Avian Wind Farm Sensitivity Map for South Africa

Criteria and Procedures Used

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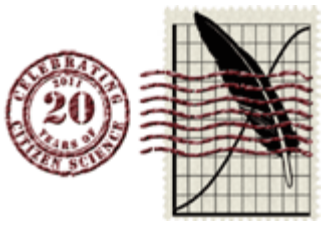

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1. Introduction

1.1. Background

During the Endangered Wildlife Trust-BirdLife South Africa Wind Energy Workshop held in Cape Town on 26 August 2010, the need for the development of an Avian Wind Farm Sensitivity Map for South Africa was identified. The purpose of the map would be to provide an indication of the geographic areas in South Africa where the establishment of wind farms might have a negative impact on birds. Such a map would identify areas of bird sensitivity in terms of the potential threats the wind energy development would have on a number of identified vulnerable species. At the Wind Energy Infrastructure Workshop, hosted by the Department of Environmental Affairs on 7 September 2010, it was conclusively agreed that such a sensitivity map would be of value in informing decision making, both for government and industry. This idea is also supported in the available international literature. For example, Madders and Whitfield stated "*The location of a wind farm is one of the few certainties known to affect the impact of a wind energy scheme on birds….Therefore spatial models that attempt to predict areas of greatest sensitivity for birds at the landscape scale can be useful design tools, enabling developments to be located so as to minimize the potential effects on identified key species*".[1]

This document sets out to achieve the following:

- Indicate possible factors, both site and species specific, that were considered when designing the sensitivity map; and
- Discuss the design of the map itself, for example the sensitivity levels that would be used for the map, colours to indicate these levels, etc.

However it should be made clear that this map must not replace pre- and post-construction bird monitoring or Environmental Impact Assessment studies. This map is a general attempt to provide guidelines to all role players where to place wind farms. At most, the map can provide guidance as to the effort required in terms of bird monitoring.

1.2. Factors to be considered

It seems as if there is a general consensus in the literature that there are three factors that should be considered when analysing the effect of wind farms on birds namely:

- Collision mortality – direct deaths due to collision with the wind turbine.
- Displacement due to disturbance, and including barriers to movement. This would include the effect of the wind turbines on birds in general due to, for example, maintenance activities and noise created by the wind turbines. The wind turbines can also create a barrier for flying birds especially where the wind turbines will be located along migration routes or in areas where birds fly between roost sites and foraging areas.

[1] (Madders and Whitfield 2006, P46)

- Direct loss of habitat to wind turbines and associated infrastructure; for example, access roads.[2]

In summary, there are therefore two main issues that should be considered. The species that will be directly affected by wind farm development, as well as the location of the property since the building and construction (and later associated infrastructure) will lead (to a smaller or larger extent) to habitat loss.

1.3. Data sources for species data and map resolution

A number of projects to collect bird distribution data exist in South Africa. Some of these are:

- Southern African Bird Atlas Projects 1 and 2 (SABAP1 and 2)
- Co-ordinated Waterbird Counts
- Birds In Reserves Project
- Coordinated Avifaunal Road Counts
- Data from Endangered Wildlife Trust (EWT) programmes

A considerable amount of data is therefore available to populate the sensitivity map. However there are a few facts to consider when trying to compare the datasets, namely:

- These data sources all make use of different resolutions; for example, quarter degree squares, 5 x 5 minute squares, and point data.
- None of these datasets alone will be able to provide us with enough data to create the sensitivity map for the whole of South Africa.
- The data were collected at different time periods.
- Different protocols were used to collect the data.

Of all the above mentioned data sources, the SABAP2 data provides the best bird distribution data for a large part of South Africa. There are a number of reasons for this statement:

- The data have been collected since 2007 and are therefore recent.
- The data are collected according to a 5'x 5' resolution. Taking into consideration that most wind farms, including the buffer which they might affect, would be larger than this area or very near to this size, this is considered to be an acceptable resolution for this map.
- All point data obtained from other data sources can be "upscaled" to the 5 x 5 minute grid level (this then also means that the exact locations of sensitive data such as bird nest sites will not be available to the public).
- The data are readily accessible to BirdLife South Africa through tools provided by the University of Cape Town's Animal Demography Unit.

[2] See for example (Bright *et al.* June 2006, P3), (Langston & Pullan 2002, P2) and (Madders and Whitfield 2006)

It was therefore decided to use the 5'x5' resolution (called a Pentad) of the SABAP2 project as the basis for the map.

However, in instances where the SABAP2 dataset does not provide sufficient coverage, SABAP1 data were used.

1.4. Data sources for properties

As will be indicated below when designing the map, it is important to take into consideration formal protected areas and areas covered by conventions and other programmes (for example, Ramsar and the Important Bird Areas (IBA) programme). Shapefiles for many of these areas are available from a number of government departments (i.e. Department of Environmental Affairs), SANBI as well as NGOs (for example the shapefile for the Important Bird Areas Programme which is owned by BirdLife South Africa).

When working with these files, care should be taken that they are in the correct datum and projection and therefore comparable in a GIS system.

2. Map criteria based on status of sites

This section will discuss the areas in South Africa that should be considered as unsuitable for a wind farm due to the protected status (legal and non-legal) of the area. These sites were attributed a high sensitivity status and a buffer zone of roughly one pentad was added to the protected areas.[3]

2.1. Formal Protected Areas

South Africa has a large and well established protected areas network. The National Environmental Management Protected Areas Act (Act 57 of 2003) is the main piece of legislation for the governance, management, regulation and monitoring of protected areas in South Africa. This act recognises the following categories of protected areas:

- Special Nature Reserves
- National Parks and Nature Reserves (including provincial nature reserves)
- Protected Environments
- World Heritage Sites declared in terms of the World Heritage Convention Act. (Act 49 of 1999)
- Marine Protected Area (not relevant to this project)
- Special protected forest areas
- Mountain catchment areas declared in terms of the Mountain Catchment Areas Act (Act no 63 of 1970)[4]

[3] For example see buffer zones suggested in (Cape 2006, P24-P25) namely 2 km for Protected Areas, 2 km from major wetlands (Ramsar sites), 500 m for other wetlands and 500 m from bird breeding sites and avian flight paths.

[4] (National Protected Area Expansion Strategy Resource Document, 2009, P11-12)

This legislation excludes the establishment of industrial developments (including wind farms) inside formal protected areas.

Shapefiles that indicate the boundaries of some of these formal protected areas are available from the website of the Department of Environmental Affairs and other sources.

2.2. Ramsar sites

Ramsar sites are wetlands that fall within the criteria as set out by the Convention on Wetlands (Ramsar 1971). South Africa is a signatory to this Convention and, although Ramsar sites do not have legal status, the South African Government has an obligation to protect these areas (industrial developments are prohibited in Ramsar sites). It would also not be in the best interest of the wind farm industry to place wind farms in areas that are under the protection of an international agreement.

A shapefile for Ramsar sites is available from the website of the Department of Environmental Affairs.

2.3. Important Bird Areas

The *Important Bird Areas of Southern Africa* directory was compiled in 1998 (Barnes 1998) and identified within South Africa 122 Important Bird Areas (IBAs) containing 59 threatened and 64 near-threatened bird species[5]. All these IBAs were objectively determined using established and globally accepted criteria. An IBA is selected on the presence of the following bird species in a geographic area:

- Bird species of global or regional conservation concern;
- Assemblages of restricted-range bird species;
- Assemblages of biome-restricted bird species; and
- Concentrations of numbers of congregatory bird species.

Since 1998 two more IBAs have been declared bringing the total number of IBAs to 124.

Although Important Bird Areas do not have any legal status, these sites are important for bird conservation and therefore have been included in the sensitivity map.

A shapefile for Important Bird Areas is available from BirdLife South Africa and can be downloaded from their website (www.birdlife.org.za).

2.4. Sites with Congregatory Birds

The establishment of wind farms near localities that host a large number of birds, either on a permanent basis or as occasional roosting or breeding site, should be discouraged. The inclusion of a buffer zone around these areas has been considered.

[5] (The Eskom Red Data Book of the Birds of South Africa, Lesotho and Swaziland 2000)

The following category of birds should be considered here:

- Large congregations of water birds (including waders).[6]
- Birds of prey that roost communally; for example, Lesser Kestrels and Amur Falcons.[7] Both these species roost in large numbers at specific places throughout their range in southern Africa and from there disperse to their feeding areas during the day. A buffer zone around each of these roosting sites was considered. The buffer zone only covers the immediate area around the roost site and not the whole foraging area and was therefore limited to 3 km. This value was based on subjective expert opinion and might be revised in the future.
- Barn Swallows roost in very large numbers in reedbeds, with some roosts numbering millions of birds. Mass mortalities could be expected if wind farms were located close to these roost sites.
- Buffer zones around known nesting sites.[8] This could include vulture colonies (Cape Vulture and White-backed Vulture), Southern Bald Ibis colonies or other nesting sites (for example birds of prey nest sites).
- Buffer zones around vulture restaurants.

3. Criteria based on species

3.1. Species of Conservation Concern

Countries have a legal and moral responsibility to conserve their biodiversity, especially species which are of conservation concern. It therefore makes sense to consider the distribution of species of conservation concern when developing an avian sensitivity map. This approach was also followed in Scotland with the design of the country's bird sensitivity map[9] and it was proposed by Anderson *et al.*[10] as the first species that should be taken into consideration when doing on-site surveys and monitoring.

Species of conservation concern were included in the species list even if a species is not susceptible to collision with a wind turbine as it might be negatively affected by some of the other factors mentioned above (such as habitat loss) or even infrastructure associated with the wind turbines, such as roads, buildings and power lines.

There are two levels of species of conservation concern in South Africa. Firstly, those species listed on a global level by the International Union for Conservation of Nature (IUCN). The categories used, in order of conservation level, are Extinct, Critical Endangered, Endangered, Vulnerable, Near-threatened and Least Concern. For purposes of the sensitivity map, the Extinct and Least Concern categories should be ignored.

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[6] (Edkins 2008, P 13)

[7] See the Kestrel project (see www.kestreling.com and www.natworld.org).

[8] (Anderson *et al.* 1999, P15)

[9] (Bright *et al.* 2006, P3)

[10] (Anderson *et al.* 1999)

The list is managed by the IUCN and updated annually by BirdLife International. The list of species is available on the IUCN and BirdLife International websites.

Secondly, there is a national red data list which is based on the publication *The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland*.[11] This book was published in 2000 and will be revised by 2013. The categories of conservation concern are the same as for the global red data list.

Both the global and national red data lists for birds include marine and terrestrial birds. As the sensitivity map will only be applicable to wind farms on land, all marine species were ignored for the purposes of this exercise. Furthermore all vagrant species were also excluded.

3.2. Endemic species, including breeding endemics

Endemic species are species whose breeding and non-breeding ranges are limited to a certain geographic region. For the purpose of this map this region would be South Africa, Swaziland and Lesotho. In addition to this category, breeding endemics were also added. These are bird species whose distribution is wider than South Africa but they only breed within the boundaries of South Africa.

As the survival of these species is dependent on the conservations actions taken within South Africa, these species were considered for inclusion in the sensitivity map.

The list of endemic birds used for this map is in line with the BirdLife South Africa Checklist of Birds in South Africa 2011 with the addition of a few species whose ranges overlaps with Lesotho and Swaziland.

3.3. Species which might be sensitive to wind farms

A number of studies have been published indicating which species or groups of birds might be sensitive to wind farms.[12] Below is an attempt to list the order, families or species as listed in these studies.

Non-Passerines

The following species can be listed in this category:

Accipitridae Raptors (i.e. Hawks, Buzzards, Kites, Eagles, Vultures, Snake-eagles,	Langston and Pullan[13] listed *Accipitridae* as a group of birds that might be especially sensitive to wind farms. This is supported by a number of other studies.[14] [15] [16] [17] Madders and Whitfield also

[11] (The Eskom Red Data Book of the Birds of South Africa, Lesotho and Swaziland, 2000)

[12] (Langston & Pullan 2002, P 3)

[13] (Langston & Pullan 2002, P 3)

[14] (Madders and Whitfield 2006, P 45)

[15] See also (Edkins 2008 P3) which list species killed at a number of sites. The raptor species listed include Vultures, Hawks and Falcons.

Harriers, Goshawks and Sparrow-hawks). Kestrels (*Falconidae*) and Secretarybird (*Sagittariidae*).	states: "*…there is a degree of consensus that raptors may be more vulnerable to collision than several other bird groups….This may be due to generally lower displacement or avoidance effects, although several other factors have been postulated as influential"*.[18] In line with the thought that all raptors are sensitive to wind farms, it was felt that all families under the order *Falconiformes* should also be added. [19]
All owl species (*Tytonidae* and Strigidae).	Langston and Pullan did not consider any owl species however Edkins listed the deaths of Eagle Owl (*Bubu bubo*) for Europe[20] and Burrowing Owl (*Speotyto cunicularia*) deaths at the Altamont Pass California.[21] Owls are also active during the night which increases their likelihood of collision with turbines.[22]
Whistling Ducks (*Dendrocygnidae*) and Ducks and Geese (*Anatidae*).	Edkins listed a number of duck species mortalities in Europe.[23]
Sandgrouse (*Pteroclidae)* Cranes (*Gruiidae*) and Bustards (*Otididae*)	The Langston and Pullan list does mention Grouse but not Sandgrouse (*Pteroclidae*) which it is thought should be included due to the size of the species. Cranes (*Gruiidae*) and Bustards (*Otididae*) are mentioned in the Langston and Pullan list. The U.S. Fish and Wildlife Services also indicated that Whooping Cranes might be affected by wind farms.[24]
Scolopacidae (Snipes, Godwits, Curlews, Whimbrels, Stints, Sandpipers, Ruffs, Turnstone, Phalaropes). *Charadriidae* (Plovers, Lapwings)	Langston and Pullan as well as Edkins[25] mention waders in the order *Charadriiformes*. For the South African list terrestrial species within the family *Scolopacidae* and *Charadriidae* have been considered.

[16] In (Edkins 2008, P 5-6) a table is produced with a list of species killed by wind farms in Europe. Raptors feature a number of times in this table (eagles, vultures, kites, buzzards, hawks, harriers and kestrels), but also a number of other species including waterbirds and even passerines.

[17] (Erickson *et al*. 2001), (Thelander and Rugge 1998)

[18] (Madders and Whitfield 2006, P 46)

[19] See also (Edkins 2008, P i) where Kestrels and Hawks are listed as birds that are killed by wind farms.

[20] (Edkins 2008, P 5-6)

[21] (Edkins 2008, P 3)

[22] (Anderson *et al.* 1999, P 15)

[23] (Edkins 2008, P 5-6)

[24] (U.S. Fish and Wildlife Services 2009, P 17)

[25] (Edkins 2008, P 5-6)

Within the family *Scolopacidae* only Snipes, Stints, Sandpipers, Ruffs and Phalaropes. All species within *Charadriidae*.	
Herons, Bitterns (Ardeidae), Storks (*Ciconiidae*) and Ibises and Spoonbills (*Threskiornithidae*).	Langston and Pullan as well as Edkins[26] list herons and storks within the order *Ciconiiformes* as being vulnerable species.
Flamingoes (*Phoenicopteridae*).	A family group that should be included due the large size of the birds.
White-winged Tern, Whiskered Tern and Caspian Tern.	Edkins[27] does list a number of tern fatalities but the species mentioned are al restricted to marine or coastal habitats. Only terns which are located inland should be considered.

Passerines

With regard to passerines the following statement is of importance: *"…it is suggested that limited information existent on passerines collisions with wind turbines is probably due to a combination of fewer studies, lower detection rates, and rapid scavenger removal*".[28] The same study warns that "*nocturnal migrating passerines*" might be especially vulnerable to wind farms.[29] The report by Erickson *et al.*[30] list numerous passerine species killed at wind farms in the United States. For example, at one wind farm, 15 of the 25 species killed were passerines[31] and, at another study, 76.4% of the species killed were passerines.[32] At a wind plant in Wyoming, 91% of the 95 fatalities were passerines. However it is important to note that most of these passerines were nocturnal migrant passerines.[33] As migration patterns in South Africa differ vastly from those in America, it cannot be directly inferred that so many passerines in this category would be killed in South Africa.

In a study by Thelander and Rugge[34], a number of passerine species are listed as fatalities at the Altamont WRA. Some of these include doves, larks, swallows, starlings and warblers.

[26] (Edkins 2008, P 5-6)
[27] (Edkins 2008, P 5-6)
[28] (Edkins 2008, P i).
[29] (Edkins 2008, P 4)
[30] (Erickson *et al.* 2001)
[31] (Erickson *et al.* 2001, P 13)
[32] (Erickson *et al.* 2001, P 14)
[33] (Erickson *et al.* 2001, P 14)
[34] (Thelander & Rugge 1998, P 12)

However, even with a high number of passerines killed in the rest of the world by wind farms it is not practical to list all passerine species in South Africa. It is proposed that only those passerine species of conservation concern be listed or any other passerine species where there is empirical evidence that the species is sensitive to wind farms in South Africa.

Nocturnal flying species

Dirksen *et al* states "*One of the most important conclusions of Winkelman's studies*[35] *was that collision risks are highest during darkness, in particular during very dark nights and during nights with bad weather".*[36] Using a number of methods and tools, including radar, they identified a number of species that migrate or move between feeding areas and roosting sites during the night. These species include waders (godwits, oystercatchers, plovers and dunlins), gulls and ducks (only Tufted Ducks and Pochards – however ducks were recorded flying over the lake where they roost during the night).

4. Process employed to design map

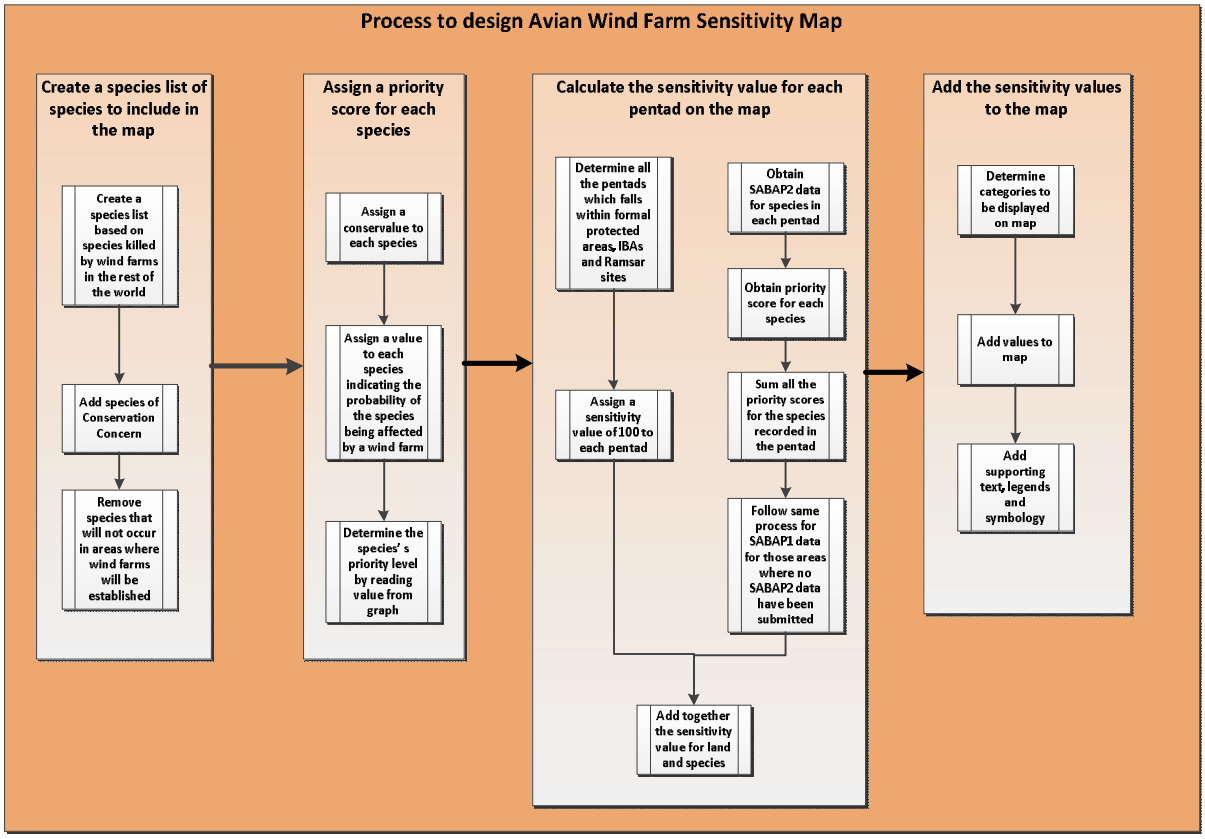
Below is a short summary of the steps that were followed to design the map:

- *Created a species list* for all birds to be considered for inclusion in the map. This includes species believed likely to be influenced by wind farms.
- *Assigned a priority score to each species*. This is through combining the conservation status of species and the probability of each species being affected by wind farms. Three sub-steps were followed here:
    - Assigned a conservation score to each species
    - Assigned a risk score to each species
    - Determined the priority score based on the conservation score and risk score of the species
- *Calculated the sensitivity value* for each pentad on the map. Three sub-steps were followed here:
    - Determined which species have been recorded at pentad level
    - Sum the total priority scores for all species recorded to obtain a sensitivity score
    - Add the sensitivity score for the status of the land to the above species sensitivity score
- *Add the sensitivity values* to the map

More detail about each of these steps will be provided in the text below. The following graph indicates the steps in graphic format.

[35] (Winkelman 1992)

[36] (Dirksen, Spaans & Van Der Winden 1998, P 97)



4.1. Creating the Species List

Creating a list of species to consider for inclusion in the map turned out to be a considerable challenge. As there is no information available in South Africa to indicate which species might be affected by wind farms it was no easy task to predict which species would be affected by wind farms. It was as difficult to assign priority scores to each species (see next point). The process set out below is the end result of considerable consultation with a number of avian experts, especially within BAWESG.

The following process was followed to create the list of species:

- A draft species list was created based on the family groups of bird that were killed or otherwise affected by wind farms in the rest of the world. Other families of birds that do not occur in the rest of the world and that might be affected by wind farms (for example all larger birds) were also added to the list.
- To this initial list were added species of Conservation Concern and endemic species.
- The initial list contained more than 250 species. With a process of elimination, the number of species was considerably reduced. For example species that are vagrants or rare were removed.
- Priority scores were then assigned to each species as discussed below.

- A conservation score was obtained by summing the scores for conservation status, endemic status and range size (conservation score = conservation status score + endemic status score + range size score).
- A risk score was calculated by summing all the other values linked to the structure and behaviour of each species.
- The final species priority score was then calculated by multiplying the risk score by two. This was done in order to give the risk score more weight. Although the conservation status of a species is important in terms of its conservation, it is the real risk to the species being affected by a wind farm that is crucial – therefore the added value to this aspect of the analysis.
- It was then decided to use the species priority score of 170 as the cut-off point. Species below this cut-off was deemed to be of a sufficient low risk not to be included in the analysis and species above as species that will add value to the map. The final list therefore contains 105 species. For a list of these species see Annexure A.

It is important to acknowledge the fact that many of the values assigned to species and the factors considered are based on expert opinion. As we have no experience or data to base our data on, it is not possible to make definitive statements. However it is hoped that as more monitoring is done the quality of data used for this map will improve considerably.

4.2. Assigning Species Priority Scores

A number of factors have been used to assign a priority score to each species. These factors can be divided into three broad categories namely the conservation status of the species, susceptibility to wind farm collisions based on structural factors of and susceptibility due to the behaviour of species. Each of the categories will be discussed below:

Conservation Status of Species

The level of conservation concern of a species (i.e. Critical Endangered, Endangered, Vulnerable and Near-threatened) will be an indication of the value of the species for conservation purposes. In order to determine a priority score the categories were sorted in order of importance and a species was allocated to the highest category. So a species that have a global conservation status of vulnerable but a regional status of endangered the species has been assigned the priority score for endangered.

The following priority scores have been assigned to each category of conservation concern:

- Species of Conservation Concern Globally Critical Endangered: 100
- Species of Conservation Concern Nationally Critical Endangered: 100
- Species of Conservation Concern Globally Endangered: 90
- Species of conservation Concern Nationally Endangered: 90
- Species of Conservation Concern Globally Vulnerable : 70
- Species of Conservation Concern Nationally Vulnerable: 70
- Species of Conservation Concern Globally Near-threatened: 50
- Species of Conservation Concern Nationally Near-threatened: 50

Endemic status of a species has also been considered in this category. The following priority scores have been assigned:

- Endemic Species: 20
- Near-Endemic Species: 15

In addition it was decided to also use the range size of a species as motivation. It is clear that due to the geographic extend of wind farms and especially the cumulative effect that potentially a large percentage of a species distribution can be affected by wind farms. This is truer of species with a limited range. Therefore it was decided to give species with a restricted range more priority by assigning the following values to each species:

- Limited range 15
- Very limited range 30

Structural Factors

As indicated above an analysis of species that have been killed by wind farms in the rest of the world, clearly shows that larger species are more susceptible to collisions (see point 3.3 above). One of the factors therefore considered is the size of the bird. In this regard the following scores have been assigned:

- Very large birds 30
- Large 30
- Medium 15
- Small 2
- Very Small 0

Behavioural Factors

A number of behavioural factors has been identified that contributes to a bird's susceptibility to collide with wind farms. For each of these factors a score has been assigned on their perceived risk factor.

Soaring

Soaring birds to a large extend use the same wind sources as do wind turbines. They also prefer mountain ridges were many wind farms will be established. So there could be a potential conflict between wind farms and soaring birds. This criteria tries to accommodate this potential conflict.

- Always, including slope soaring 20
- Always 15
- Usually 10
- Regularly 5
- Never 0

Predatory

Many of the species killed by wind farms are also predatory in nature (see point 3.3 above) and has therefore been added as a factor to consider. This might be due to the fact that they get killed when they fly into a wind turbine as they fly after their prey at high speeds.

- Highly 10
- Partially 5
- Never 0

Ranging behaviour

Another common characteristic of birds affected by wind farms in the rest of the world is that they have very wide ranging behaviour. This factor has therefore also been added.

- Very wide 15
- Long, daily commuter 10
- Wide 5
- Sedentary 0

Flocking behaviour

Birds in large flocks might be killed in a large event as they fly close together. Also many flocking species are in the group of birds that are killed by wind farms.

- Always 10
- Sometimes 5
- Never 0

Night flying

There is evidence that species that fly at night are more susceptible to collisions than diurnal species (see point 3.3 above). This is most probably due to the fact that for most species their vision at night is not as good as during the day and they will not be able to see the wind turbines at night. The categories below make provision for species that are active during dawn to species that are active at night. The most susceptible species are those that commute during night from roosting sites to feeding areas or between feeding areas as for example between water bodies.

- Nocturnal commuter 15
- Nocturnal 10
- Crepuscular 5
- Sometimes crepuscular 2
- Diurnal 1

Aerial display

Many bird species have aerial displays at about the height of the wind turbine. In fact certain species might never fly at the height of a wind turbine except when they are doing their aerial displays during breeding season. This is therefore a risk factor that needs to be considered in the analysis.

- Frequent 10
- Occasional 5
- Never 0

Habitat preference

Most wind farms will most probably be established in open areas and especially those areas with an open relief. The influence of wind farms on species in forests, for example, would therefore be minimal or even nonexistent (except where they might move between forested areas over an open area). However species that frequent open areas would carry a higher risk factor as indicated below.

- Open with relief 40
- Open 30
- Semi-open 20
- Closed 0

Sensitivity to disturbance

Most probably the biggest effect on birds by wind farms will be in terms of displacement and not collision. Many species that are sensitive to any form of development or disturbance in their area will abandon such an area and move to other suitable areas if available. Each bird species have been assigned a value based on their sensitivity. In many instances there will be a direct link to the conservation status of the species and the sensitivity value of a species. “Urban” species have also adapted to disturbance and have been assigned a lower value than “rural” birds which might not have adapted as well.

- High 10
- Medium 5
- Low 0

Overlap with wind farms

During the analysis of the species list it became clear that there are numerous species that score a high priority value but will never really occur in the same area as a wind farm. In some species there might be a small overlap. It was therefore decided to take this factor into consideration in the analysis by assigning a value to each species based on the overlap of the species with a wind farm.

- Definite Overlap 30

- Possible Overlap 10
- No Overlap 0

4.3. Calculating the Sensitivity Values

Introduction

The basic purpose of the sensitivity map is to allocate a sensitivity value to a geographic area of the country. As indicated earlier, sensitivity values are based on two factors the protection status of the land and secondly the status of the species.

Status of the land

With regard to the *status of the land,* it was decided to assign one sensitivity score to each pentad within a formal protected area, Ramsar site or Important Bird Area. The reason for doing so is based on the following argument. The purpose of the map is to indicate how sensitive the species or the land is in terms of wind farm development. Formal protected areas, Ramsar sites or IBAs indicate the same sort of value in terms of this sensitivity – there are birds (and other taxa) in those areas that might be negatively influenced by a wind farm (or any other development in that area). The fact that the one area has a higher level of protection than the other does not make the area more sensitive in terms of the birds that occur there. On the contrary we might be able to argue that in terms of sensitivity with regard to birds, the IBAs might be more important than areas that will have a higher level of protection for there might be formal protected areas with few threatened bird species while IBAs will contain more of those species.

So following this argument it is believed that it is correct to assign all “protected areas” the same sensitivity level.

For the purpose of this map, all pentads within Formal Protected Areas, IBAs and Ramsar sites (with a buffer zone of one pentad around each formal protected area also included), were assigned a sensitivity value of 100.

Water bodies such as rivers, estuaries and wetlands

During discussions with experts considerable concerns were expressed about the possible effect of wind farms on water birds. During the first iterations of the species list water birds were included in the species list. However this inclusion resulted in a very long list of species and it was decided to remove water birds from the list and cater for them by adding a sensitivity value of 75 to all pentads where large water bodies occur.

For this purpose the maps created by the National Freshwater Ecosystems Priority Areas (NFEPA) project were used (see http://gsdi.geoportal.csir.co.za/projects/national-freshwater-ecosystem-priority-areas-nfepa-project). The project is a “multi-partner project between the CSIR, Water Research Commission, South African National Biodiversity Institute, Department of Water and

Environmental Affairs, South African Institute of Aquatic Biodiversity and South African National Parks" and maps all the water bodies within South Africa.

Due to the large number of water bodies listed in these maps it would have been ineffective to consider all the water bodies for inclusion. It was therefore decided to only include those water bodies listed as "Floodplain wetland" and "Estuaries". These included most river systems as can be seen from the map below.

Status of the species

SABAP2 and SABAP1 data

As indicated, the geographic area or pentad where a species to be considered is located should be provided a sensitivity value based on the species that have been recorded in the pentad.

The following process was followed to achieve this:

- SABAP2 records of all the species to be considered for this map were received from the Animal Demography Unit.
- The priority score for all species were obtained and summed per pentad.

For areas where no SABAP2 data are available, all pentads within a QDS were assigned a sensitivity value based on the species recorded in the QDS for the SABAP1 data. In instances where there is not a high diversity of habitats within a QDS (for example, areas in the Northern Cape) this process should provide an accurate sensitivity value for each pentad. However in QDS with a high diversity of habitats the sensitivity values might not be a fair reflection of the situation on the ground. However, this is the only other available option and as more and more data are received for SABAP2 the accuracy of the sensitivity levels will improve.

Other data sources

During the first "experimental" version of this map the option was considered to add vulture colonies, Lesser Kestrel and Amur Falcons roost sites as well as other data such as Blue Swallow nest sites to the map by giving areas where these sites occur extra sensitivity. However doing this skewed the data on the map and complicated analysis considerably. It was therefore decided to have different maps for vulture colonies (including a buffer zone of 40km) and Kestrel and Amur Falcon Roost sites (3km buffer):

- Cape Vulture Colonies: A list of Cape Vulture Colonies for the Western and Eastern Cape were received from Dr André Boshoff. In addition, known Cape Vulture Colonies in the rest of the country have also been added to the map.
- Lesser and Amur falcon roost sites were added to the map based on information received from the kestrel monitoring programme (www.kestreling.com).

Final Calculation

Based on these two categories the sensitivity value for the pentad (the unit used to designate the geographic area) was calculated as follows. The species priority score for each species as well as the sensitivity value for the land that occur in a pentad were counted together to obtain a score for that pentad. For example, four threatened species are recorded in a pentad with the following priority scores: 395, 300 and 200, 150.The land sensitivity score for the pentad is 100. These scores are then summed to obtain an overall score of 12145 for the pentad. Finally the score was divided by 10 to make it easier to plot the values on the map.

4.4. Displaying the Sensitivity Values on the Map

A number of options to indicate the sensitivity levels on the map have been tried and tested. Two of these are:

- Indicate the sensitivity by only three levels; for example low, medium and high sensitivity. Each category can then be assigned a different colour to make it easy to identify the relevant category.
- Indicate the sensitivity level using one colour graded from light to dark. The categories to be created can be selected using ArcView to reflect different levels of sensitivity.

The first option provided a number of problems. Firstly, due to the large number of species to be considered for this project, the sensitivity scores covered a large range – from 1 to nearly 400. This made it extremely difficult to assign sensible values to only three categories. Within each category the difference between the highest and lowest value was too far apart and valuable information was lost.

There was furthermore the worry that areas indicated in red can be perceived as “No Go” zones and as indicated in the Introduction it is not the purpose of the document to indicate such zones.

The second method was found to be of more value. Any number of categories can be selected and a more detailed map is the result. The problem with perceived “No Go” zones is also largely eliminated.

The Natural Breaks (Jenks) classification system has been used. According to this is an international accepted statistical method to classify data “based on natural groupings inherent in the data. Class breaks are identified that best group similar values and that maximize the differences between classes. The features are divided into classes whose boundaries are set where there are relatively big differences in the data values”.

5. Confidence factor

It is clear that there are a number of factors that will significantly influence the accuracy of the map. One of these is the accuracy of the data that have been used to populate the map. It is clear that the number of SABAP2 lists that have been submitted per pentad will significantly affect the number of species recorded – that is up to a point of about 7-10 lists after which the number of species added to the list will decline significantly. With regard to SABAP1, studies have indicated that after about 7 lists the number of new species added to a list decline considerably.

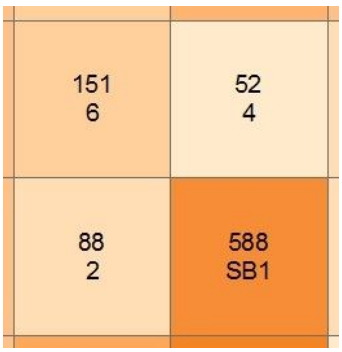
A very basic confidence factor has therefore been designed based on the number of lists submitted. With 1 list the factor will be very low but for any pentad with more than ten lists the confidence factor will be high. The table below indicates the confidence factor in relation to the number of lists submitted.

Number of Lists Submitted	Confidence Factor
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10 Plus	10
SABAP1 Data	SB1

This score will be indicated on the map to assist with the evaluation of the data on the map.

6. Publication of the Map

It is important that the map is easily accessible to the general public as well as developers, EIA specialists and other role players. The best way to make the map available is through internet services and by overlaying the map onto Google Earth. Any person can therefore navigate to the proposed development site and determine the sensitivity values.



Each pentad on the map will have a colour according to the sensitivity value of the area as well as two values (see example to the right):

- The top value will indicate the sensitivity value
- The bottom value the data confidence factor (in percentage)
- In the case where only SABAP1 data have been used the lower value will be SB1

However there is an inherent risk that the data can be misused or misinterpreted, especially if the data confidence factor, as described above, is not taken into consideration. A decision has therefore been taken to create a web page whereby the following warnings/disclaimers/notes will be published before a person can view the map:

- The sensitivity map **does not** replace the EIA or pre- and post-construction monitoring processes. At most, the map provides some guidance as to the level of monitoring that should be done.
- The map **does not** indicate "No-Go" zones. Even areas with high sensitivity values do not mean that a wind farm cannot operate in the area without any detriment to birds. What it does indicate is a high risk value and something the wind farm developer should seriously take into consideration when considering different areas for possible development.
- The sensitivity values on the map are influenced by the extent of the available data. The confidence factor should therefore be taken into consideration when evaluating the data. A pentad with a low number of species and a low number of cards might mean that there could possibly be more species in the area that have not been recorded.
- Some of the data on the map are based on SABAP 1 which might be outdated.
- Please refer to the Document entitled "Avian Wind Farm Sensitivity Map for South Africa: Criteria and Procedures Used" which can be downloaded here: …….. for details as to how the map was designed.

The user of the map will then have to click on a link indicating that the above notes have been read and understood. After doing so the person will be able to view the map.

7. Conclusion

It should be clear from the above description that the Avian Wind Farm Sensitivity Map remains a work in progress. As new data are received, the sensitivity values on the map will undoubtedly be affected. More atlas lists will provide a better idea on bird distribution and, as wind farms are erected, we will understand better as to which species will be affected by wind farms which will necessitate a change in the values that have been assigned for species on the map.

When analysing the map, this fact should be kept in mind. Especially for those areas with a few lists care should be taken when making decisions.

An earlier warning should also be repeated (and emphasized) that this map in no way replaces pre- and post-construction bird monitoring and Environmental Impact Assessment Studies at wind farms.

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9. Annexure A: List of Species considered for Avian Wind Farm Map

Below is a list of species that were considered for inclusion in the Avian Wind Farm Sensitivity Map for South Africa.

The priority score that has been assigned to each species is listed in the last column.

Common Names	Species Priority Score
Bearded Vulture	**395**
Cape Vulture	**385**
Wattled Crane	**349**
Southern Bald Ibis	**330**
Martial Eagle	**330**
Black Harrier	**325**
Ludwig's Bustard	**320**
Blue Crane	**320**
Secretarybird	**320**
Black Stork	**310**
Great White Pelican	**310**
Blue Swallow	**304**
Taita Falcon	**304**
African Marsh-Harrier	**300**
Pink-backed Pelican	**300**
Denham's Bustard	**300**
Grey Crowned Crane	**294**
Greater Flamingo	**290**
Lesser Flamingo	**290**
Peregrine Falcon	**290**
Yellow-billed Stork	**290**
Verreauxs' Eagle	**290**
African Fish-Eagle	**290**
Southern Ground-Hornbill	**290**
African Grass-Owl	**289**
Lesser Kestrel	**284**
White-headed Vulture	**280**
White-backed Vulture	**280**
Kori Bustard	**280**
Lanner Falcon	**280**
White-bellied Korhaan	**270**
Tawny Eagle	**270**
Lappet-faced Vulture	**270**
Blue Korhaan	**270**
African Crowned Eagle	**270**

Damara Tern	**264**
Pallid Harrier	**260**
Red Lark	**260**
Bateleur	**260**
Hooded Vulture	**250**
Cape Eagle-Owl	**250**
Jackal Buzzard	**250**
Botha's Lark	**250**
White-winged Flufftail	**250**
Bat Hawk	**245**
Yellow-breasted Pipit	**245**
Black-winged Pratincole	**242**
Woolly-necked Stork	**240**
Marabou Stork	**240**
Sclater's Lark	**240**
Rudd's Lark	**240**
Yellow-throated Sandgrouse	**235**
Agulhas Long-billed Lark	**235**
Booted Eagle	**230**
Black-chested Snake-Eagle	**230**
Cape Cormorant	**230**
Chestnut-banded Plover	**230**
White Stork	**220**
Saddle-billed Stork	**220**
Black Kite	**220**
Caspian Tern	**220**
Barlow's Lark	**210**
Ayres's Hawk-Eagle	**210**
Montagu's Harrier	**210**
Amur Falcon	**210**
Steppe Buzzard	**210**
Verreaux's Eagle-Owl	**210**
Cape Parrot	**209**
Southern Black Korhaan	**200**
Southern Pale Chanting Goshawk	**200**
Black-bellied Bustard	**200**
Cape Rock-jumper	**200**
Drakensberg Rock-jumper	**200**
Southern Banded Snake-Eagle	**195**
White-backed Night-Heron	**194**
Karoo Korhaan	**190**
Osprey	**190**
Grey-winged Francolin	**190**
Marsh Owl	**190**

Wahlberg's Eagle	**190**
African Harrier-Hawk	**190**
Long-crested Eagle	**190**
Short-tailed Pipit	**185**
Buff-streaked Chat	**185**
Black-winged Lapwing	**184**
Mountain Pipit	**180**
Northern Black Korhaan	**180**
Melodious Lark	**180**
Brown Snake-Eagle	**180**
African Hawk-Eagle	**180**
Rosy-throated Longclaw	**180**
Short-clawed Lark	**175**
Black-shouldered Kite	**174**
Greater Kestrel	**174**
Red-necked Falcon	**174**
Red-footed Falcon	**174**
Spotted Eagle-Owl	**170**
Forest Buzzard	**170**
Black Sparrowhawk	**170**
Rufous-chested Sparrowhawk	**170**
Broad-tailed Warbler	**170**
Shelley's Francolin	**170**
Palm-nut Vulture	**170**
Victorin's Warbler	**170**
Black-rumped Buttonquail	**170**