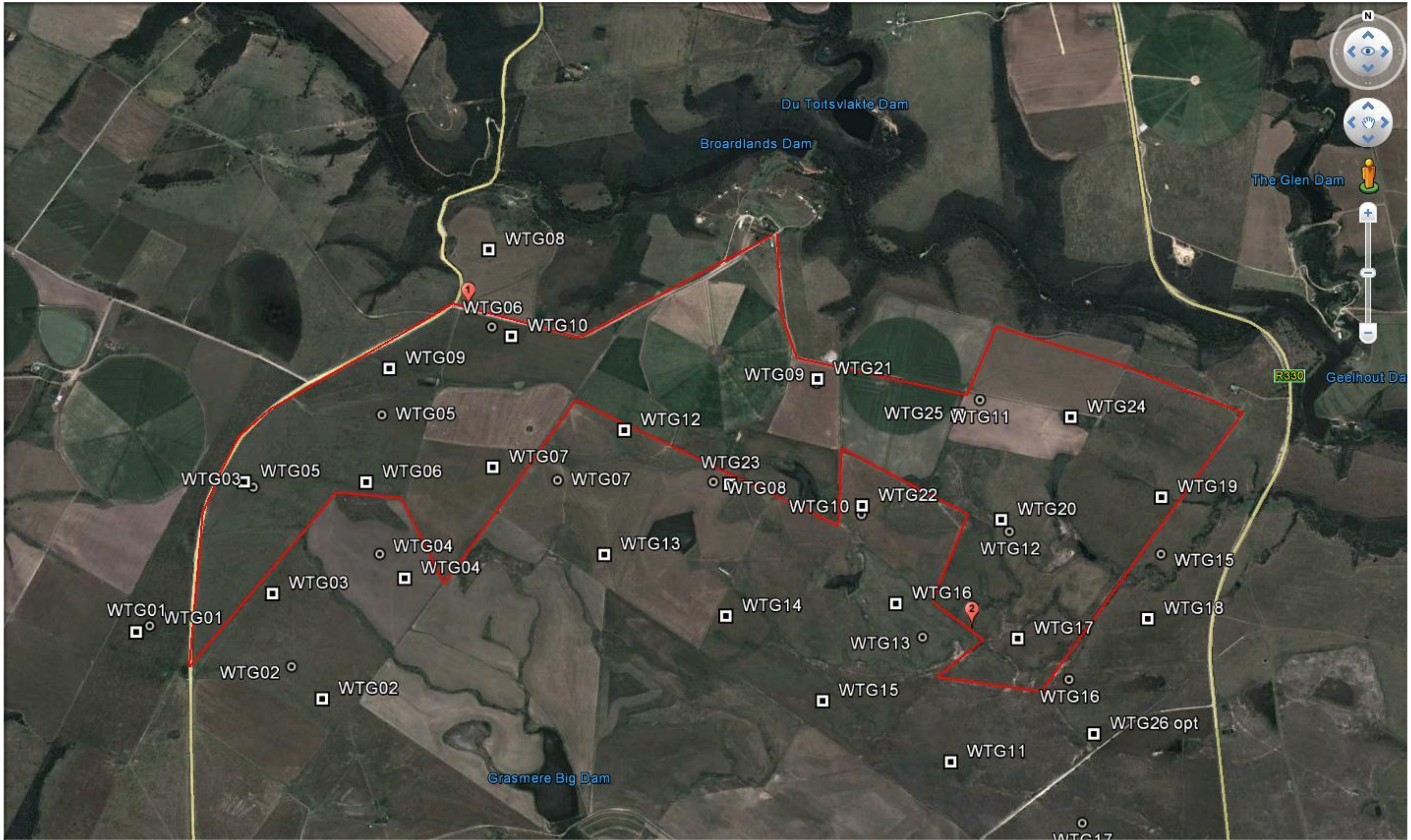


Figure 6.1: The 15 km transect (red line) and vantage points (red placemarks) that were used to record birds in the study area, overlaid on the proposed 30.6 MW (circles) and 50MW (squares) turbine locations layout (Preferred Alternative and Alternative 1) as at 01 October 2012.

6.1.4 Assumptions and limitations

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

- It is inevitable that observations at vantage points will be biased towards those species that are more visible (i.e. larger species), and flights that are closer to the observer. It must therefore be accepted that the chances of a bird being missed increases with the distance from the observer. This means that information on flight paths gathered during vantage point watches must be interpreted with this caveat in mind.
- The analyses of the data in this report should be viewed as descriptive and preliminary. The final pre-construction report will include an in depth statistical analyses of the final dataset.
- 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, strong reliance had to be placed on professional opinion.

6.1.5 Declaration of Independence

I, Chris van Rooyen, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed WKN Windcurrent SA (Pty) Ltd Wind Energy Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Mr Chris van Rooyen (Chris van Rooyen Consultants)

6.2 DESCRIPTION OF AFFECTED ENVIRONMENT

The natural vegetation in the survey area consists of Humansdorp Shale Renosterveld and Gamtoos Thicket (Mucina & Rutherford 2006). However, vegetation structure is more critical in determining bird habitat than actual plant composition (Harrison *et al.* 1997). Therefore, the description of the habitat 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 (please consult the Chapter 5 for a detailed discussion of vegetation types).

The proposed development site is situated within the Fynbos biome (Harrison *et al*. 1997). The Fynbos biome (which broadly contains two vegetation types namely fynbos and renosterveld) is characterized by a high diversity of plant species 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 with 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 vegetation, it is more important to examine the micro-habitats available to birds, most of which are the result of human-induced transformation. These are generally evident at a much smaller spatial scale than the natural vegetation communities.

The following bird habitat classes were defined within the survey area (see Figure 6.2 and Appendix 6.1):

- Agriculture: The majority of the sites consist of agricultural land, and mostly comprises of pastures (for cattle grazing), both irrigated and dry-land, structurally resembling short grassland;
- Thicket: Very dense, in places impenetrable, shrub present in steep valleys along drainage lines. Small trees are also present;
- Wetlands: Includes both man-made dams and natural seasonal wetlands which, when dry, consist of short grassland virtually indistinguishable from the surrounding pastures. In the rainy season, depending on the amount of rainfall, some of the wetlands contain standing water for weeks up to several months ; and
- Scrub: Mostly natural renosterveld consisting of a mixture of grass and scattered shrubs.

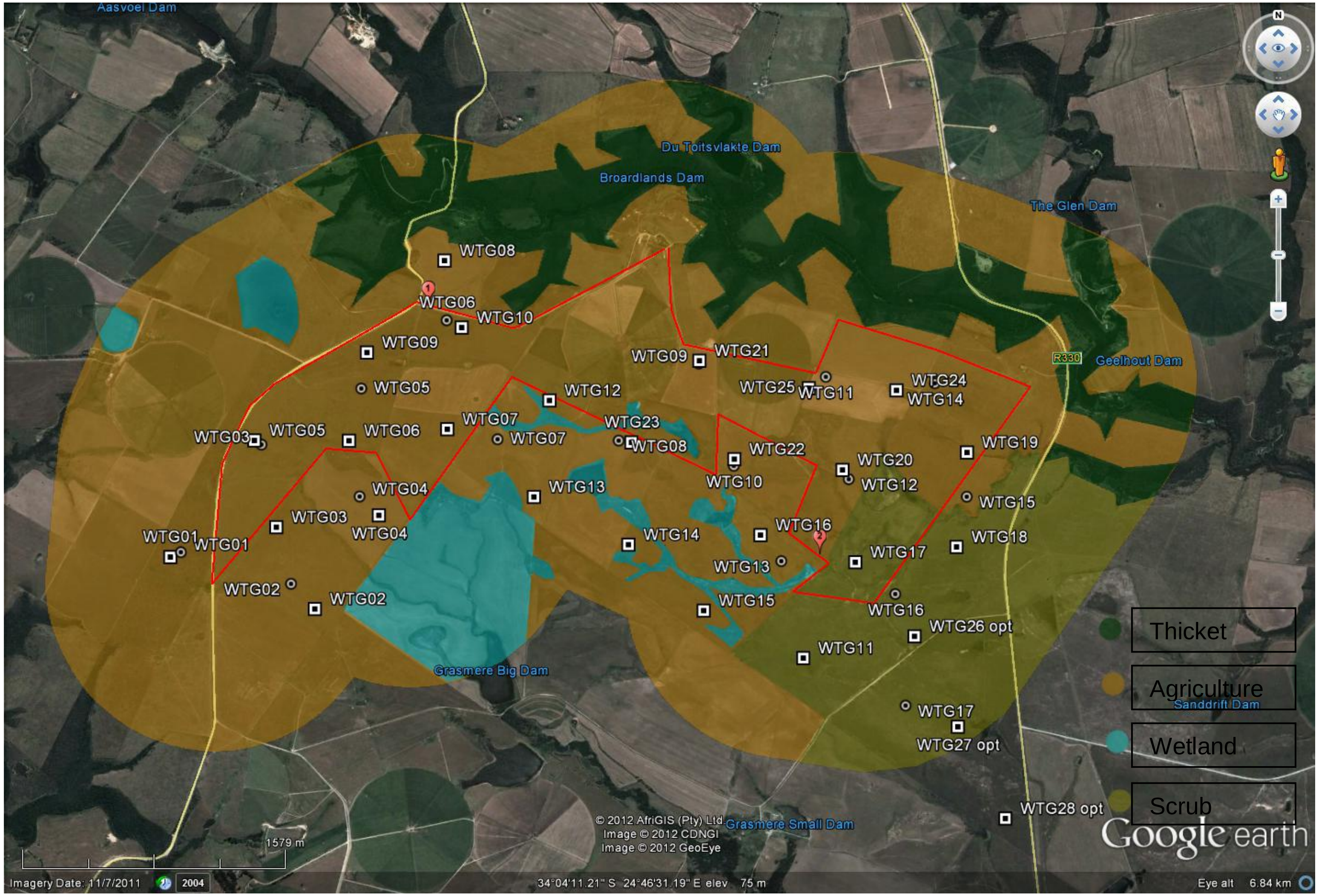


Figure 6.2: The bird habitat classes in the survey area, together with proposed turbine layouts as at 01 October 2012.

Within the survey area approximately 7% of the bird habitat is classified as wetland, 15% as thicket, 13% as scrub and 65% as agriculture. These are estimates and may change depending on the rainfall pattern in any given year, but for purposes of the analyses, these ratios were assumed to be an accurate estimate to work with.

A total of 16 priority species was identified during the survey period (see Table 6.1 and Figure 6.3 below).

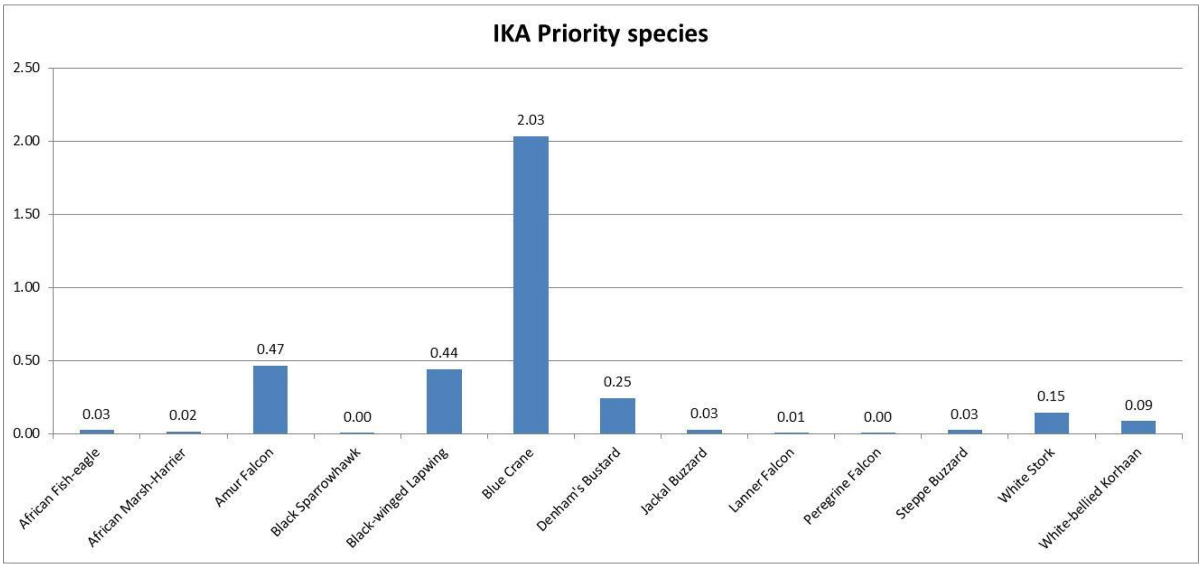


Figure 6.3: Index of kilometric abundance (IKA) for priority bird species recorded during transect surveys

Table 6.1: Priority species recorded to date at Banna ba Pifhu Wind Farm

Common name	Scientific name	Transect counts	Vantage point counts
African Fish-Eagle	*Haliaeetus vocifer*	*x*	*x*
Peregrine Falcon	*Falco peregrinus*	*x*	
Jackal Buzzard	*Buteo rufofuscus*	*x*	*x*
Blue Crane	*Anthropoides paradiseus*	*x*	*x*
Black Sparrowhawk	*Accipiter melanoleucus*	*x*	*x*
Denham's Bustard	*Neotis denhamii*	*x*	*x*
Steppe Buzzard	*Buteo vulpinus*	*x*	*x*
Lanner Falcon	*Falco biarmicus*	*x*	*x*
Black-winged Lapwing	*Vanellus melanopterus*	*x*	*x*
White-bellied Korhaan	*Eupodotis senegalensis*	*x*	*x*
Osprey	*Pandion haliaetus*		*x*
White Stork	*Ciconia ciconia*		*x*
African Harrier Hawk	*Polyboroides typus*		*x*
African Marsh-Harrier	*Circus ranivorus*		*x*
Amur Falcon	*Falco amurensis*	*x*	*x*
Secretarybird	*Sagittarius serpentarius*		*x*

6.3 IDENTIFICATION OF ISSUES AND IMPACTS

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 due to collision with associated power line infrastructure.

6.3.1 Mortalities from collisions with wind turbines

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 analysed 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). Many of the studies of buildings, communication towers, and powerlines were conducted in response to known or perceived problems with avian collisions, and therefore may not be representative of all structures in the United States. As a consequence, using averages of these estimates to project total avian fatalities in the U.S. would be biased high. The estimates provided for the sources of avian mortality listed above, except wind generation facilities, are based on subjective models and are very speculative.

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 (Thelander & Smallwood 2007), and in Tarifa and Navarra in Spain (Barrios & Rodrigues 2004). 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, especially when rarer species of conservation concern are affected (e.g. Denham's Bustard, Blue Crane and African Marsh-Harrier). 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 (Jenkins *et al.* 2010), 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 (Jenkins *et al.* 2010), 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. A Spanish database of over 7000 recorded turbine collisions contains no Great Bustards *Otis tarda*

(A. Camiña pers. comm). The same seems to be the case in Austria (Raab *et al.* 2009). However, this can only be verified in a local context 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. Martial Eagle and Secretarybird) to use slopes for lift, which may increase their exposure to turbines. Gentle slopes may also pose a bigger risk than steep slopes for large soaring species, as updrafts from gentle slopes are weaker than those from steeper slopes, so turbines situated on the tops of gentle slopes should pose a bigger risk to these birds than those situated atop steep slopes (De Lucas *et al.* 2008) Birds also lower their flight height in some locations, for example when following the coastline or crossing a ridge (Smallwood pers.comm; Smallwood is the head of the Scientific Review Committee of Altamont Pass Wind Resource Area and is based in California), 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) as there is less lift for birds to clear the turbines. 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 the 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).

The effects of night-time illumination in increasing the risk of collisions with the turbines has not been adequately tested, and the results of studies are contradictory (Johnson *et al.* 2007). Studies involving lighted objects or towers indicate that lights may attract birds, rather than disorient or repel them, resulting in collision mortality (Cochran & Graber 1958; Herbert 1970; Weir 1976; Crockford 1992; APLIC 1994; Johnson *et al.* 2007). This is mostly a problem for nocturnal migrants (primarily passerines) during poor visibility conditions. Different colour lights vary in their attractiveness to birds and their effect on orientation. Several studies have shown that intermittent lights have less of an effect on birds than constant lights, with reduced rates of mortality (Weir 1976; Jaroslow 1979; EPRI 1985; APLIC 1994). In addition, some studies suggest that replacing white lights with red lights may reduce mortality by up to 80%. This may be due to the change in light intensity rather than the change in wavelength (Weir 1976). However, Ugoretz (2001) suggest that birds are more sensitive to red lights and may be attracted to them. Quickly flashing white strobe lights appear to be less attractive. The issue is however far from settled - a study at Buffalo Ridge, Minnesota, where most of the collision fatalities were classified as nocturnal migrants, found little difference between lighted and unlighted turbines (Johnson *et al.* 2000).The consensus among researchers is to avoid lighting the turbines if possible, but that is against civil aviation regulations (Civil Aviation Regulations 1997). Lighting may also indirectly contribute to avian collision risks in that it may attract insects which in turn attract nocturnal bird activity.

6.3.2 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). 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 between 600 - 1000m may occur in the case of the Great Bustard *Otis tarda*, a species of comparable size and behaviour to the Denham's Bustard (Langgemach 2008; Wurm & Kollar as quoted by Raab *et al.* 2009).

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, or 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.

In a recent study, monitoring data from wind farms located on unenclosed upland habitats in the United Kingdom were collated to test whether breeding densities of upland birds were reduced as a result of wind farm construction or during wind farm operation. Red Grouse *Lagopus lagopus scoticus*, Snipe *Gallinago gallinago* and Curlew *Numenius arquata* densities all declined on wind farms during construction. Red Grouse densities recovered after construction, but Snipe and Curlew densities did not. Post-construction Curlew densities on wind farms were also significantly lower than reference sites. Conversely, densities of Skylark *Alauda arvensis* and Stonechat *Saxicola torquata* increased on wind farms during construction. There was little evidence for consistent post-construction population declines in any species, suggesting that wind farm construction can have greater impacts upon birds than wind farm operation (Pierce-Higgens *et al.* 2012).

6.3.3 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).

6.3.4 Collision mortality with associate power lines

Because of their size and prominence, components of electrical infrastructure 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; 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 electricity line. Collisions, on the other hand, could be a major potential problem.

Collisions probably 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 (Jenkins *et al.* 2010; 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 Endangered Wildlife Trust since August 1996, 1512 (63.8%) were Red Data species (Van Rooyen 2007).

In the Overberg region of the Western Cape power line collisions have long been recorded as a major source of avian mortality (Van Rooyen 2007). Most numerous amongst power line collision victims are Blue Crane and Denham's Bustard (Shaw 2009). It has been estimated that as many as 10% of the Blue Crane population in the Overberg are killed annually on power lines, and figures for Denham's Bustard might be as high as 30% of the Overberg population (Shaw 2009). These figures are extremely concerning, as it represents a possible unsustainable source of unnatural mortality. However the steady increase in Blue Crane numbers since regular road counts started in 1994 provides evidence that the Blue Crane population in the Overberg is currently absorbing the collision impact without any obvious decrease in numbers (Young 2011).

6.4 PERMIT REQUIREMENTS

No specific legal requirements are applicable that pertain to avifauna.

From an international perspective, the Convention on Biological Diversity (CBD) is applicable. The overall objective of the CBD is the "…conservation of biological diversity, [and] the sustainable use of its components and the fair and equitable sharing of the benefits …" (www.cbd.int). The CBD aims to effect international cooperation in the conservation of biological diversity and to promote the sustainable use of living natural resources worldwide. Cooperation in ensuring the conservation and sustainable use of biodiversity is attended to in southern Africa, with all relevant role-players. International meetings are held to incorporate traditional knowledge into the implementation of the CBD and related aspects of biodiversity. The Convention also aims to bring about sharing of the benefits arising from the utilisation of natural resources. The White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (July 1997) implements this at a national level, through the use of applicable resources in the tourism industry; community participation (including industry and business) in biodiversity management; and integration of conservation and sustainable use of biodiversity into all sectors, including industry.

The Convention on the Conservation of Migratory Species of Wild Animals is also applicable (www.cms.int). This Convention, commonly referred to as the Bonn Convention, (after the German city where it was concluded in 1979), came into force in 1983. This Convention's goal is to provide conservation for migratory terrestrial, marine and avian species throughout their entire range. This is very important, because failure to conserve these species at any particular stage of their life cycle could adversely affect any conservation efforts elsewhere. The fundamental principle of the Bonn Convention, therefore, is that the Parties to the Bonn Convention acknowledge the importance of migratory species being conserved and of Range States agreeing to take action to this end whenever possible and appropriate, paying special attention to those migratory species whose conservation status is unfavourable, and individually, or in co-operation taking appropriate and necessary steps to conserve such species and their habitat. Parties acknowledge the need to take action to avoid any migratory species becoming endangered. South Africa acceded to this convention in 1991.

The most important guidance document from an avifaunal impact perspective that is currently applicable to wind energy development is the *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"* (Jenkins *et al.*

2011). This document was published by the Endangered Wildlife Trust (EWT) and Birdlife South Africa (BLSA) on 31 March 2011. This protocol prescribes a pre-construction period that stretches over a minimum of 12 months and includes all major periods of bird usage in that period, as well as a post-construction component. This document is not legally binding on developers, but has the full support of the South African Wind Energy Association (SAWEA).

6.5 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

6.5.1 Mortalities from collisions with wind turbines

A total of 144 hours of vantage point watches (summer = 36 hours, winter/early spring = 36 hours, late spring = 36 hours, autumn = 36 hours) has been completed to date in order to record flight patterns and altitudes of priority species.

In the four sampling periods, priority species were recorded flying over the VP area for a total of 8 hours 34 minutes. A total of 1162 individual flights were recorded. Of these, 605 flights were at low altitude (below rotor height), 386 flights were at medium altitude (i.e. approximately within rotor height) and 171 flights at high altitude (above rotor height). The passage rate for recorded flights of priority species over the VP area (all heights) was 8.07 flights/hour. For medium altitude flights only, the passage rate was 2.68 flights/hour.

Figures 6.4 – 6.6 below provide a breakdown of the species and flight heights recorded during the four sampling periods, in various wind conditions. In addition to species specific analyses, it was decided to group species with similar flight characteristics in the following manner (see Figures 6.7):

- *Medium to large terrestrial species*: Medium to large birds that spend most of the time foraging on the ground. They are generally reluctant to fly and generally fly short distances at low to medium altitude, usually powered flight. Some species undertake longer distance flights at higher altitudes, when commuting between foraging and roosting areas. At the wind farm site, cranes, bustards, lapwings and korhaans are included in this category.
- *Soaring species*: Species that spend a significant time on the wing in a variety of flight modes including soaring, kiting, hovering and gliding at medium to high altitudes. At the wind farm site, these are mostly raptors and storks, but medium and high gliding flights and all soaring flights of Blue Cranes are also included in this category.

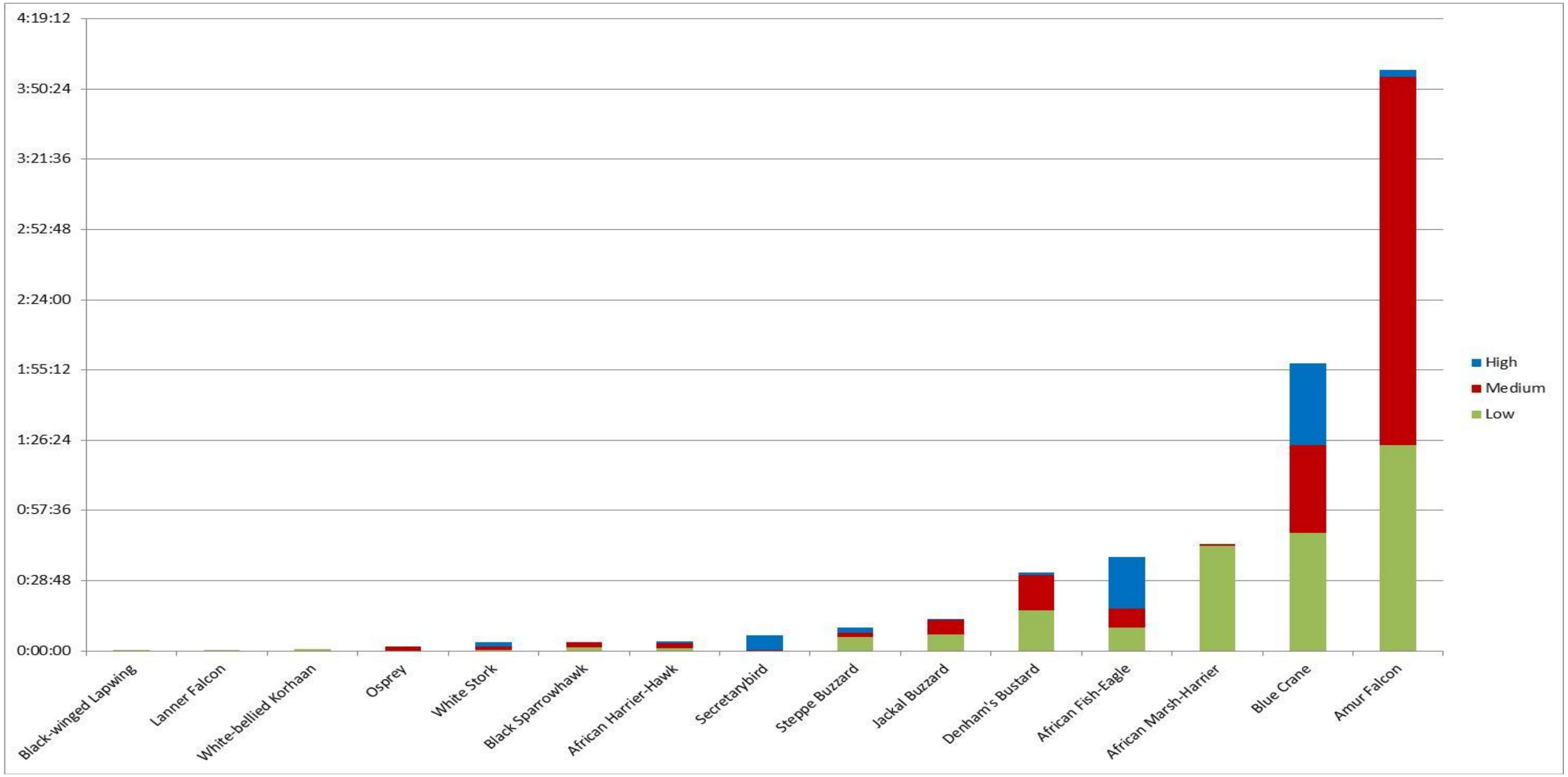


Figure 6.4: Breakdown of priority species vantage point observations (all flight heights). Time is hours: minutes: seconds.

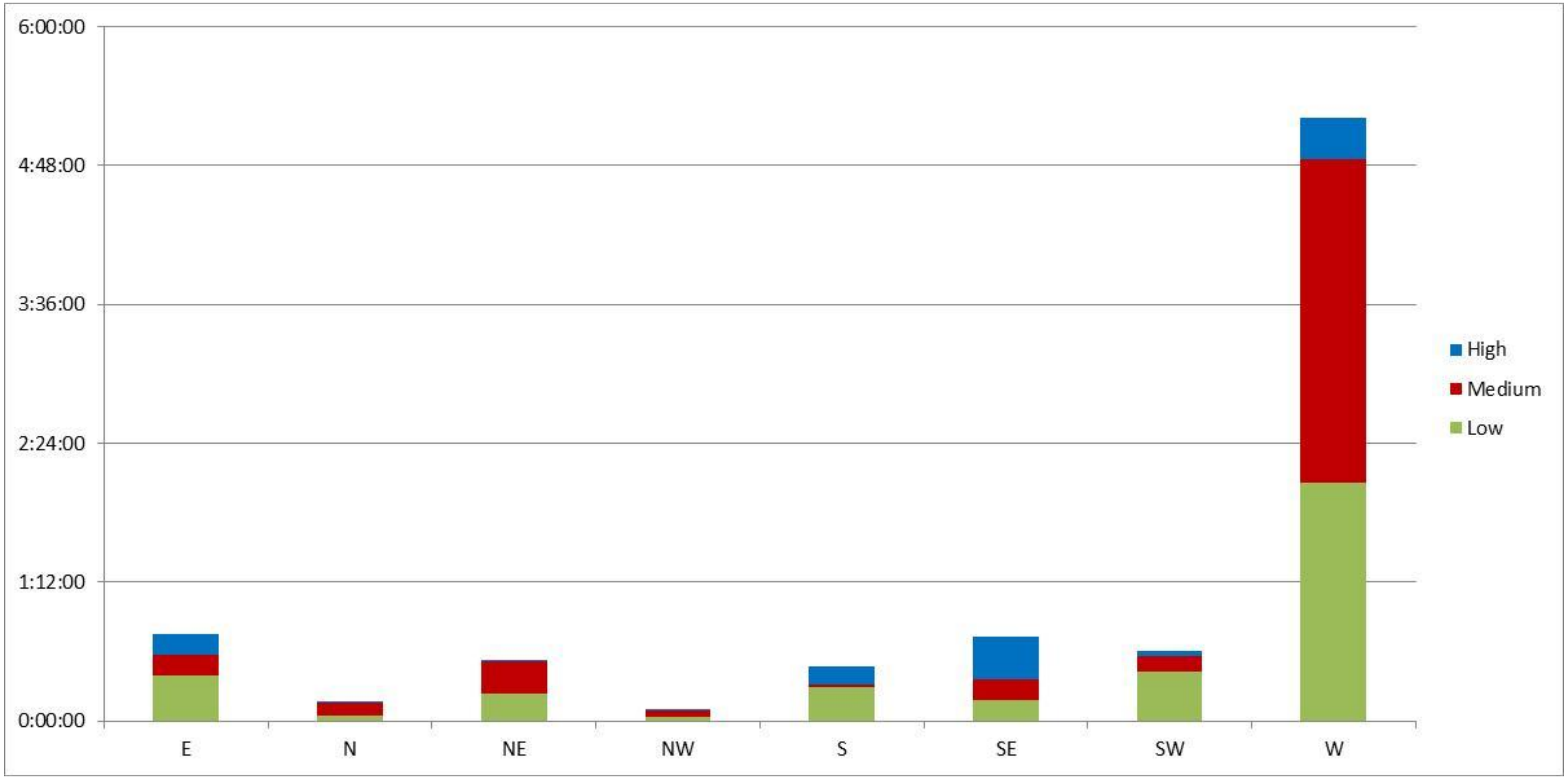


Figure 6.5: Duration of priority species flights in various wind directions. Time is hours: minutes: seconds.

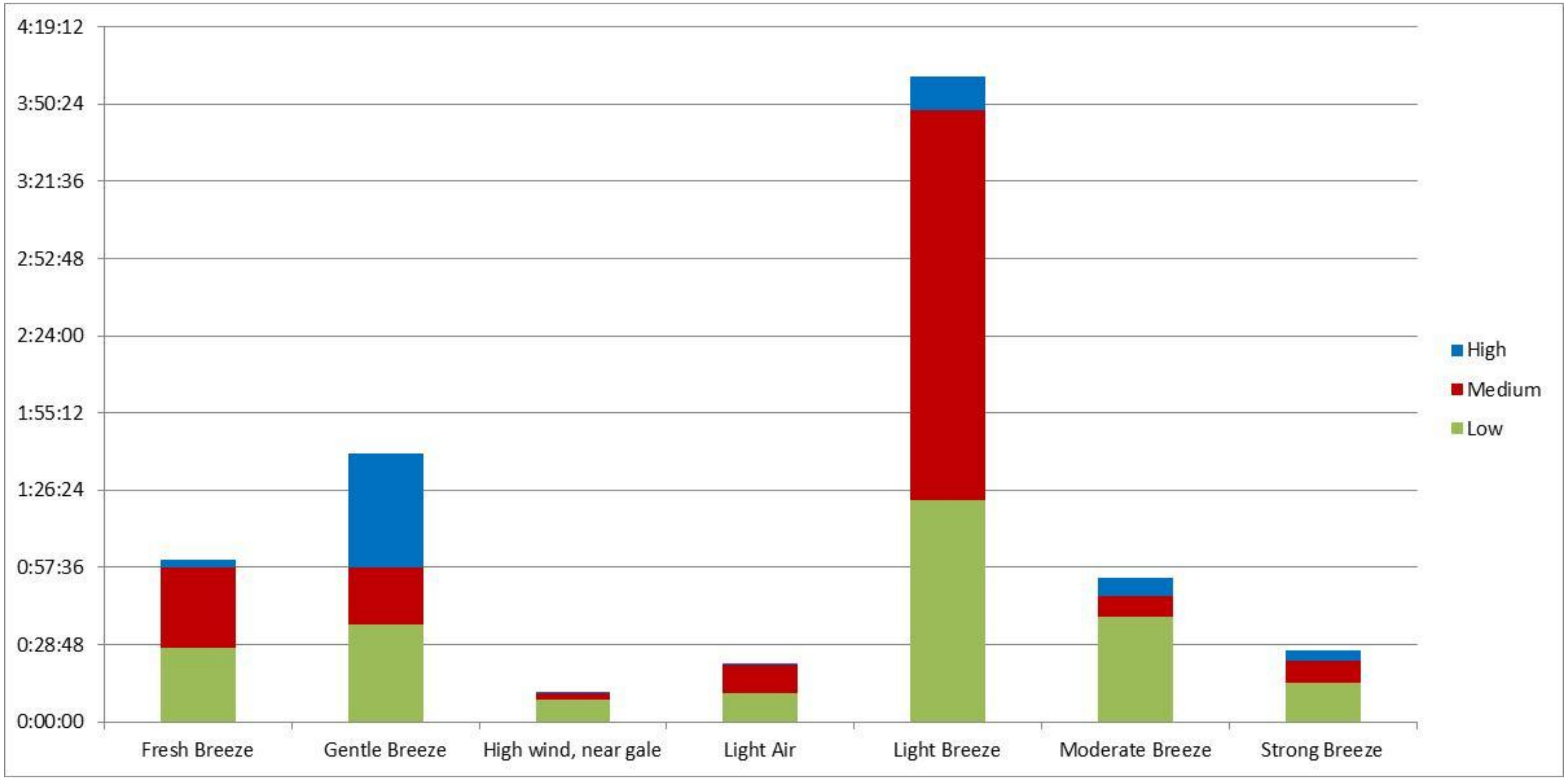


Figure 6.6: Flight heights and duration of priority species in various wind strengths (Beaufort scale). Time is hours: minutes: seconds.

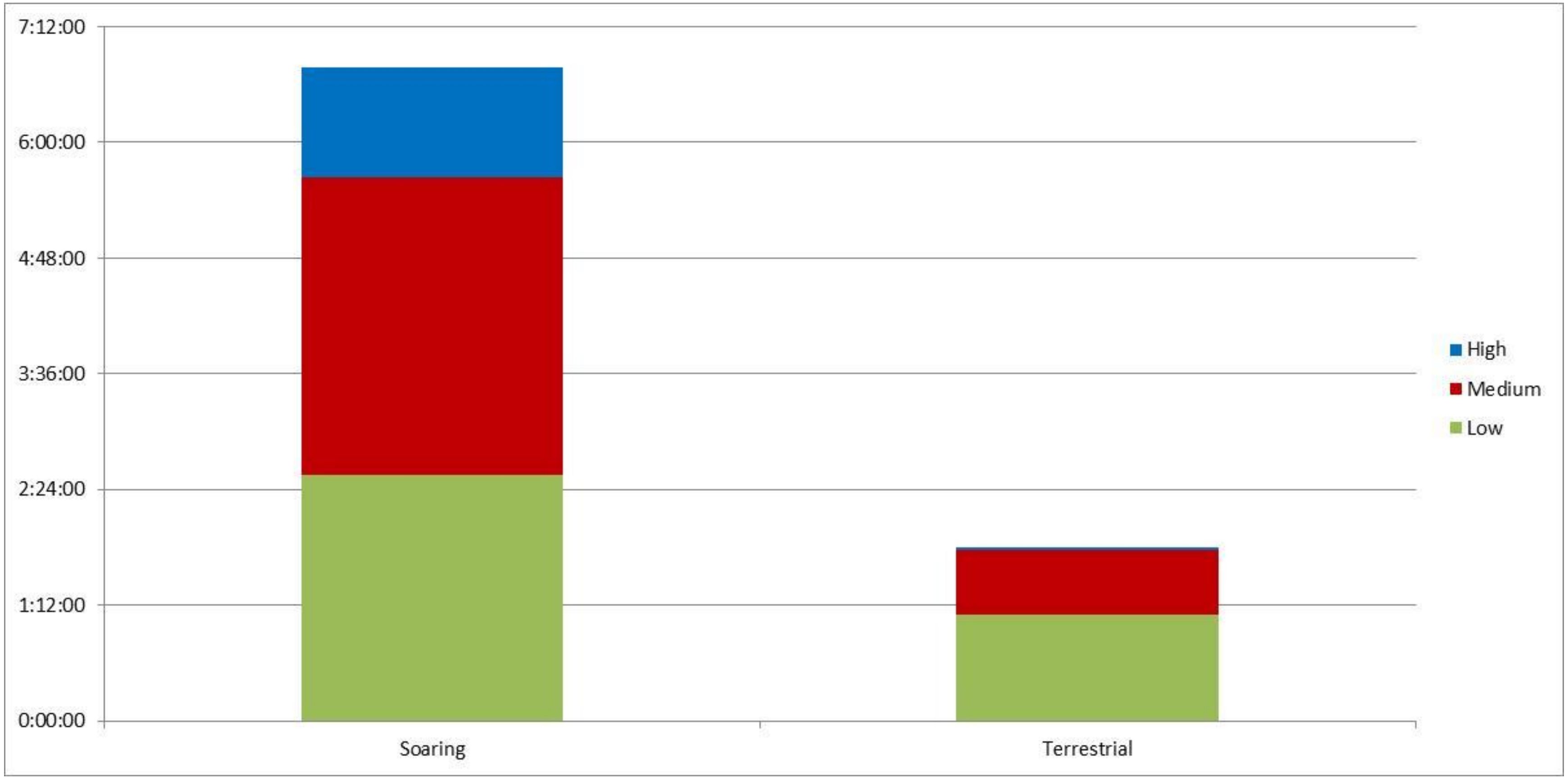


Figure 6.7: Breakdown of priority species classes vantage point (VP) observations (all flight heights). Time is hours: minutes: seconds.

The data collected for priority species for the VP counts in the sampling periods provide some preliminary pointers for the following:

- Soaring species spent a lot more time flying at medium height over the turbine area than terrestrial species. This is to be expected as terrestrial species generally spend their time foraging on the ground – soaring species would therefore be more at risk of collisions than terrestrial species, all things being equal;
- There are indications of an association between light breezes and soaring species flying at medium height over the turbine area;
- There are indications of an association between westerly winds and soaring species flying at medium height over the turbine area;
- Based purely on time spent at medium height over the turbine area, Amur Falcons are most likely to interact with the turbines, followed by Blue Cranes and Denham's Bustard (it should be noted that Denham's Bustard might be displaced from the area, thereby reducing the risk of collisions).

The conclusions above must be viewed as **preliminary.** In the final pre-construction report, the data will be subjected to rigorous statistical analysis to assess whether preliminary indications of associations between variables are indeed statistically significant.

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 duration of individual flight lines and the number of individual birds crossing the square (see Figures 6.8 – 6.12 for the map of medium altitude flights recorded).

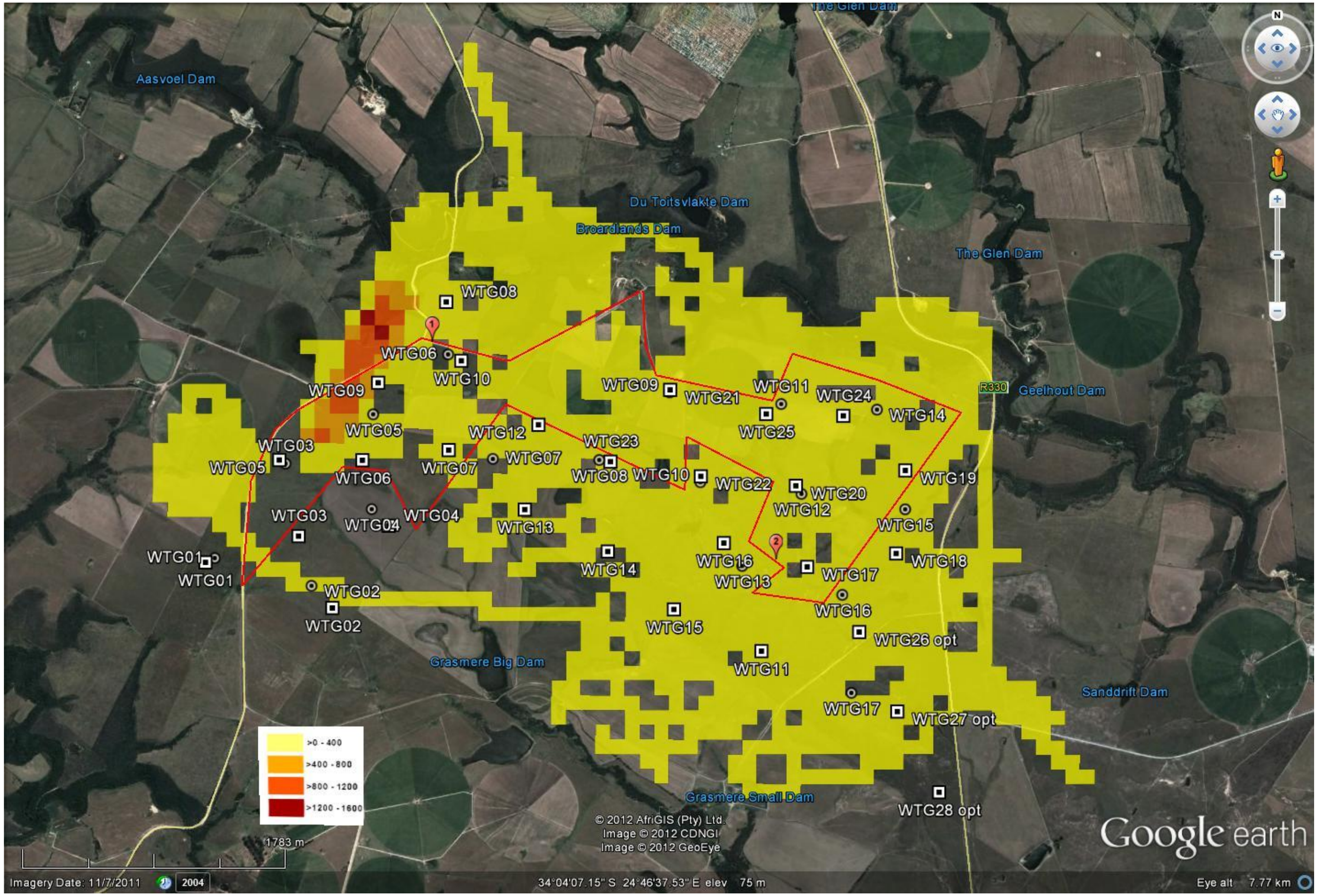


Figure 6.8: Map of medium height flights recorded at VP points – all priority species.

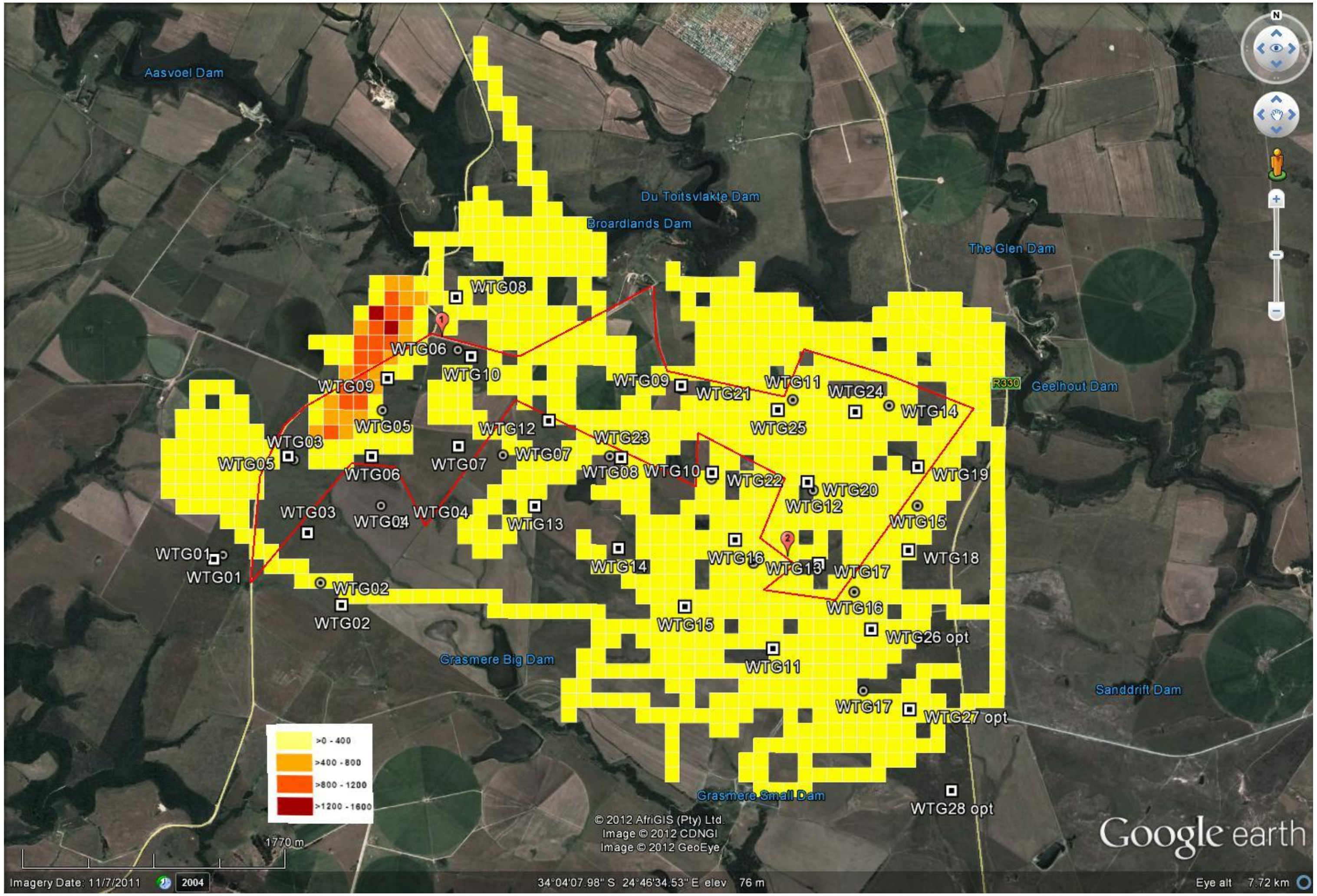


Figure 6.9: Map of medium height flights recorded at VP points – soaring priority species.

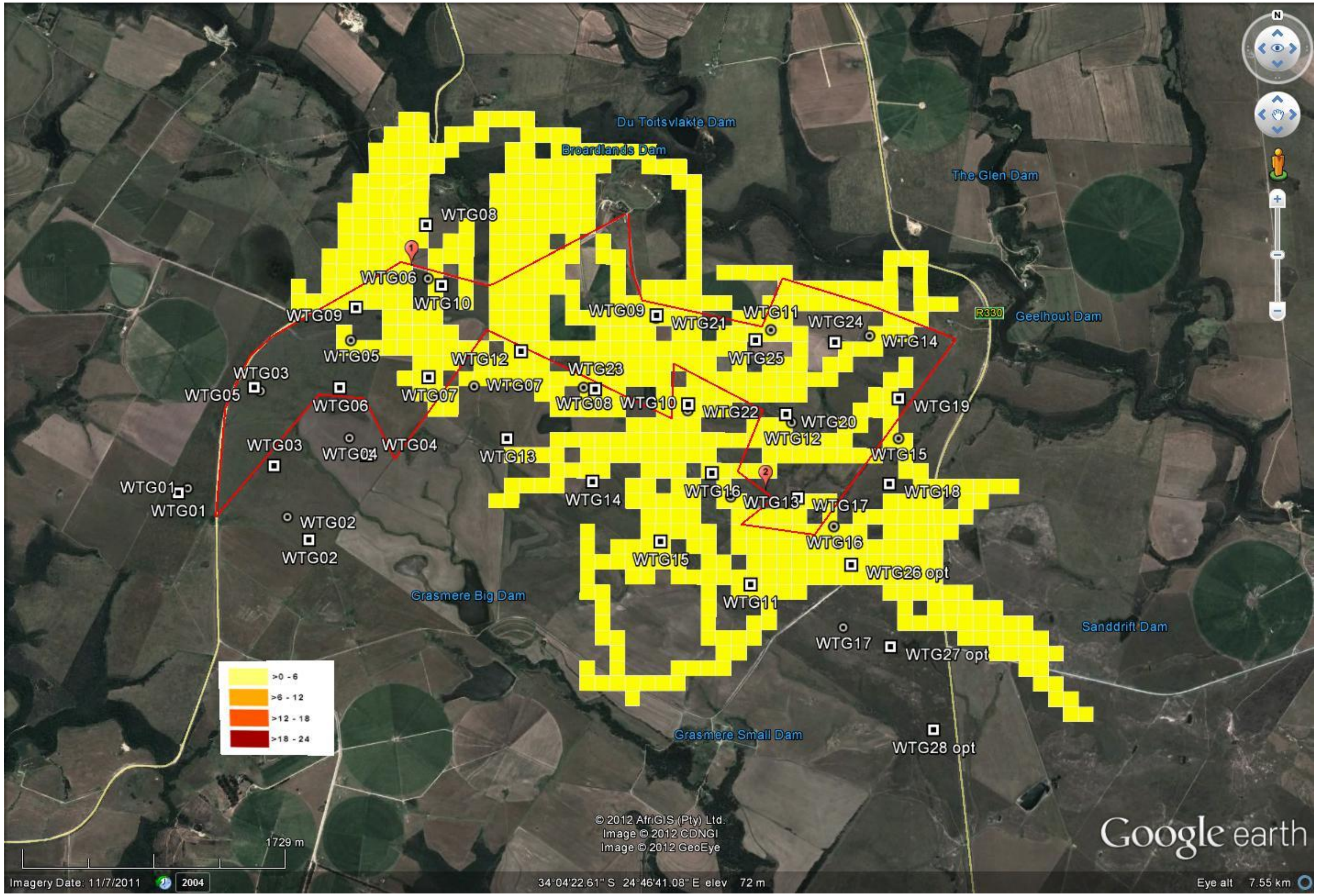


Figure 6.10: Map of medium height flights recorded at VP points – terrestrial priority species.

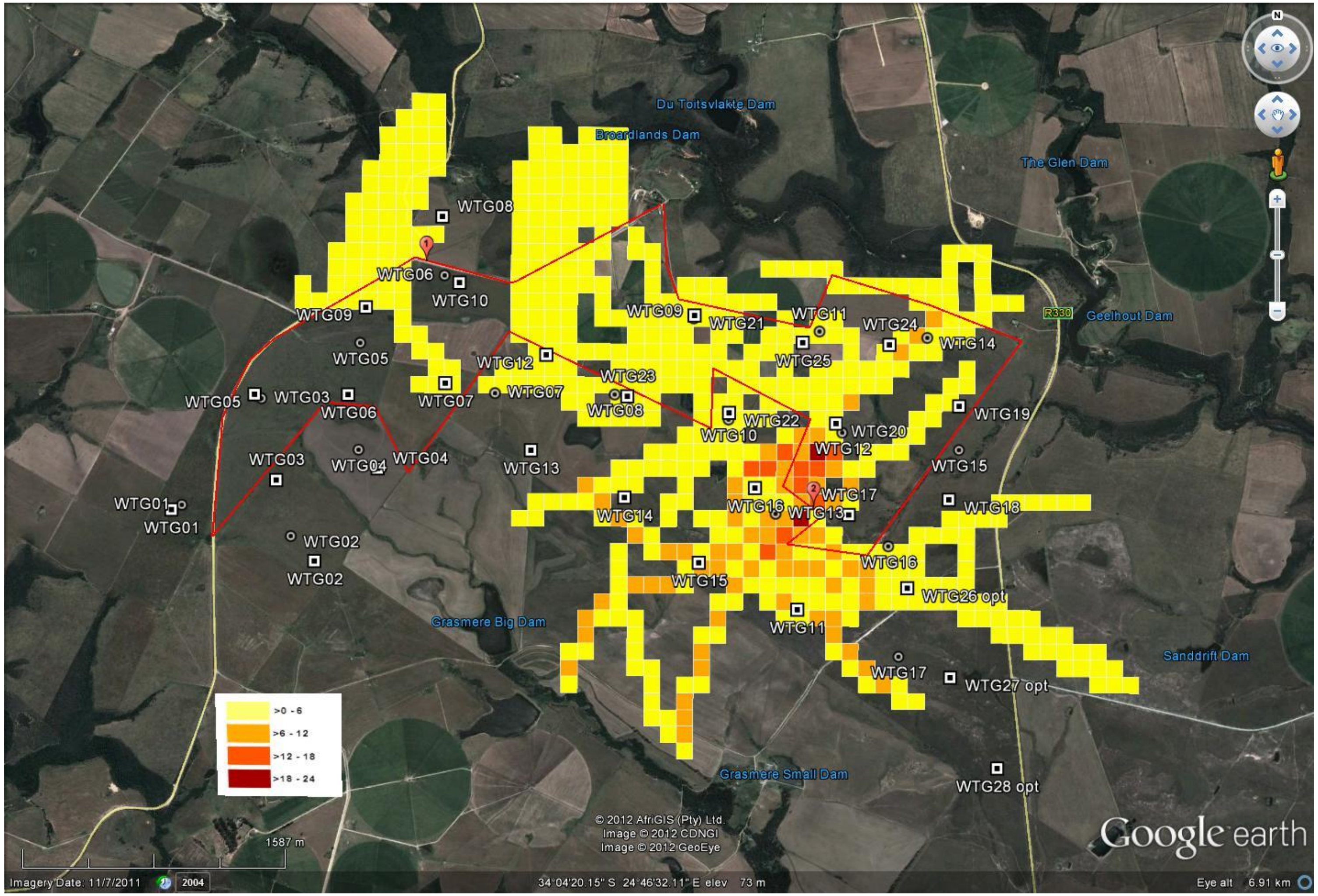


Figure 6.11: Map of medium height flights recorded at VP points – Blue Cranes.

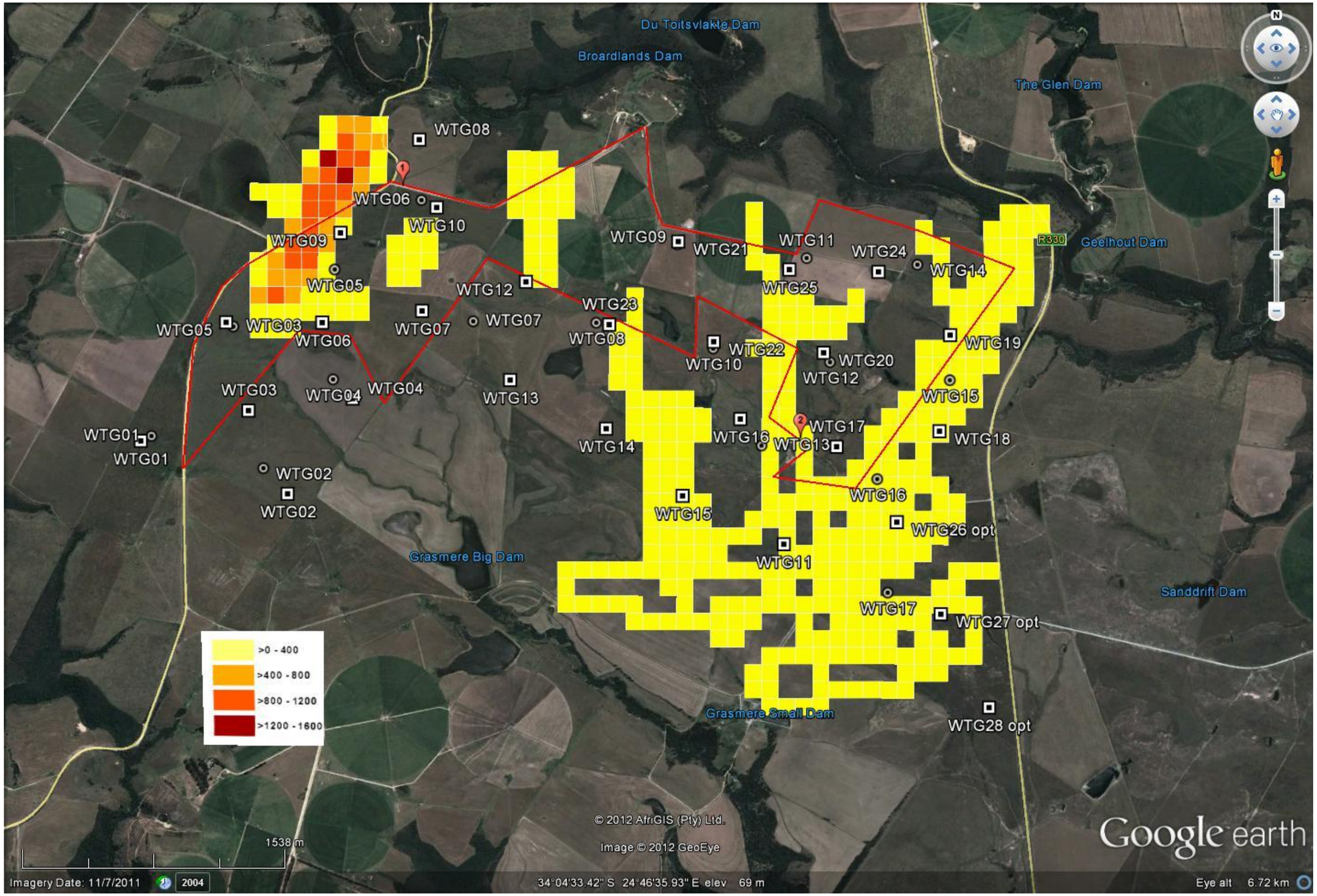


Figure 6.12: Map of medium height flights recorded at VP points – Amur Falcons.

As far as collision risk is concerned, the following preliminary observations are made, based on the data gathered to date:

- The passage rates for priority species of 8.07 flights/hour (all heights) and 2.68 flights/hour (medium heights) indicate significant flight activity over the turbine area.
- Based solely on the amount of time spent at medium height over the turbine area, soaring species seem to be more at risk of collision than terrestrial species.
- Of the priority species recorded (both soaring and terrestrial species), Amur Falcons are most exposed to potential collision risk, based on the number of birds observed at the site at medium height over the turbine area.
- Of the terrestrial priority species recorded, Blue Cranes and Denham's Bustard are most exposed to potential collision risk, based on the number of birds observed at the site at medium height over the turbine area.
- Flight patterns of priority species at medium height recorded to date indicate areas where flight activity is more concentrated (see Figures 6.8 – 6.12), although it is acknowledged that observations are inevitably biased towards the centre of the VP area. It seems that suitable foraging habitat might be an important factor in flight activity patterns for Amur Falcon.
- No specific flight paths or areas of concentrated priority species activity has been identified to date that will necessitate the relocation of any of the currently planned turbines (as at 01 October 2012).

6.5.2 Management actions for mitigation of collision risk

The following management actions are recommended to reduce the risk of collisions to priority species:

- The dataset must be analysed in order to establish the statistical significance of potential trends that have been identified so far (e.g. the influence of wind direction and wind strength). This will assist in the formulation of the final recommendations.
- 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 assess actual collision rates. If actual collision rates indicate high mortality levels, the following mitigation measures will have to be considered:
    - Halting operation of specific turbines during high risk conditions, or reducing rotor speed, to reduce the risk of collision mortality.

6.5.3 Displacement due to disturbance

The transect was counted 16 times: four times per sampling period. A total of 10855 birds were recorded, of which 848 were priority species and 10007 non-priority species, belonging to 125 species (see Appendix 6.2). An Index of Kilometric Abundance (IKA = birds/km) was calculated for each priority species, and also a figure for all priority species combined, which comes to 3.53 birds/km (see Figure 6.3 above). An indication of habitat preference was determined by calculating a habitat/species diversity index (habitat surface area ÷ number of priority species recorded for that habitat type - see Figure 6.13) and a habitat/species abundance index (habitat surface area ÷ number of individual birds recorded for that habitat type – see Figure 6.14 - 6.18). The former is needed to get an indication of which habitat type supports the greatest variety of species at the site, and the latter to get an indication of which habitat is likely to attract the biggest number of individual birds. For the habitat indexes, all records of birds commuting over the site were excluded from the analysis.

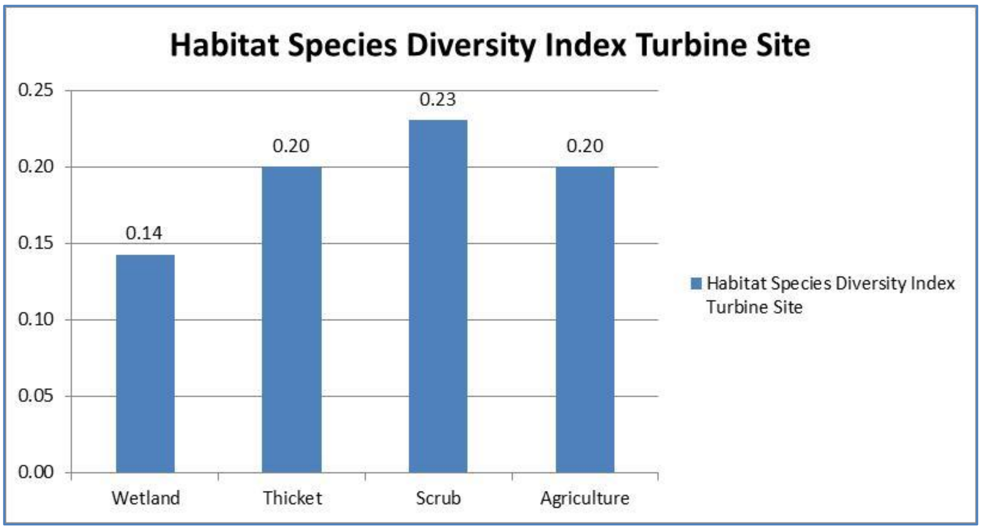


Figure 6.13: Habitat Diversity Index for priority species

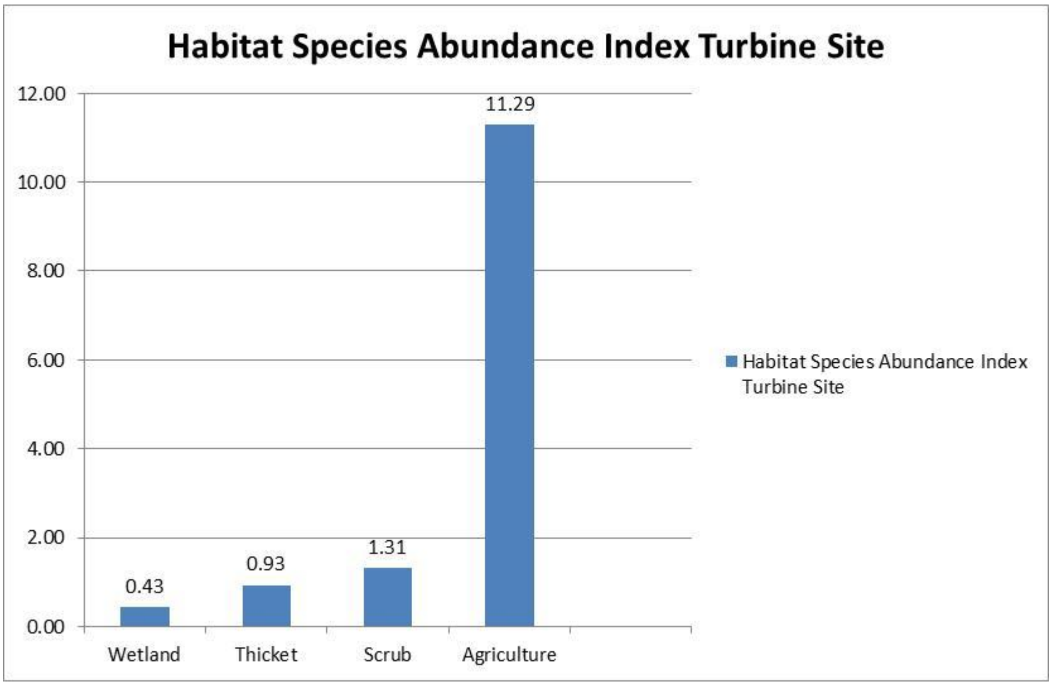


Figure 6.14: Habitat Abundance Index for priority species

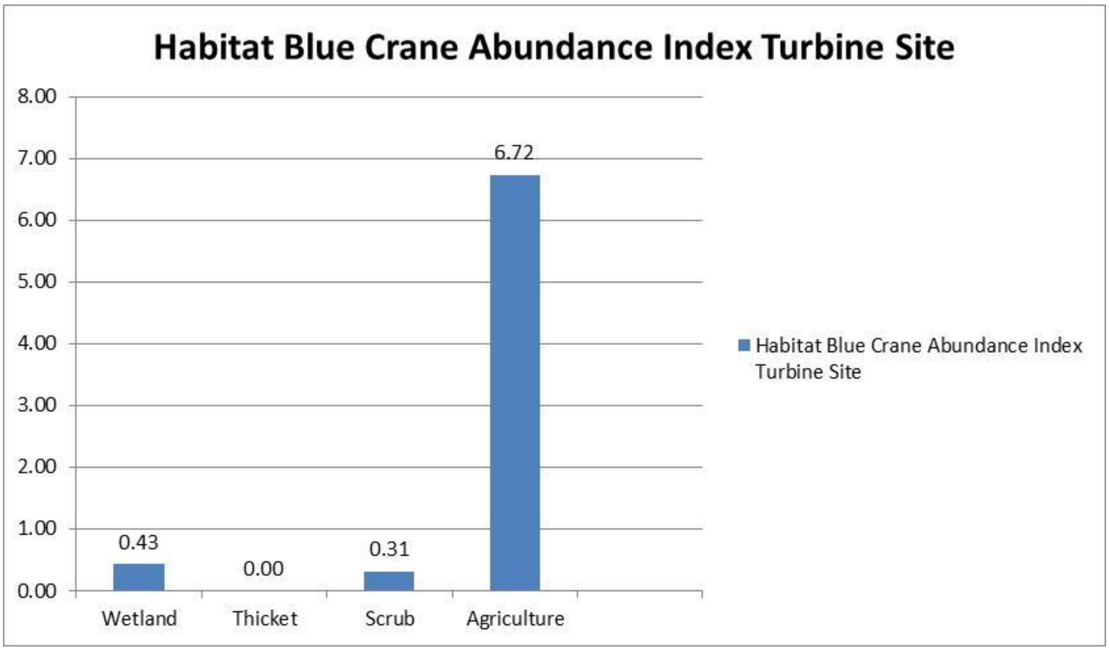


Figure 6.15: Habitat Abundance Index for Blue Cranes

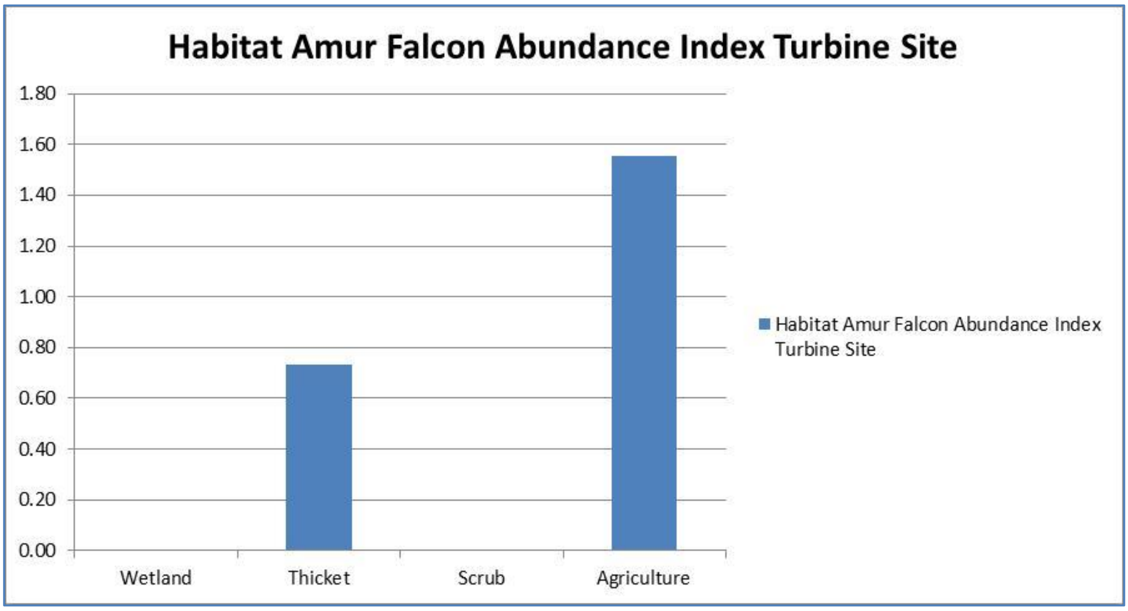


Figure 6.16: Habitat Abundance Index for Amur Falcons

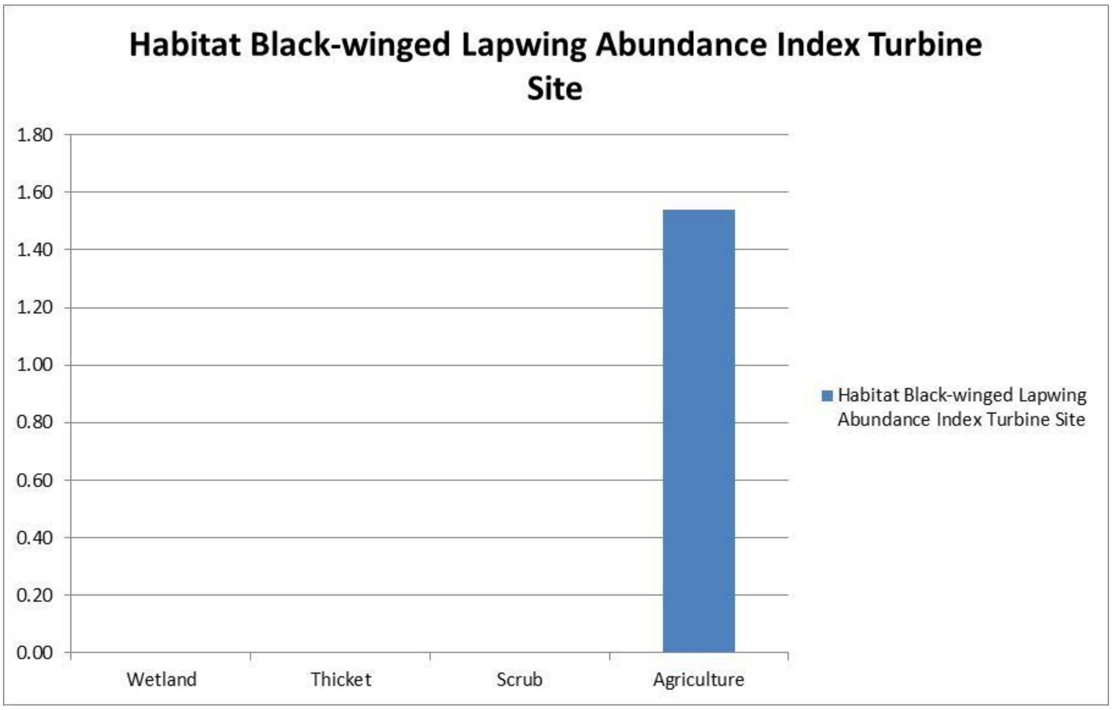


Figure 6.17: Habitat Abundance Index for Black-winged Lapwing

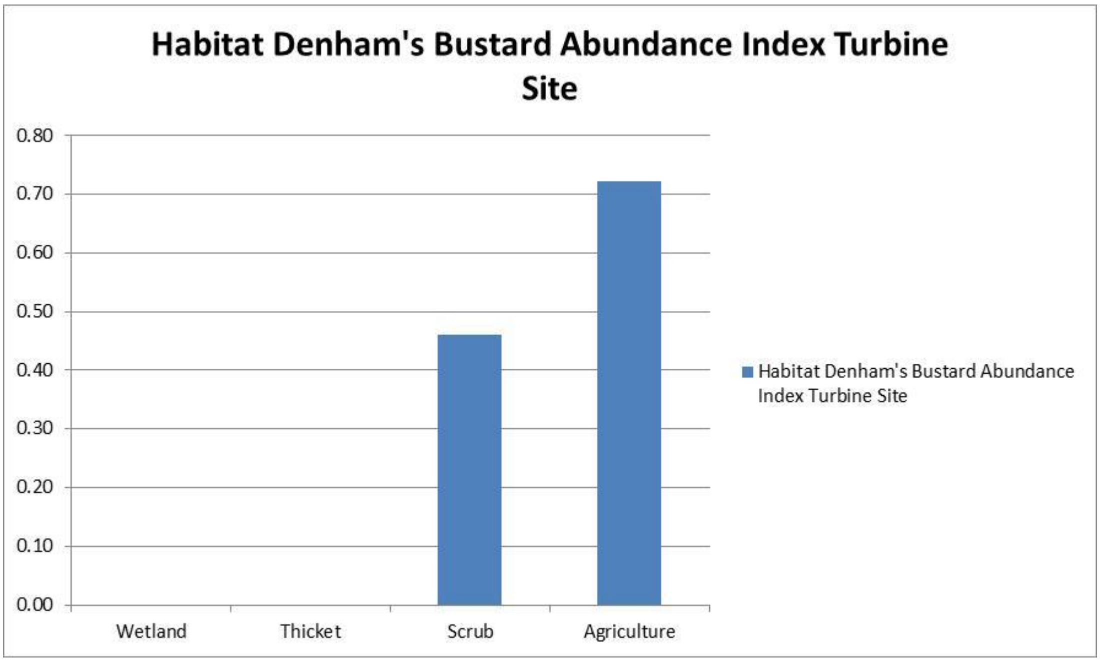


Figure 6.18: Habitat Abundance Index for Denham's Bustard

From the results of the transect surveys the following trends emerged:

- The survey area supports particularly high densities of Blue Crane, and Amur Falcon, Black-winged Lapwing and Denham's Bustard were also recorded regularly;
- Proportionally the biggest number of individuals of priority species is found in agriculture; but the diversity of priority species is relatively evenly distributed across all four habitat types.
- Agriculture is the most important foraging habitat type for all four priority species which were recorded in the highest numbers (Blue Crane, Amur Falcon, Black-winged Lapwing and Denham's Bustard), but scrub also emerged as an important habitat type for Denham's Bustard.

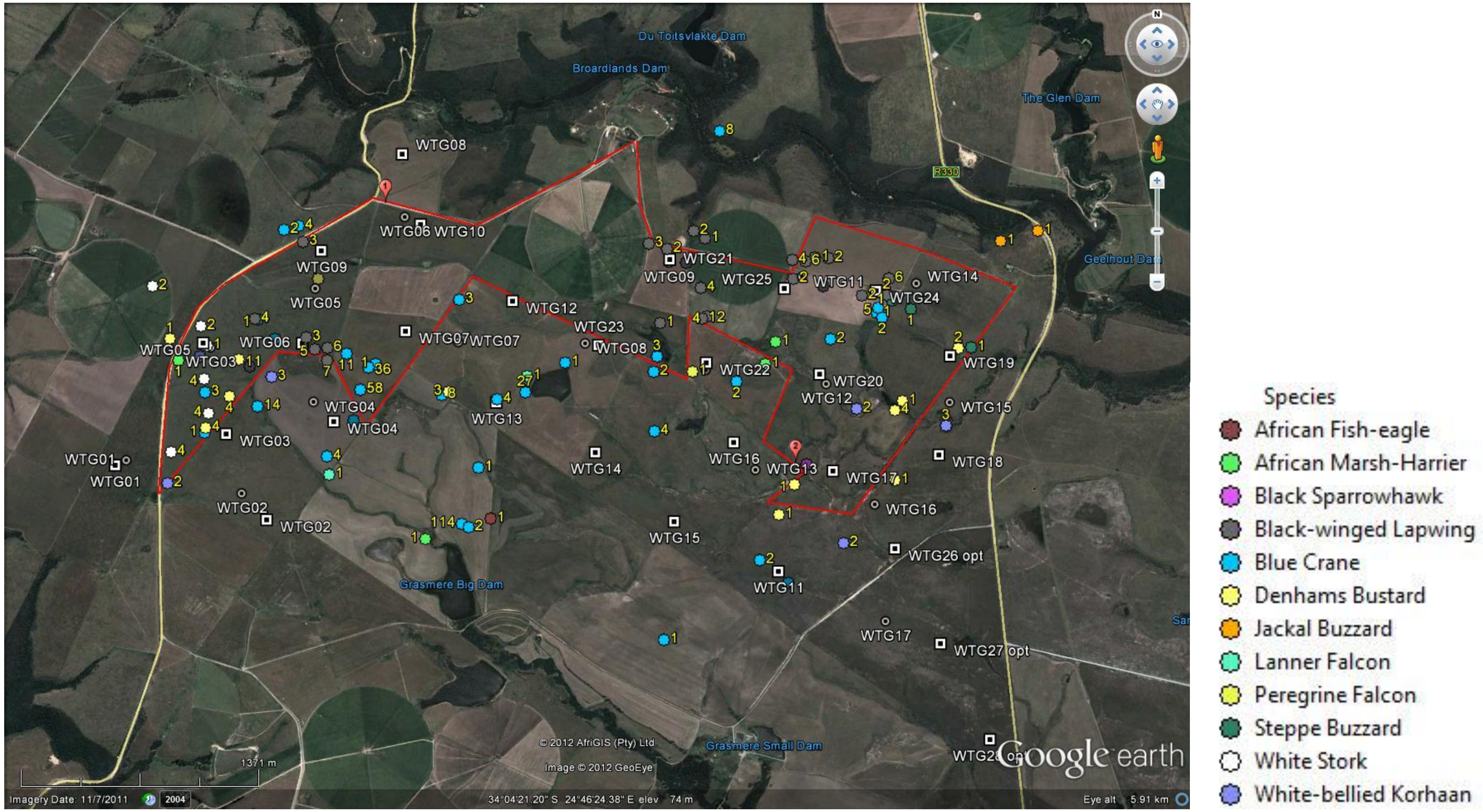


Figure 6.19: Map indicating the location of priority species recorded during pre-construction monitoring

At this stage, it can only be speculated about the impact of potential displacement on large terrestrial birds in the study area, particularly Denham's Bustard, White-bellied Korhaan and Blue Crane as this will only become apparent once the post-construction monitoring commences.

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 between 600 - 1000m may occur in the case of the Great Bustard *Otis tarda*, a species of comparable size and behaviour to the Denham's Bustard (Langgemach 2008; Wurm & Kollar as quoted by Raab *et al.* 2009). 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. Should the Denham's Bustard display high fidelity to its leks (display areas) and breeding sites (as for example the Great Bustard *Otis tarda* does), displacement (which is effectively habitat loss and fragmentation) caused by wind farm developments may impose a higher threat than direct mortality and may be irreversible. The potential for habituation is always there, but due to the lack of scientific proof, the application of the pre-cautionary principle is appropriate. Long term monitoring is the only way to establish if Denham's Bustard will habituate to wind farms and continue to use the habitat in the immediate vicinity. No display activity or breeding sites of Denham's Bustards were recorded during the surveys.

As far as raptors are concerned, the chances of displacement during the construction phase are likely to be higher than during the operational phase, due to the increased activity at the site. However, this impact is likely to be temporary. Generally speaking, raptors are fairly tolerant of wind farms, and continue to use the area for foraging (Madders & Whitfield 2006).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 may be less prone to displacement, they have adapted well to anthropogenic disturbances and agriculture activity – the birds co-exist without problems on farms with intensive agricultural operations. In fact, the birds' presence is inextricably linked to agricultural activities (Young 2003 - 2011b; pers.obs.).

Based on the data gathered (transect and focal point surveys), no relocation of planned turbines are required at this stage for either preferred alternative (30.6 MW) or alternative 1 (50 MW).

In addition to transect surveys and point counts, areas of suitable habitat on and outside the proposed site area were searched for the presence of raptor nests (riverine cliffs) bustard and korhaan nests (scrub) and wetlands (blue crane roosts). To date, no such potential focal points were discovered during these searches.

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

- Activities should be restricted as much as possible to the footprint area, and access to the remainder of the site should be strictly controlled in order to minimise potential disturbance of sensitive priority species, both during construction and the operational phase;
- 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 undertaken, using the same protocol as is currently implemented. Thereafter, the frequency for further monitoring will be informed by the results of the initial 12-month period;

- Once the wind farm is operational, very little practical mitigation is possible other than to restrict access to the remainder of the property. Maintenance personnel and vehicles must be strictly supervised in order to ensure that no unnecessary trespassing takes place in areas which are not associated with the maintenance activities.
- If significant displacement is recorded during the post-construction period, the option of securing off-sets to compensate for the loss of priority species habitat will have to be investigated. It is acknowledged that determining off-sets is a complicated process and determining what would constitute an appropriate offsets does not fall within the ambit of this report.

6.5.4 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 (see Chapter 5 of this report).

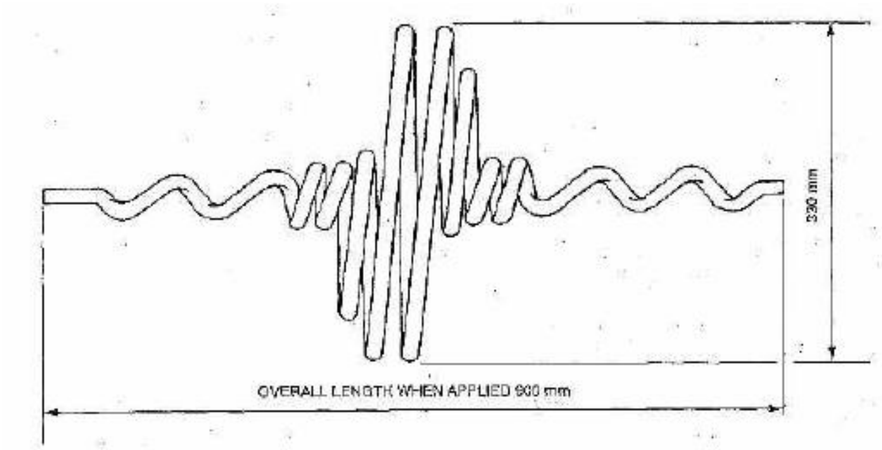
6.5.5 Power line related collision mortality

It is proposed to connect the wind farm substation to the existing 66 kV Melkhout / St. Francis overhead power line, which passes through the site. Currently two alternative alignments have been identified, but the connection points still need to be confirmed by Eskom. Irrespective of where the alignment is planned, it will need to be mitigated because of the high density of collision sensitive species, particularly Blue Crane and Denham's Bustard, on the site.

The proposed 66kV power line should be marked with Bird Flight Diverters (BFDs) to lower the risk of avian collisions with the power line. The recommended BFD is the Double Loop Bird Flight Diverter (see Figure 6.20). The BFDs should be fitted to the earthwire, 5 metres apart, alternating black and white.

PLP – The connection you can count on

Double Loop Bird Flight Diverter



Material Used: Manufactured from rigid solid high impact polyvinyl chloride, possessing excellent chemical and strength properties and which will retain good physical characteristics within the range of extreme temperatures. Outdoor aging tests indicate that the material does not deteriorate in function or appearance from the effects of severe weather conditions. Industrial fumes and salt water cannot seriously degrade the properties of rigid PVC.

Colour: White or Black

Lay Direction: Bird Flight Diverters are supplied right hand lay for both right hand and left hand lay bare conductors and insulated cables.

CATALOGUE NO.	CONDUCTOR/ E/WIRE DIA. RANGE
BFD 0914/LD2*	9 mm – 14 mm

*Add B or W to denote colour

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Figure 6.20: Recommended Bird Flight Diverter

6.5.6 Cumulative impacts

The assessment of cumulative effects on birds is a complex and specialised process, and a high degree of uncertainty can be introduced at a number of stages (SNH 2005[i]). Broadly, there are five stages:

- Define the species to be considered
- Consider the limits or 'search area' of the study
- Decide the methods to be employed
- Review the findings of existing studies
- Draw conclusions on cumulative effects within the study area

Target species will usually be:

- species considered of high conservation importance; and/or
- species considered to be vulnerable to wind farms by virtue of their behaviour or ecology

A cumulative assessment can apply at a number of levels, for example:

- an individual pair, or birds occupying a single breeding site;
- a regional or local population
- a national population

Assessing cumulative effects on a national population would require widespread consideration of wind farm developments nationally, and this would normally be too onerous a task to expect of the developer in one proposal which on its own is unlikely to have more than a marginal effect. Therefore, assessment of impacts on national populations is best undertaken by appropriate agencies in the context of strategic planning, **and should not be required in the context of assessing a single proposal**. Assessing cumulative effects on birds involves the same methods as those to assess effects on an individual proposal. Where available, use should be made of any post-construction monitoring studies on any existing development, which can reduce the uncertainty in any conclusions. Cumulative assessments require more information than individual assessments, and may require relevant authorities and developers to share data and monitoring studies which otherwise might be considered as commercial-in-confidence. Given the competitive climate in the renewable energy sector in South Africa, getting developers to share data remains a huge challenge.

There are currently eleven wind farms planned for the area between Tsitsikamma and Port Elizabeth (M. Langlands pers.comm). 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 as yet to measure it against, secondly because the extent of actual impacts will only become known once a few wind farms are developed, and thirdly because the number of wind farms to be developed remains uncertain. It is therefore imperative that pre-construction and post-construction monitoring are implemented at all the new proposed sites, in accordance with the latest *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al.* 2011). This will provide the data necessary to improve the assessment of the cumulative impact of wind development on priority species (provided developers are prepared to share data). At this stage, indications are that, depending on the number of wind farms that are developed, displacement may emerge as a significant impact, particularly for species such as Denham's Bustard, White-bellied Korhaan and Secretarybird. The extent of the impact on the regional populations of these species however will depend on a species' susceptibility to displacement and number of wind farms that are actually developed. It is highly unlikely that every wind farm planned in the Jeffreys Bay, Humansdorp and Oyster Bay area will actually be developed. Collisions of Blue Cranes could also be a significant impact, if the species susceptibility to power line collisions is anything to go by (although it is acknowledged that this may not be a valid analogy).

6.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The criteria for the assessment of impacts are fully explained in the Chapter 4 of this report. A summary of the impact assessments for the preferred alternative comprising 30.6 MW and alternative 1 comprising 50 MW are provided in Table 6.2 and Table 6.3 respectively.

6.6.1 Assessment criteria

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

- **Nature of impact** – this reviews the type of effect that a proposed activity will have on the environment and includes "what will be affected and how?
- **Extent** – this indicates whether the impact will be local and limited to the immediate area of development (the site); limited to within 5km of the development; or whether the impact may be realized regionally, nationally or even internationally.
- **Duration** – this reviews the lifetime of the impact, as being short term (0 – 5 years), medium (5 – 15 years), long term (>15 years but where the impacts will cease after the operation of the site), or permanent.
- **Intensity** – here it is established whether the impact is destructive or innocuous and it is described as either low (where no environmental functions and processes are affected), medium (where the environment continues to function but in a modified manner) or high (where environmental functions and processes are altered such that they temporarily or permanently cease).
- **Probability** – this considers the likelihood of the impact occurring and is described as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of prevention measures).

The status of the impacts and degree of confidence with respect to the assessment of the significance is stated as follows:

- **Status of the impact**: A description as to whether the impact will be positive (a benefit), negative (a cost), or neutral.
- **Degree of confidence in predictions**: The degree of confidence in the predictions, based on the availability of information and specialist knowledge. This is assessed as high, medium or low.

Based on the above considerations, an overall evaluation of the significance of the potential impact is provided, which is described as follows:

- **Low***:* Where the impact will not have an influence on the decision or require to be significantly accommodated in the project design
- **Medium:** Where it could have an influence on the environment which will require modification of the project design or alternative mitigation;
- **High:** Where it could have a ‘no-go’ implication for the project unless mitigation or re-design is practically achievable.

Table 6.2: Impact summary – Preferred Alternative (30.6 MW)

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
CONSTRUCTION PHASE – PREFERRED ALTERNATIVE (30.6 MW)									
Displacement of priority species due to disturbance	Negative	Local	Short term	High	Highly probable	High	▪ Restrict the construction activities to the footprint area. Do not allow any access to the remainder of the property.	Medium	High
Displacement of priority species due to habitat destruction	Negative	Site	Long term	Low	Highly probable	Low	• No mitigation is possible to prevent the permanent habitat transformation caused by the construction of the wind farm infrastructure. In order to prevent habitat destruction (i.e. more than is necessary), the recommendations of the specialist ecological study must be strictly adhered to.	Low	High

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
OPERATIONAL PHASE – PREFERRED ALTERNATIVE (30.6 MW)									
Displacement of priority species due to disturbance caused by the operation of the wind farm.	Negative	Local	Medium to long term, depending on whether habituation takes place.	High	Highly probable for bustards, probable for Blue Cranes, Secretarybirds and korhaans, and improbable for raptors.	Medium-high	▪ 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 frequency for further monitoring will be informed by the results of the initial 12-month period. ▪ Very little practical mitigation is possible other than to restrict access to the remainder of the property. Maintenance personnel and vehicles must be strictly supervised in order for ensure that no unnecessary disturbance of priority species takes place. ▪ If significant displacement is recorded during the post-construction period, the option of securing off-sets to compensate for the loss of priority species habitat will have to be investigated. It is acknowledged that determining off-sets is a complicated process and determining what would constitute an appropriate offsets does not fall within the ambit of this report.	Medium to low, depending on whether habituation takes place, or off-set compensation is implemented.	Raptors – high Bustards, cranes and korhaans - medium

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Collisions of priority species with the turbines	Negative	Mostly local and regional but global in the case of migratory species, namely White Stork, Steppe Buzzard and Amur Falcon.	Long term	High	Probable for soaring species, especially Amur Falcon, probable for Blue Cranes, korhaans and bustards. Overall probability will be significantly less than alternative 1, because of 30% reduction in number of turbines.	Medium	▪ The dataset must be analysed in order to establish the statistical significance of potential trends that have been identified so far (e.g. the influence of wind direction and wind strength). This will assist in the formulation of the final recommendations. ▪ 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 assess actual collision rates. If actual collision rates indicate high mortality levels, the following mitigation measures will have to be considered: ○ Halting operation of specific turbines during high risk conditions, or reducing rotor speed, to reduce the risk of collision mortality.	Low	Low - medium

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Collisions with the associated power line	Negative	Mostly local and regional (Blue Crane and Denham's Bustard) but global in the case of migratory species, namely White Stork	Long term	High	Highly probable	Medium	The proposed 66kV power line should be marked with Bird Flight Diverters (BFDs) to lower the risk of avian collisions with the power line. The recommended BFD is the Double Loop Bird Flight Diverter (see Figure 6.20). The BFDs should be fitted to the earthwire, 5 metres apart, alternating black and white.	Low	Medium

Table 6.3: Impact summary – Alternative 1 (50MW)

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
CONSTRUCTION PHASE – ALTERNATIVE 1 (50 MW)									
Displacement of priority species due to disturbance	Negative	Local	Short term	High	Highly probable	High	▪ Restrict the construction activities to the footprint area. Do not allow any access to the remainder of the property.	Medium	High
Displacement of priority species due to habitat destruction	Negative	Site	Long term	Low	Highly probable	Low	• No mitigation is possible to prevent the permanent habitat transformation caused by the construction of the wind farm infrastructure. In order to prevent habitat destruction (i.e. more than is necessary), the recommendations of the specialist ecological study must be strictly adhered to.	Low	High

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
OPERATIONAL PHASE – ALTERNATIVE 1 (50 MW)									
Displacement of priority species due to disturbance caused by the operation of the wind farm.	Negative	Local	Medium to long term, depending on whether habituation takes place.	High	Highly probable for bustards, probable for Blue Cranes, Secretarybirds and korhaans, and improbable for raptors.	Medium-high	▪ 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 frequency for further monitoring will be informed by the results of the initial 12-month period. ▪ Very little practical mitigation is possible other than to restrict access to the remainder of the property. Maintenance personnel and vehicles must be strictly supervised in order for ensure that no unnecessary disturbance of priority species takes place. ▪ If significant displacement is recorded during the post-construction period, the option of securing off-sets to compensate for the loss of priority species habitat will have to be investigated. It is acknowledged that determining off-sets is a complicated process and determining what would constitute an appropriate offsets does not fall within the ambit of this report.	Medium to low, depending on whether habituation takes place, or off-set compensation is implemented.	Raptors – high Bustards, cranes and korhaans - medium

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Collisions of priority species with the turbines	Negative	Mostly local and regional but global in the case of migratory species, namely White Stork, Steppe Buzzard and Amur Falcon.	Long term	High	Highly probable for soaring species, especially Amur Falcon, probable for Blue Cranes, korhaans and bustards.	Medium	▪ The dataset must be analysed in order to establish the statistical significance of potential trends that have been identified so far (e.g. the influence of wind direction and wind strength). This will assist in the formulation of the final recommendations. ▪ 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 assess actual collision rates. If actual collision rates indicate high mortality levels, the following mitigation measures will have to be considered: ○ Halting operation of specific turbines during high risk conditions, or reducing rotor speed, to reduce the risk of collision mortality.	Low	Low - medium

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Collisions with the associated power line	Negative	Mostly local and regional (Blue Crane and Denham's Bustard) but global in the case of migratory species, namely White Stork	Long term	High	Highly probable	Medium	The proposed 66kV power line should be marked with Bird Flight Diverters (BFDs) to lower the risk of avian collisions with the power line. The recommended BFD is the Double Loop Bird Flight Diverter (see Figure 6.20). The BFDs should be fitted to the earthwire, 5 metres apart, alternating black and white.	Low	Medium

6.7 CONCLUSIONS

Although this is a relatively small wind farm site, it is not without intrinsic value for priority avifauna from a foraging, roosting and breeding perspective. The combination of pastures, wetlands and scrub is particularly well suited for Denham's Bustard, Blue Crane, White-bellied Korhaan, Black-winged Lapwing and Amur Falcon, as is the whole of the Jeffreys Bay, Humansdorp and Oyster Bay agricultural districts. Displacement of some priority species is possible, particularly Denham's Bustard, but at this stage, with no wind farms having been constructed as yet in the area, it is not possible to test the validity of this statement. However, should this impact materialise, the cumulative effect of displacement of particularly Denham's Bustard (and possibly White-bellied Korhaan) might have regional or even national implications, depending on the number of wind farms that gets to be developed in the region, and the level of displacement. As far as the risk of mortality due to collisions is concerned, with the data currently available, it would seem that soaring species, and particularly Amur Falcons, might potentially be most exposed to this impact, and Blue Cranes to a lesser extent. Implementation of the proposed mitigation measures should reduce some of the envisaged impacts from medium to low, but while some impacts are low to start with, for others, very little practical mitigation is possible (see Tables 6.2 and 6.3). It is proposed to connect the wind farm substation to the existing 66 kV Melkhout / St. Francis overhead power line, which passes through the site. Currently two alternative alignments have been identified, but the connection points still need to be confirmed by Eskom. Irrespective of where the alignment is planned, it will need to be mitigated because of the high density of power line collision sensitive species, particularly Blue Crane and Denham's Bustard, on the site. As far as turbine layout alternatives are concerned, the preferred option (comprising 30.6 MW) is preferred from a potential bird impact perspective. The preferred option contains 30% fewer turbines compared to the alternative 1 layout of 50 MW, therefore the collision risk should be significantly less.

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Appendix 6.1: Bird habitat at the proposed Banna Ba Pifhu wind facility site

Figure 1: Irrigated pastures

Figure 2: Dryland pastures

Figure 3: Scrub

Figure 4: Wetland

Figure 5: Thicket

Appendix 6.2: List of species recorded at the proposed Banna Ba Pifhu wind facility site

African Black Swift	*Anhinga rufa*
African Darter	*Haliaeetus vocifer*
African Fish-eagle	*Apus barbatus*
African Goshawk	*Circus ranivorus*
African Marsh Harrier	*Anthus cinnamomeus*
African Harrier-hawk	*Polyboroides typus*
African Pipit	*Ortygospiza atricollis*
African Quailfinch	*Platalea alba*
African Sacred Ibis	*Saxicola torquatus*
African Spoonbill	*Falco amurensis*
African Stonechat	*Tachymarptis melba*
Alpine Swift	*Hirundo rustica*
Amur Falcon	*Apalis thoracica*
Barn Swallow	*Circus maurus*
Bar-Throated Apalis	*Lybius torquatus*
Black Harrier	*Ardea melanocephala*
Black-backed puffback	*Vanellus*
Black-Collared Barbet	*Oriolus larvatus*
Black-headed Heron	*Anthropoides paradiseus*
Black-headed Oriole	*Telophorus zeylonus*
Blacksmith Lapwing	*Crithagra sulphuratus*
Black-winged Lapwing	*Riparia paludicola*
Blue Crane	*Serinus canicollis*
Bokmakierie	*Corvus capensis*
Brimstone Canary	*Lamprotornis nitens*
Brown-Throated Martin	*Macronyx capensis*
Burchell's Coucal	*Cossypha caffra*
Cape Batis	*Anas smithii*
Cape Canary	*Passer melanurus*
Cape Crow	*Streptopelia capicola*
Cape Glossy Starling	*Motacilla capensis*
Cape Longclaw	*Anas capensis*
Cape robin-chat	*Ploceus capensis*
Cape Shoveler	*Cisticola textrix*
Cape Sparrow	*Bubulcus ibis*

Cape Teal	*Lanius collaris*
Cape Turtle-Dove	*Coturnix coturnix*
Cape Wagtail	*Sturnus vulgaris*
Cape Weaver	*Estrilda astrild*
Cape White-eye	*Vanellus coronatus*
Cattle Egret	*Neotis denhami*
Cloud Cisticola	*Dicrurus adsimilis*
Common Fiscal	*Alopochen aegyptiaca*
Common Quail	*Stenostira scita*
Common Sandpiper	*Megaceryle maximus*
Common Starling	*Hirundo cucullata*
Common Waxbill	*Coracias garrulus*
Crowned Lapwing	*Egretta alba*
Denham's Bustard	*Egretta garzetta*
Diderick Cuckoo	*Bostrychia hagedash*
Egyptian Goose	*Numida meleagris*
European Roller	*Passer domesticus*
Fiscal Flycatcher	*Buteo rufofuscus*
Forest Canary	*Larus dominicanus*
Fork-tailed Drongo	*Charadrius pecuarius*
Giant Kingfisher	*Euplectes progne*
Great Egret	*Galerida magnirostris*
Greater Striped Swallow	*Apus affinis*
Green wood-hoopoe	*Anthus similis*
Grey Heron	*Cisticola tinniens*
Hadeda ibis	*Cisticola fulvicapilla*
Hamerkop	*Hirundo dimidiata*
Helmeted Guineafowl	*Falco peregrinus*
House Sparrow	*Vidua macroura*
Jackal Buzzard	*Turdus olivaceus*
Kelp Gull	*Calandrella cinerea*
Kittlitz’s Plover	*Streptopelia semitorquata*
Knysna Woodpecker	*Fulica cristata*
Lanner Falcon	*Pternistis afer*
Large-billed Lark	*Phalacrocorax africanus*
Levaillant's Cisticola	*Falco rupicolus*
Little Egret	*Hirundo fuligula*
Little Grebe	*Mirafra africana*
Little Swift	*Telophorus olivaceus*
Long-billed Pipit	*Andropadus importunus*

Long-tailed Widowbird	*Laniarius ferrugineus*
Neddicky	*Columba guinea*
Olive Bush-shrike	*Eupodotis senegalensis*
Olive Thrush	*Euplectes orix*
Osprey	*Pandion haliaetus*
Pearl-breasted Swallow	*Threskiornis aethiopicus*
Peregrine Falcon	*Colius striatus*
Pied Crow	*Burhinus capensis*
Pin-tailed Whydah	*Plectropterus gambensis*
Red-billed Teal	*Buteo vulpinus*
Red-Capped Lark	*Cisticola lais*
Red-chested Cuckoo	*Ciconia ciconia*
Red-eyed Dove	*Phalacrocorax lucidus*
Red-knobbed coot	*Corvus albicollis*
Red-necked Spurfowl	*Apus caffer*
Reed Cormorant	*Anas undulata*
Rock Kestrel	*Cisticola juncidis*
Rock Martin	*Accipiter tachiro*
Rufous-naped Lark	*Dryoscopus cubla*
Secretarybird	*Sagittarius serpentarius*
Sombre Greenbul	*Vanellus armatus*
Southern Boubou	*Centropus burchellii*
Southern Grey-headed Sparrow	*Batis capensis*
Southern Red Bishop	*Zosterops virens*
Southern Tchagra	*Actitis hypoleucos*
Speckled Mousebird	*Chrysococcyx caprius*
Speckled Pigeon	*Crithagra scotops*
Spotted Thick-knee	*Phoeniculus purpureus*
Spur-winged Goose	*Ardea cinerea*
Steppe Buzzard	*Scopus umbretta*
Tambourine Dove	*Campethera notata*
Wailing Cisticola	*Falco biarmicus*
White Stork	*Tachybaptus ruficollis*
White-bellied Korhaan	*Corvus albus*
White-Breasted Cormorant	*Anas erythrorhyncha*
White-Necked Raven	*Cuculus solitarius*
White-rumped Swift	*Passer diffusus*
White-throated Swallow	*Tchagra tchagra*
White-winged Tern	*Turtur tympanistria*
Wood Sandpiper	*Hirundo albigularis*

Yellow Bishop	*Chlidonias leucopterus*
Yellow Canary	*Tringa glareola*
Yellow-billed Duck	*Euplectes capensis*
Yellow-fronted Canary	*Crithagra flaviventris*
Zitting Cisticola	*Crithagra mozambicus*
African Snipe	*Gallinago nigripennis*
Black Cuckoo	*Cuculus clamosus*
Black Sparrowhawk	*Accipiter melanoleucus*
Brown-hooded Kingfisher	*Halcyon albiventris*
Cape Grassbird	*Sphenoeacus afer*
Common Shrike	*Lanius collurio*
Greater Double-collared Sunbird	*Cinnyris afer*
Plain-backed Pipit	*Anthus leucophrys*
Three-banded plover	*Charadrius tricollaris*