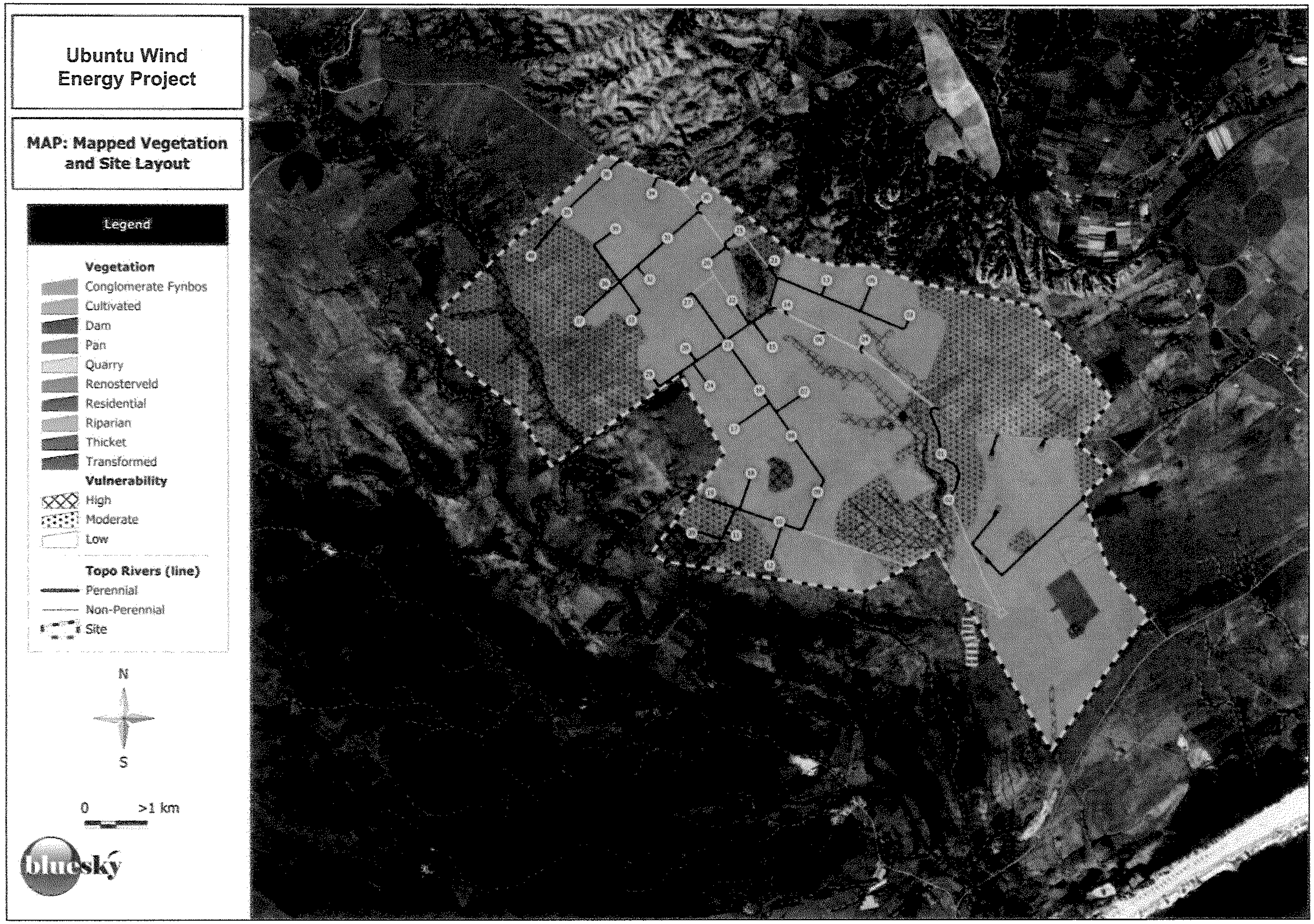

Figure 5.43: Mapped Vegetation communities with alternative B layout overlain (V100).

5.4.3.3 Alternative C: 33 X 3MW Turbines (V112)

Proposed alternative Layout C will comprise 33 x 3 MW wind turbines with associated access roads and cabling (see Figure 5.44). Existing roads have been utilised as far as possible, which will serve to reduce overall impacts to some extent.

The resulting loss of habitat will be proportional to the area vegetation clearing required to construct the access roads, cabling and 40 turbine sites with associated hard-standing surfaces. Overall this is likely to result in a slightly lower impact (due to the lower number of hard-standing surfaces) to the overall site than alternative A, although access roads will still be required.

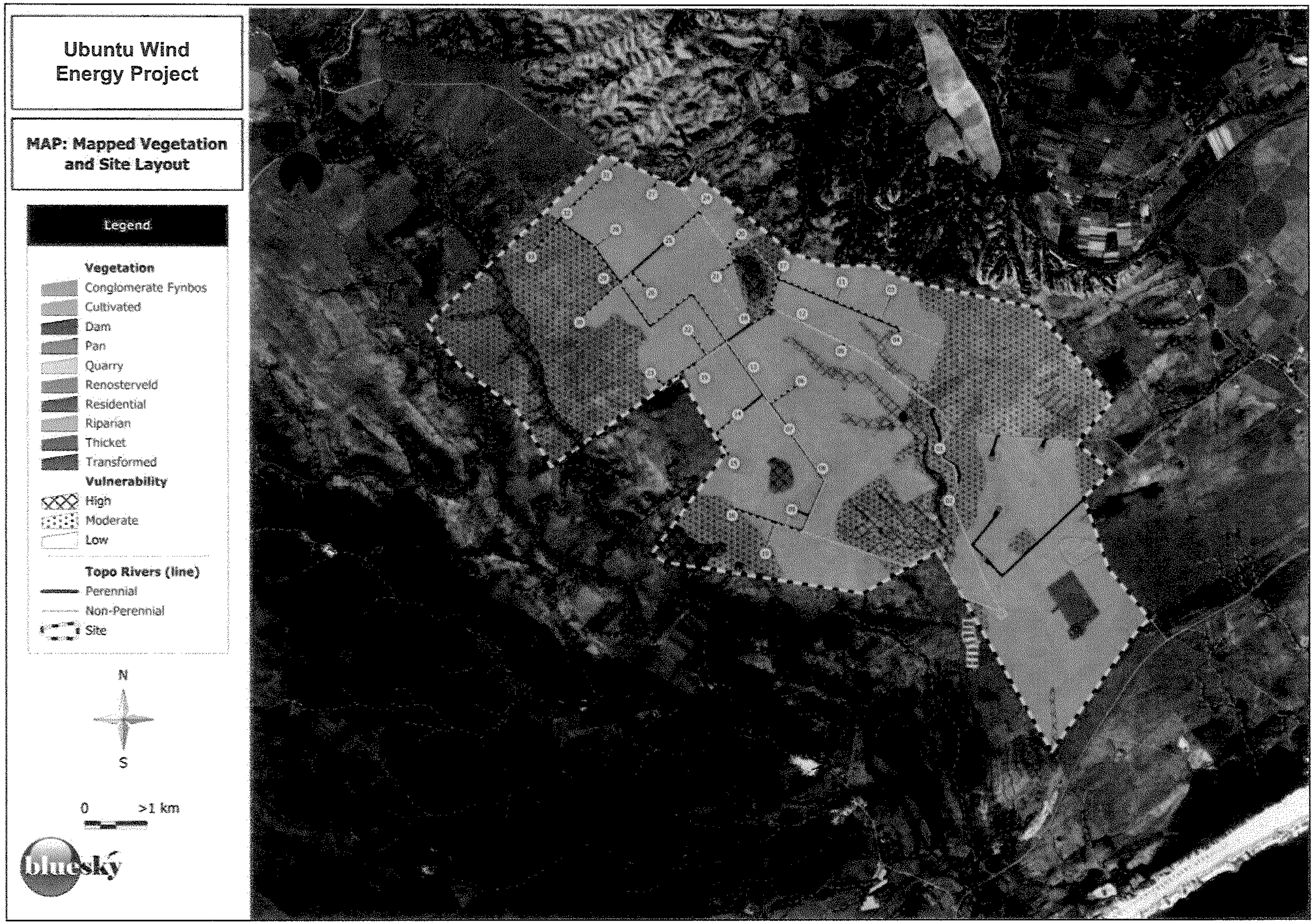

Figure 5.44: Mapped Vegetation communities with alternative C layout overlain (V112).

5.5 PERMIT REQUIREMENTS

5.5.1 Obtaining permission for the destruction, relocation and/or removal of protected plant species

It is recommended that before the clearing of the proposed site is authorized, the appropriate permission be obtained timeously from the Eastern Cape Department of Economic Development and Environmental Affairs (DEDEA) for the destruction of both animal and plant species protected by the Provincial Nature Conservation Ordinance of 1974 and ToPS (Trade of Protected Species). In order to obtain permission to remove or destroy species occurring under the respective legislation, an application letter needs to be sent to DEDEA together with a Flora and Fauna Relocation Plan. This letter must list the species (separate fauna and flora applications) that will be removed, destroyed or relocated and the reason for their removal or destruction. These permits may be subject to certain conditions, for example allowing various nurseries to collect plants before vegetation clearance commences, the removal of certain species for rehabilitation purposes etc. The project proponent will be informed of these conditions after the application has been received by DEDEA and a possible site visit undertaken. On completion of the relocation operation an audit report will be required by the department.

Plant species identified for which permits will be required in terms of the Provincial Nature Conservation Ordinance No. 19 of 1974 (PNCO), the National Forests Act of 1998 (NFA), and those classified as threatened or near threatened according to IUCN 2002 (Golding, 2002) are listed in Table 5.4. Protected species will be removed from the construction areas and relocated to a designated relocation area. Plant search and rescue should be conducted within the areas where construction/ vegetation clearing activities are to occur. Permits for the protected flora must be obtained timeously from the respective departments:

- Department of Forestry and (DWAF) for NFA permits: Mr Thabo Nokoyo; Department of Water Affairs and Forestry; Port Elizabeth; Email: NokoyoT@dwaf.gov.za; Tel: (041)586 4884; Fax: (041) 586 0379.
- Department of Economic Development and Environmental Affairs (DEDEA) for PNCO permits: Alan Southwood; Private Bag X5001; Greenacres; Port Elizabeth; 6057; Email: alan.southwood@deaet.ecape.gov.za ;Tel: (041) 508 5800; Fax: (041) 585 1964/585 1958.

5.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

5.6.1 General Impact Rating Scale for Specialists/ Baseline data

5.6.1.1 Methodology for rating significance of impacts:

The following methodology is to be applied in the specialist studies for the assessment of potential impacts (methodology supplied by the CSIR).
The assessment of impact significance should be based on the following convention:
Nature of impact - this reviews the type of effect that a proposed activity will have on the environment and should include "what will be affected and how?".
Extent - this should indicate whether the impact will be:

- local and limited to the immediate area of development (the site);

- limited to within 5 km of the development; or
- whether the impact may be realized regionally, nationally or even internationally.

Duration - this should review the lifetime of the impact, as being:

- very short term (0 - 1 years),
- short term (1 - 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 should be established whether the impact is destructive or innocuous and should be 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 should be described as:

- improbable (low likelihood)
- probable (distinct possibility)
- highly probable (most likely) or
- definite (impact will occur regardless of prevention measures).

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 should be assessed as high, medium or low.

Based on the above considerations, the specialist must provide an overall evaluation of the **significance** of the potential impact, which should be 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.

Significance Rating

Intensity: HIGH

		Duration				
		Permanent	Long term	Medium term	Short term	Very short term
Extent	National	High	High	High	High	Medium
	Regional	High	High	High	High	Medium
	Local	High	High	Medium	Medium	Medium
	Site specific	Medium	Medium	Medium	Medium	Medium

Intensity: MEDIUM

		Duration				
		Permanent	Long term	Medium term	Short term	Very short term
Extent	National	High	High	High	Medium	Medium
	Regional	High	High	High	Medium	Medium
	Local	Medium	Medium	Medium	Medium	Medium
	Site specific	Medium	Medium	Medium	Medium	Low

Intensity: LOW

		Duration				
		Permanent	Long term	Medium term	Short term	Very short term
Extent	National	Medium	Medium	Medium	Medium	Medium
	Regional	Medium	Medium	Medium	Medium	Medium
	Local	Medium	Medium	Medium	Medium	Low
	Site specific	Medium	Medium	Medium	Low	Low

Furthermore, the following must be considered:

- Impacts should be described both before and after the proposed mitigation and management measures have been implemented.
- All impacts should be evaluated for both the construction, operations and decommissioning phases of the project, where relevant.
- The impact evaluation should take into consideration the cumulative effects associated with this and other facilities which are either developed or in the process of being developed in the region, if relevant.
- Management actions: Where negative impacts are identified, specialists must specify practical mitigation objectives (i.e. ways of avoiding or reducing negative impacts). Where no mitigation is feasible, this should be stated and the reasons given. Where positive impacts are identified, management actions to enhance the benefit must also be recommended. The specialists should set quantifiable standards for measuring the effectiveness of mitigation and enhancement.

Monitoring: Specialists should recommend monitoring requirements to assess the effectiveness of mitigation actions, indicating what actions are required, by whom, and the timing and frequency thereof.

Table 5.6. Impact assessment

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
CONSTRUCTION PHASE									
Loss of vegetation habitat in:									
Loerie Conglomerate Fynbos	Negative	localised	permanent	medium	definite	medium	Vegetation clearing must be limited to the required footprint. Micro-siting of footprints should avoid more sensitive vegetation during final site planning as far as possible.	low	high
Humansdorp Shale Renosterveld	Negative	localised	permanent	medium	definite	medium	Vegetation clearing must be limited to the required footprint. Micro-siting of footprints should avoid more sensitive vegetation during final site planning as far as possible.	low	high
Gamtoos Thicket	Negative	localised	permanent	low	improbable	medium	River crossing and clearing of thicket should be avoided	low	high
Riparian and Wetland vegetation	Negative	Highly localised	Long-term	low	probable	medium	Crossing of riparian areas should use existing road crossings where possible Rehabilitation of vegetation to take place after construction. Clearing of vegetation to be kept to required for crossing construction.	low	high
Reduction or changes to ecological processes and functioning in:									
Loerie Conglomerate Fynbos	Negative	localised	long-term	medium	definite	medium	Road network to be kept to a minimum in this vegetation unit and clearing to be kept to a minimum width. Road network kept to a minimum in	low	high

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
							design phase.		
Humansdorp Shale Renosterveld	Negative	localised	long-term	medium	definite	medium	Road network to be kept to minimum width and avoid more sensitive seep areas and drainage lines.	low	high
Gamtoos Thicket	Negative	localised	permanent	low	improbable	medium	Loss of Gamtoos Thicket and thicket clumps unlikely to occur and small thicket clumps should be avoided during micro-siting.	low	high
Riparian and Wetland vegetation	Negative	localised	permanent	low	improbable	medium	Loss of Riparian vegetation limited to a few well sited crossing along roads and unlikely to be significant. Appropriate measures to be implemented to minimise impacts at stream crossings.	low	high
Temporary fragmentation of habitats	Negative	localised	long term	medium	probable	medium	Vegetation clearing must be limited to the required footprint and rehabilitated immediately after construction. Road construction should be commenced in a phased manner to reduce large scale fragmentation.	low	high
Increased risk of alien invasion in drainage lines and disturbed areas	Negative	localised	long term	medium	probable	medium	Alien invasive management plan to be implemented during operational phase Rehabilitation to be implemented in a phased manner directly after construction for a given area is completed.	low	high
Changes in natural fire regime (reduction in wildfires is positive, elimination of all fires is negative for fynbos-controlled burns should	Negative/ positive	localised	long term	medium	probable	medium	Maintaining sufficient buffer zones to allow the presence of suitable fire breaks Roads may act as additional fire breaks and help to decrease extent of runaway fires.	low	moderate

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
be done every 10 years or so.							Road borders should be regularly maintained to ensure that vegetation remains short and that they therefore serve as an effective firebreak. Flammable litter and discarded glass bottles should be removed regularly. Implement fire fighting strategy as part of EMP. Signage along roads to indicate fire risk in the area.		
Reduction of ecosystem functioning	Negative	localised	long term	low	probable	medium	Alien species should be monitored and cleared when necessary. Avoid direct loss of natural vegetation outside of required footprints where possible. Final planning to avoid ecologically more sensitive areas.	low	high
Loss of species of special concern and SSC habitat									
Loerie Conglomerate Fynbos habitat	Negative	localised	permanent	medium	definite	medium	Vegetation clearing must be limited to the required footprint.	low	high
Humansdorp Shale Renosterveld	Negative	localised	permanent	medium	definite	medium	Vegetation clearing must be limited to the required footprint.	low	high
Gamtoos Thicket habitat	Negative	localised	permanent	low	improbable	medium	Vegetation clearing must be limited to the required footprint.	low	high
Loss of floral SSC	Negative	localised	permanent	medium	probable	medium	Vegetation clearing must be limited to the required footprint. Plant rescue and relocation operation must be conducted before any site clearing occurs, especially within areas having intact vegetation.	low	medium

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Habitat destruction may affect faunal diversity and composition									
Reptiles	Negative	Site/Footprint	Permanent	Medium	Definite	Medium	Search and rescue operations conducted before construction phase begins. Reptiles must be relocated to a place similar to the place where they were found. Reptiles which enter the construction zone must be relocated as soon as possible from the site. A professional reptile handler must be used when removing and relocating a reptile. Habitats near the construction site where no construction is to take place must be clearly demarcated as no-go areas. Clearly marked buffer zones should be in place between the construction zone and no-go areas. Materials, such as rocks, taken from the construction zone must be stored and kept to be used in the rehabilitation process to create new habitats for the reptiles.	Low	High
Amphibians	Negative	Site/Footprint	Permanent	Medium	Definite	Medium	Search and rescue operations conducted before construction phase begins. Amphibians must be relocated to a place similar to the place where they were found. Amphibians which enter the	Low	High

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
							construction zone must be relocated as soon as possible from the site. Habitats near the construction site where no construction is to take place must be clearly demarcated as no-go areas.		
Mammals	Negative	Site/Footprint	Permanent	Low	Probable	Medium	Search and rescue operations conducted before construction phase begins. Mammals must be relocated to a place similar to the place where they were found. Mammals which enter the construction zone must be relocated as soon as possible from the site. Habitats near the construction site where no construction is to take place must be clearly demarcated as no-go areas.	Low	High
Road mortality from truck/vehicle and other service vehicles									
Reptiles	Negative	Site/Roads	Short-term	Medium	Definite	High	Search and rescue conducted before or during this activity. Care should be taken when working in this area. Care must be taken to ensure slow driving on the site, speed limits should be enforced. Should areas be noted where Death on Road incidents are excessive, traffic calming measures should be implemented.	Low	High
Amphibians	Negative	Site/Roads	Short-term	Medium	Definite	**High (when**	Search and rescue conducted before	Low	High

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
						raining) Low when not raining	or during this activity. Care must be taken to ensure slow driving on the site during rainfall periods. Search and rescue conducted before or during this activity. Should areas be noted where Death on Road incidents are excessive, notably after rainfall, traffic calming measures should be implemented or roads temporarily closed.		
Mammals	Negative	Site/Roads	Short-term	Medium	Probable	Medium	Search and rescue conducted before or during this activity for small mammals only, large mammals will move away from the site. Care must be taken to ensure slow driving on the site, speed limits should be enforced. Dead animals found on the roads must be removed to prevent scavengers from being attracted to the road and harmed. Should areas be noted where Death on Road incidents are excessive, traffic calming measures should be implemented.	Low	High
Poaching									
Mammals	Negative	Site	Permanent	Low	Possible	Medium	Worker education, Monitoring and removal of snares to be implemented	Low	High
Fauna harmed by fences (mammals/reptiles)									
Reptiles/ Mammals	Negative	Site/Fence	Permanent	High	Probable	High	The fence used to surround the	Medium	High

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
		lines					footprint must be of a nature to allow fauna to pass through it, especially electrified fences. Use of Bonox type fencing that allows through movement of fauna. Regular visits to the site to check if any fauna are indeed trapped. Access gates into the fenced off areas to be closed at all times.		
Corridor disruptions as a result of habitat fragmentation for:									
Reptiles	Negative	Site	Permanent	Low	Possible	Medium	Road design must be such that it allows free movement of fauna Do not places fences on the side of the roads	Low	High
Amphibians	Negative	Site	Permanent	Low	Possible	Medium	Road design must be such that it allows free movement of fauna Do not places fences on the side of the roads Construction of roads over wetlands/rivers/streams must be of the nature that the water is allowed to flow under the road, this will secure corridor continuity for amphibians.	Low	High
Mammals	Negative	Site	Permanent	Low	Improbable	Medium	Road design must be such that it allows free movement of fauna Do not places fences on the side of the roads	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									
Reduction or changes to ecological processes and functioning in:									
Loerie Conglomerate Fynbos	Negative	localised	long-term	medium	definite	medium	Road network to be kept to a minimum in this vegetation unit and clearing to be kept to a minimum width. Road network kept to a minimum in design phase.	low	high
Humansdorp Shale Renosterveld	negative	localised	long-term	medium	definite	medium	Road network to be kept to minimum width and avoid more sensitive seep areas and drainage lines.	low	high
Gamtoos Thicket	negative	localised	permanent	low	improbable	medium	Loss of Gamtoos Thicket and thicket clumps unlikely to occur and small thicket clumps should be avoided during micro-siting.	low	high
Riparian and Wetland vegetation	negative	localised	permanent	low	improbable	medium	Loss of Riparian vegetation limited to a few well sited crossing along roads and unlikely to be significant. Appropriate measures to be implemented to minimise impacts at stream crossings.	low	high
Increased risk of alien invasion in drainage lines and disturbed areas	negative	localised	long term	medium	probable	medium	Alien invasive management plan to be implemented during operational phase.	low	high
Changes in natural fire regime	negative /positive	localised	long term	medium	probable	medium	Maintaining sufficient buffer zones to allow the presence of suitable fire breaks Roads may act as additional fire breaks and help to decrease extent of runaway fires. Road borders should be regularly	low	moderate

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
							maintained to ensure that vegetation remains short and that they therefore serve as an effective firebreak. Flammable litter and discarded glass bottles should be removed regularly Implement fire fighting strategy as part of EMP. Signage along roads to indicate fire risk in the area.		
Reduction of ecosystem functioning	negative	localised	long term	low	probable	medium	Alien species should be monitored and cleared when necessary.	low	high
Habitat destruction may affect faunal diversity and composition for:									
Reptiles	Positive	Site	Permanent	Medium	Probable	Low	Habitat may be created after construction.	Low	High
Amphibians	Negative	Site	Permanent	Medium	Probable	Low	Road mortalities to be monitored.	Low	High
Mammals	Negative	Site	Permanent	Medium	Probable	Low	Mammals likely to adapt to new environment.	Low	High
Road mortality from truck/vehicle and other service vehicles									
Reptiles	Negative	**Site/Roads**	**Permanent**	**High**	**Definite**	**High**	Must be audited and monitored and traffic calming measures implemented.	Medium	High
Amphibians	Negative	**Site/Roads**	**Permanent**	**High**	**Definite**	**High (when raining) Low when not raining**	Must be audited and monitored and traffic calming measures implemented.	Medium	High
Mammals	Negative	**Site/Roads**	**Permanent**	**High**	**Definite**	**High**	Must be audited and monitored and traffic calming measures implemented.	Medium	High

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Poaching									
Mammals	Negative	**Site**	**Permanent**	**Low**	**Possible**	**Low**	Monitoring and removal of snares to be implemented.	Low	High
Fauna harmed by fences (mammals/reptiles)									
Reptiles/ Mammals	Negative	**Site**	**Permanent**	**Medium**	**Probable**	**Medium**	Fences design to be fauna friendly.	Low	High
Corridor disruptions as a result of habitat fragmentation									
Reptiles	Positive	**Site**	**Permanent**	**Medium**	**Definite**	**Medium**	Habitat may be created after construction.	Low	High
Amphibians	Negative	**Site**	**Permanent**	**High (when raining) Low when not raining**	**Definite**	**High (when raining) Low when not raining**	Road mortalities to be monitored.	Medium	High
Mammals	Negative	**Site**	**Permanent**	**Low**	**Probable**	**Low**	Mammals likely to adapt to new environment. Road mortalities to be monitored.	Low	High

Table 5.7. Monitoring programme

Impact	Mitigation/Management action	Monitoring		
		Methodology	Frequency	Responsibility
CONSTRUCTION PHASE				
Loss of vegetation habitat	Search and Rescue before/during construction and post construction rehabilitation to be undertaken	Search and Rescue to be audited and species recorded	Weekly	ECO Search and Rescue contractor
Temporary fragmentation of habitats	Construction areas to be kept to minimum	Construction activities to be monitored and audited	Weekly	ECO Search and Rescue contractor
Increased risk of alien invasion in drainage lines and disturbed areas	Alien management Plan to be implemented	Audit Alien Management and monitor occurrence of weedy and alien species	Monthly	ECO
Changes in natural fire regime	Fire management plan to be implemented	Regular checks that fire management plan recommendations are implemented	Monthly	ECO
Reduction of ecosystem functioning	No monitoring			
Loss of species of special concern and SSC habitat	A plant search and rescue plan to be implemented before construction commences COnstruction footprint and disturnace to within reasonable limits	A list of relocated flora to be compiled as part of site audit	Weekly	ECO

Impact	Mitigation/Management action	Monitoring		
		Methodology	Frequency	Responsibility
Loss of floral SSC	Search and Rescue before/during construction and post construction rehabilitation to be undertaken.	Pre-construction search and rescue Site Audit	Daily Weekly	Flora specialist ECO
Loss of Faunal Habitat	Search and Rescue before/during construction and rehabilitation to be undertaken. Monitor for trapped/displaced fauna Monitor for injured fauna and DoR incidents	Pre-construction search and rescue Site Audit	Daily Weekly	Faunal specialist ECO
Road mortality from truck/vehicle and other service vehicles	Monitor for injured fauna and DoR incidents	Site Audit	Weekly and during rainfall for amphibians	ECO
Poaching	Check fences for snares	Site Audit	Weekly	ECO
Fauna harmed by fences (mammals/reptiles)	Check fences for snares	Site Audit	Weekly	ECO
Corridor disruptions as a result of habitat fragmentation	Monitor for trapped/displaced fauna	Site Audit	Weekly	ECO
OPERATIONAL PHASE				
Reduction or changes to ecological processes and functioning	Check that mitigation recommendations have been implemented and adhered to	Site Audit	Monthly	ECO

Impact	Mitigation/Management action	Monitoring		
		Methodology	Frequency	Responsibility
Increased risk of alien invasion in drainage lines and disturbed areas	Alien management Plan to be implemented	Audit Alien Management and monitor occurrence of weedy and alien species	Biannually	ECO
Changes in natural fire regime	Fire management plan to be implemented	Regular audit of Fire Management Plan implementation and record any fires	Biannualy and record location and extent after each fire and actions implemented	ECO
Loss of Habitat	Monitor for trapped/displaced fauna	Site Audit	Monthly	ECO
Road mortality from truck/vehicle and other service vehicles	Monitor for injured fauna and DoR incidents Implement traffic calming measures where necessary	Site Audit	Monthly and during/after rainfall for amphibians	ECO
Poaching	Check fences for snares	Site Audit	Monthly	ECO
Fauna harmed by fences (mammals/reptiles)	Check fences for snares	Site Audit	Monthly	ECO
Corridor disruptions as a result of habitat fragmentation	Monitor for trapped/displaced fauna	Site Audit	Monthly	ECO

5.7 CONCLUSIONS

5.7.1 Vegetation and Flora

Within the context of the original vegetation of the area the a range of Gamtoos Thicket, Loerie Conglomerate Fynbos, Shale Renosterveld, Wetland/Pan/Seep vegetation communities cover the sites. These areas have been transformed and degraded to a varying extent predominantly through agriculture and some alien plant infestation. Specialised habitats within this matrix would have included the fire resistant rocky refugia, seasonal seeps and pans and drainage lines with associated riparian vegetation and seep areas.

- Site sensitivity is variable across the site, largely dependent on the level of agriculture related transformation and degradation.
- Degradation in the form of invasive alien plant infestations tends to be very limited and patchy on the site.
- Areas with a moderate sensitivity include those having intact vegetation but with a Least threatened or Vulnerable conservation status.
- Areas indicated as having a high sensitivity include critically endangered and endangered vegetation units and specialised habitats including rocky outcrops, seeps, wetlands and pans.
- Areas having a low sensitivity include areas transformed for pastures, severely degraded and heavily invaded areas, and areas having a low conservation status.

Impacts identified as having a moderate significance after mitigation tend to be those where sites and access roads are sited in areas indicated as having a moderate to high sensitivity vegetation units, or where disruptions to ecological processes may occur (drainage lines). In the initial design phase these more sensitive areas (Gamtoos Thicket, drainage lines, wetlands and intact vegetation) have been avoided very effectively and thus impacts will be minimal

Turbine sites having a moderate sensitivity include sites positioned in vegetation with intact habitat and an elevated conservation status (Humansdorp Shale Renosterveld and Loerie Conglomerate Fynbos and wetlands) and/or provides important ecological functions that may be reduced as a result of the proposed activity (drainage lines). Whilst final micro-siting and mitigation measures are recommended, no turbine sites or access roads are present that can be deemed to have a high sensitivity. Final positioning of turbine and hard standing areas to avoid the most-sensitive areas is recommended (such as avoiding small thicket pockets, any rocky outcrops and seeps/ wetlands or drainage lines) and minor changes to road alignments to maximise use of already disturbed areas (such as existing roads and fence lines).

Areas having an elevated sensitivity were identified during the initial design phase and these areas have been effectively avoided in the windfarm layout.

Turbines (and associated roads and infrastructure) in moderate sensitivity areas would be considered to be acceptable if the recommendations are implemented and monitored adequately in the EMP.

5.7.2 Fauna

This specialist study described the terrestrial fauna potentially affected by the construction and operation of the wind farm and its associated infrastructure. Potential impacts on the terrestrial fauna of the area were identified and assessed for their significance. The most important findings of the investigation are summarised below.

- The erection of the wind turbines, i.e. during construction, may give rise to certain impacts, but provided the mitigatory measures are enforced, these impacts can be minimised, or eliminated entirely.
- The erection of the wind turbines in terms of the operational phase has the potential to result in positive impacts, such as habitat preservation etc.
- In terms of decommissioning the impacts will be similar to those that occur during construction. It is presumed that the wind farms are permanent, i.e. they will undergo periodic upgrades but will not be decommissioned, therefore discussion of the potential impacts of decommissioning is likely to be academic.
- The development of this project will be positive; i.e.: a "no-go" alternative will lead to non-preservation of the area and thus will be negative.
- Some species of special concern present in the area will be affected by this development.
- All amphibians are of *least concern* and are well protected elsewhere.
- The reptiles of special concern are the FitzSimon's long-tailed seps and the Elandsberg Dwarf Chameleon. Although these species are well protected elsewhere (.i.e. Lady Slipper Nature Reserve) their known distribution is limited.
- The species that will be mostly affected during the construction of this project are the species that cannot vacate the affected area themselves, e.g. tortoises, burrowing reptiles and burrowing mammals. These species can suffer direct mortality. Traffic on the access roads to and from the construction sites would most likely result in road kills.

5.7.3 Summary of Risks and Impacts

The following key impacts as a result of the project are expected:

5.7.3.1 Direct loss of habitat

Construction of the turbines will result in a loss of habitat but most of the turbine sites are in areas having a lower conservation status and/or are in a degraded or transformed state. Those sites within areas having an elevated conservation status are restricted in number. Overall loss (footprint area) will be limited in extent and thus impacts are deemed to be within acceptable levels. Impacts in the elevated risk areas can be reduced by micro siting to avoid high sensitivity areas as far as possible.
Roads will have the greatest impact where the access roads impact exposed outcrop habitat and traverse seep, wetland or inland pans. This can be reduced to acceptable levels through appropriate crossing design and final micro siting to use existing crossing points and areas that are already degraded and/or transformed.
Although final **Infrastructure** positioning has not been undertaken (including temporary lay-down areas, cluster construction sites and substations), these can and should be sited in areas that are already transformed.

5.7.3.2 Loss of Species of special concern and habitat

- Loss of SSCs and habitat is most extensive on exposed outcrops on hilltops and ridges;

- The final siting of turbines and construction / infrastructure areas should be undertaken by the ECO in consultation with respective specialists to minimise any loss of SSCs and habitat;
- Avoid areas containing SSCs where possible (i.e. endemics on exposed outcrops);
- Permits will be required for species to be removed and/relocated;
- Relocate SSCs when unavoidable into adjacent areas.

5.7.3.3 Changes to species composition and changes to ecological processes

- Possible drying out of seeps and wetlands (and dams) as result of road network;
- Final road design should take cognisance of these constraints (in conjunction with the hydrological specialist report)
- Changes in seed dispersal due to dispersal agent mortalities (i.e. birds and bats) – this is likely to have the greatest impact on thicket habitat;
- Fragmentation of intact habitats (via roads and power lines) can result in the reduction or changes to ecological connectivity and ecological processes.

5.7.3.4 Increased fire risk and alien plant invasion resulting from vehicles

- Fire frequency and magnitude may be decreased after construction because of the fire-break effect of roads and easier access during fires;
- A fire management plan and awareness signage must be implemented as part of the EMP;
- Alien plant species could be introduced during the construction and operational phases, especially along road verges and adjacent to turbine footprints;
- An alien plant management plan including comprehensive monitoring to be incorporated into the EMP for the construction and operational phases;

5.7.4 Recommendations

5.7.4.1 Vegetation

- Rocky outcrops should be avoided as far as possible, especially with respect to fragmentation by roads.
- Endemic and protected plants must be removed from the site footprints to be safeguarded from destruction and relocated either to undeveloped areas or off-site in consultation with conservation authorities and relevant botanical specialists. These plants can be replanted in adjacent areas or used in rehabilitation.
- The portions of the site that are already degraded/transformed are well suited to the proposed development.
- An ECO/ESO must be appointed to oversee the Environmental Management Plan and relocation of the Species of Special Concern before construction commences.
- The removal of alien invasive plant species from the site will reduce the spread of these species into surrounding areas.
- A long-term alien management plan to control invasive species must be implemented within the designated Open Space areas.
- Permission must be obtained from the provincial authorities to destroy or remove any protected plant species (indicated in Table 5.5).
- Kikuyu grass must NOT be utilised during regrassing of verges, turbine footprints and other landscaped areas within the site, particularly adjacent to riparian and/wetland habitats.

5.7.4.2 Drainage Lines, Seeps, Wetlands, Pans and Dams

- No disturbance may occur within 32 m of any water-course and construction or any other disturbance should be avoided within a 32 m buffer around any wetland features, pans and dams without necessary permission from the Department of Water Affairs. Where unavoidable the required General Authorisation permits will be required from the Department of Water Affairs **before** any construction activities commence.
- Activities in wetland areas should seek to minimize the following impacts:
    a. Changes to the flow pattern within the wetland through drainage channels which cause flow to become more channelled and less diffuse, thereby reducing the wetness of the area. Road crossings must be constructed using appropriate engineering to minimize any flow pattern changes. Drainage line crossings (bridges/culverts) must take into account the sensitivity of the habitat and ecological processes and appropriate designs must be utilised so as not to impede water flow regimes and ecological processes.
    b. Disturbances of the soil, making it more susceptible to erosion. Any disturbances during construction must be done as rapidly as possible and disturbed areas rehabilitated timeously. Construction in wetland/seep areas is best not undertaken during the rainy season.
    c. Changes in the surface roughness and vegetation cover (when these are reduced the ability of the wetland to slow down water flow, reduce erosion and purify water are reduced).
    d. Replacement of the natural vegetation by introduced plants, which generally reduces the value of the wetland for wetland dependent species. Only local species should be used in any rehabilitation work after construction.
- Disturbances to seep areas and areas will require detailed surveying before any construction commences so that appropriate design measures can be implemented to facilitate lateral water flow, especially where roads may traverse such areas.
- Where stream and seep crossings cannot be avoided, they should be sited where seeps/streams are narrowest and most disturbed or existing road and track crossings should be upgraded. Stream and seep crossing design must incorporate measures to minimise alterations to lateral flow, to prevent downstream drying-out and up-stream flooding that differs substantially from current conditions. No seasonal pans should be traversed, including those that have been excavated to increase water storage capacity. Any roads running upslope of pans must be constructed so as not to impede lateral water movement and must minimise siltation and erosion risks.

5.7.4.3 Environmental Management Programme Recommendations

A. <u>Guidelines for inclusion in the Environmental Management Programme (EMP):</u>

- Since the sites are located in catchment areas, activities at certain sites (and road crossings) may have an impact on downstream areas. The retention of natural areas is important to minimize cumulative downstream impacts, especially those associated with stormwater runoff. Removal of alien vegetation, rehabilitation of natural vegetation and long-term erosion management are important aspects that must be addressed in the EMP.
- Open Space Management guidelines must be incorporated into the EMP to manage areas adjacent to turbine sites and to help inform landowners as to possible risks and the appropriate management measures.
- A plant relocation plan must be incorporated into the EMP and for submission with permit applications. Comprehensive rescue and temporary storage in a suitable constructed

temporary nursery or storage area for plants deemed to require rescue for replanting, and for plants that will be useful during rehabilitation

- Special attention should be given to *Cyrtanthus obliquus*, *Delosperma ecklonis, Erepsia aristata* and *Gasteria pulchra* which, although not uncommon in other areas are somewhat less widespread and common than other species.
- The Construction EMP should contain clear guidelines for clearing of vegetation where construction activities are to commence;
- The Operational EMP must contain management measures to be implemented during operation of the wind farm. These measures should cover alien plant control and fire management plans.
- A detailed revegetation and rehabilitation plan must be implemented during the post-construction and operational phase.

B. <u>Rehabilitation potential and processes</u>

- A detailed environmental specification guideline is provided in Appendix B.1 in EMP, Section B of this EIA Report.

C. <u>"No-Go" Areas</u>

- "No-go" areas must be demarcated clearly (using fencing and appropriate signage) before construction commences.
- Contractors and construction workers must be informed of the "no-go" areas and held accountable for any infringements that may occur.
- No access to the demarcated areas should be permitted during construction and contractors must be informed of the location of these areas. A suitable control measure (such as a penalty system) must be implemented to discourage infringement by contractors.
- Activities including, but not restricted to, the following must not be permitted in designated "no-go" areas:
  - Dumping of any material during and after construction;
  - Turning of vehicles;
  - Trampling and urination by construction workers; and
  - Lighting fires.

D. <u>Alien Vegetation Management Plan</u>

- An alien vegetation removal programme must be implemented to remove alien vegetation from within the "no-go" areas and should run concurrently with construction activities;
- Cleared alien vegetation must not be dumped on adjacent intact vegetation during clearing but should be temporarily stored in a demarcated area (in consultation with the relevant botanical specialist;
- Cleared vegetation must be either removed from site or burned *in-situ* in the temporary storage area;
- Any seed bearing material should be removed from the drainage area to prevent the spread of seed.
- Chopped brushwood can be used to stabilise steep areas that may be susceptible to erosion during clearing activities;
- A suitable revegetation or rehabilitation plan must be implemented after alien vegetation clearing.
- A long-term alien vegetation maintenance plan, including monitoring and removal of new invasive plants, must be designed and implemented in conjunction with a suitably qualified expert.

E. River crossings

- Bridge/culvert design must be such that it minimises impact to the riparian areas with minimal alterations to water flow and must permit the movement of fauna and flora;
- Bridge/culvert construction must be completed as timeously as possible and efforts must be in place to minimise the erosion risk and sedimentation of the stream during construction, especially during high rainfall events.

F. Plant Relocation Plan and Species of Special Concern Search and Rescue

- A suitable timeframe must be allowed *before* construction commences to undertake the plant rescue and relocation operation;
- Plants that can be used during rehabilitation should be identified and stored appropriately off-site for use after construction and alien vegetation clearing;
- Plants identified as being suitable for relocation can either be removed from the site or replanted within the proposed buffer areas.

G. Permit applications for the destruction, relocation and/or removal of protected plant species

It is recommended that before the clearing of the proposed site is authorized, the appropriate permission be obtained timeously from the Eastern Cape Department of Economic Development and Environmental Affairs (DEDEA) for the **destruction of flora and fauna species protected by the Provincial Nature Conservation Ordinance of 1974**.

All individuals of the protected indigenous species should be avoided if possible, if not they should be translocated or utilized during rehabilitation and landscaping. If neither is possible permits will be required to either trim or remove individuals. Species indicated as being protected would require permits from the respective department **before** any site clearing/removal commences.

The person or organisation responsible for the relocation of these plant species must work in advance of the vegetation clearing team, and locate as well as relocate individual plant specimens. Removed plants must be excavated by hand in such a way that the plants, especially the roots are not damaged. Plants should be temporarily planted out either in plastic bags or in-situ in an area that is not affected by the proposed development. Should bags be used, they shall be large enough to contain the entire plant's root system. Bags must be filled with local top soil material. Plants must be watered regularly, protected from damage and otherwise maintained to ensure healthy growth. On completion of the civil work the plants must be re-planted out in scattered clumps at areas on the site to be rehabilitated as directed by the Environmental Control Officer (ECO). Individuals of all removed species will need to be housed in a nursery until such time as relocation areas have been identified.

5.7.5 *Fauna*

- Ecological corridors occur predominantly along the rivers, drainage lines and seep areas, thus design should be such that it does not impede these corridors unnecessarily;
- Riparian zone and stream crossings should be designed to allow for animal movement where necessary;
- Restrict road development to the required footprint;
- No off-road vehicle use outside of designated road network should be permitted;
- Limit road activity where possible to daylight working hours;
- Maintaining wide road verges with low vegetation cover may further minimise mortalities
- Search and rescue operations must be conducted before construction begins.

- The construction zone and "no-go" areas must be clearly marked.
- Animals must be relocated to places similar to those where they were found;
- Animals which enter the construction zone must be relocated as soon as possible.
- A professional reptile handler must be used when removing and relocating a reptile.
- Habitats near the construction site where no construction is to take place must be clearly demarcated as "no-go" areas.
- Materials, such as rocks, taken from the construction zone must be stored and kept to be used in the rehabilitation process to create new habitats for reptiles.
- Care must be taken to ensure vehicles are driven slowly on the site. Speed limits should be enforced particularly during rain storms when frogs may cross the roads. A speed limit of 60 km/h should be implemented on the access roads to the site and a 40 km/h speed limit on the construction site for the cranes and on access roads during rainstorms.
- Road kills should be removed to avoid additional mortalities of scavengers
- The workers on site must be educated during site induction about the laws protecting wildlife. Penalties should be used as a deterrent.
- Regular fence inspections need to be conducted to remove any snares and to check for trapped animals.
- Fences used to surround the footprint must be of a nature to allow animals to pass through them.
- Regular monitoring on the site for any fauna trapped animals.
- Access gates into the fenced off areas to be closed at all times.
- Placing of structures (culverts) under roads to allow reptiles such as tortoises to cross under the road will promote corridor continuity.
- If fences are placed along roads, they must permit animals to pass through them.
- Construction of roads over wetlands/rivers/streams must be designed so that the water is allowed to flow under the road, this will secure corridor continuity for amphibians.

5.8 APPENDICES

Appendix 5.1. Plant Species List

Botanical Name	Family	Status*	Wetlands/Seeps	Renosterveld/ Fynbos	Thicket	Pastures and Transformed
Abutilon sonneratianum	Malvaceae				Y	
Acacia cyclops	Fabaceae	CARA 2		Y		Y
Acacia mearnsii	Fabaceae	CARA 2			Y	
Acanthaceae sp.	Acanthaceae			Y		
Allophylus decipiens	Sapindaceae				Y	
Aloe africana	Asphodelaceae				Y	
Aloe africana	Asphodelaceae	PNCO		Y	Y	
Aloe speciosa	Asphodelaceae	PNCO			Y	
Anginon sp.	Apiaceae					
Anthospermum aethiopicum	Rubiaceae				Y	
Apodytes dimidiata	Icacinaceae				Y	
Argyrolobium polyphyllum	Fabaceae			Y		
Aristida sp.	Poaceae		Y	Y		
Aspalathus chortophila	Fabaceae			Y		
Asparagus aethiopicus	Asparagaceae	PNCO			Y	
Asparagus capensis	Asparagaceae	PNCO			Y	
Asparagus racemosus	Asparagaceae	PNCO			Y	
Asparagus striatus	Asparagaceae	PNCO			Y	
Asplenium cordatum	Aspleniaceae				Y	
Atriplex sp.	Chenopodiaceae		Y			
Azima tetracantha	Salvadoraceae				Y	
Barleria irritans	Acanthaceae			Y		
Berkheya heterophylla	Asteraceae			Y		Y
Blepharis integrifolia	Acanthaceae				Y	
Blepharis procumbens	Acanthaceae			Y		
Bobartia orientalis	Iridaceae	PNCO		Y		
Boophone disticha	Amaryllidaceae	PNCO		Y		
Briza maxima	Poaceae		Y			Y
Bulbine frutescens	Hyacinthaceae	PNCO			Y	
Canthium spinosum	Rubiaceae				Y	
Capparis sepiaria	Brassicaceae				Y	
Carissa bispinosa	Apocynaceae				Y	
Cenchrus ciliaris	Poaceae				Y	
Centella asiatica	Apiaceae			Y		Y
Chaetacanthus setiger	Acanthaceae				Y	
Chasmanthe aethiopica	Iridaceae	PNCO			Y	
Chasmanthe sp.	Iridaceae	PNCO		Y		
Cheilanthes viridis	Pteridophyta				Y	
Chrysocoma ciliata	Asteraceae			Y		

Botanical Name	Family	Status*	Wetlands/Seeps	Renosterveld/ Fynbos	Thicket	Pastures and Transformed
Cliffortia sp.	Rosaceae			Y		
Clutia sp.	Euphorbiaceae			Y		
Commelina africana	Commelinaceae		Y	Y		
Conyza ivaefolia	Asteraceae		Y	Y		
Corymbium africanum	Asteraceae			Y		
Cotyledon campanulata	Crassulaceae				Y	
Cotyledon tomentosa	Crassulaceae				Y	
Crassula muscosa	Crassulaceae				Y	
Crassula nemorosa	Crassulaceae			Y	Y	
Crassula orbicularis	Crassulaceae				Y	
Crassula tetragona	Crassulaceae			Y		
Crotalaria capensis	Fabaceae				Y	
Cussonia thyrsiflora	Araliaceae				Y	
Cyanotis speciosa	Commelinaceae					
Cynanchum ellipticum	Apocynaceae				Y	
Cynodon dactylon	Poaceae		Y		Y	Y
Cyperus sp.	Cyperaceae		Y			
Cyphia sylvatica	Campanulaceae			Y		
Cyrtanthus obliquus	Amaryllidaceae	PNCO		Y		
Cyrtanthus sp.	Amaryllidaceae					
Delosperma ecklonis	Mesembryanthemaceae	PNCO			Y	
Digitaria eriantha	Poaceae					Y
Diospyros pallens	Ebenaceae			Y	Y	
Disa sp.	Orchidaceae	PNCO		Y		
Disparago ericoides	Asteraceae			Y		
Dodonaea viscosa	Sapindaceae			Y		
Ehretia rigida	Poaceae				Y	Y
Ehrharta calycina	Poaceae		Y		Y	Y
Ehrharta erecta	Poaceae				Y	Y
Elytropappus rhinocerotis	Asteraceae			Y	Y	Y
Eragrostis capensis	Poaceae		Y			Y
Eragrostis curvula	Poaceae					Y
Erepsia aristata	Mesembryanthemaceae	PNCO		Y		
Erica cerinthoides	Ericaceae	PNCO		Y		
Erica pectinifolia	Ericaceae	PNCO		Y		
Eriocephalus africanus	Asteraceae				Y	
Eriospermum brevipes	Ruscaceae			Y		
Euclea crispa	Ebenaceae				Y	
Euclea racemosa	Ebenaceae				Y	
Euclea undulata	Ebenaceae			Y	Y	
Euphorbia silenifolia	Euphorbiaceae					
Euphorbia triangularis	Euphorbiaceae				Y	
Euphorbia woodii	Euphorbiaceae					
Euryops sp.	Asteraceae			Y		

Botanical Name	Family	Status*	Wetlands/Seeps	Renosterveld/ Fynbos	Thicket	Pastures and Transformed
Eustachys paspaloides	Poaceae				Y	Y
Exomis microphylla	Amaranthaceae				Y	
Felecia filifolia	Asteraceae			Y		
Ficinia nodosa	Cyperaceae				Y	
Gasteria pulchra	Asphodelaceae	PNCO			Y	
Gazania linearis	Asteraceae			Y		
Gerbera sp.	Asteraceae			Y		
Gladiolus longicollis	Iridaceae	PNCO		Y		
Gnidia styphelioides	Thymelaeaceae			Y		
Grewia occidentalis	Tiliaceae				Y	
Gymnosporia capitata	Celastraceae			Y	Y	
Gymnosporia heterophylla	Celastraceae				Y	
Gymnosporia polyacantha	Celastraceae				Y	
Haemanthus sp.	Amaryllidaceae	PNCO		Y		
Haplocarpha lyrata	Asteraceae			Y		
Haworthia cooperi	Asphodelaceae	PNCO		Y		
Helichrysum anomalum	Asteraceae			Y		
Helichrysum cymosum	Asteraceae			Y		Y
Helichrysum nudifolium	Asteraceae			Y		
Hermannia althaeoides	Sterculiaceae			Y		
Hermannia flammea	Sterculiaceae			Y		
Heteropogon contortus	Poaceae				Y	Y
Hibiscus aethiopica small	Malvaceae			Y		
Hibiscus pusillus	Malvaceae			Y	Y	
Hippobromus pauciflorus	Sapindaceae				Y	
Hyparrhenia hirta	Poaceae			Y		Y
Hypoestes aristata	Acanthaceae				Y	
Hypoxis angustifolia	Hypoxidaceae	PNCO		Y		
Indigastrum costatum	Fabaceae				Y	
Indigofera denudata	Fabaceae			Y		
Indigofera hedyantha	Fabaceae				Y	
Indigofera heterophylla	Fabaceae			Y		
Ischyrolepis sp.	Restionaceae	PNCO		Y		
Jasminum angulare	Oleaceae				Y	
Knowltonia cordata	Ranunculaceae					
Lactuca capensis	Asteraceae					
Launaea sp.	Asteraceae					
Lauridia tetragona	Celastraceae				Y	
Ledebouria ensifolia	Hyacinthaceae	PNCO		Y		
Leonotis ocymifolia	Lamiaceae			Y		
Leucadendron salignum	Proteaceae	PNCO		Y		
Leucospermum cuneiforme	Proteaceae	PNCO		Y		
Lobelia tomentosa	Lobeliaceae			Y		
Lycium ferocissimum	Solanaceae					

Botanical Name	Family	Status*	Wetlands/Seeps	Renosterveld/ Fynbos	Thicket	Pastures and Transformed
Maerua cafra	Capparaceae				Y	
Maytenus undata	Celastraceae				Y	
Melica racemosa	Poaceae				Y	
Melinis repens	Poaceae		Y			Y
Metalasia aurea	Asteraceae			Y		
Metalasia densa	Asteraceae			Y		
Montinia caryophyllacea	Montiniaceae			Y		
Morella serrata	Myricaceae			Y		
Mystroxylon aethiopicum	Celastraceae				Y	
Nemesia floribunda	Scrophulariaceae			Y		
Nylandtia spinosa	Polygalaceae				Y	
Oedera genistifolia	Asteraceae			Y		
Olea europaea subsp africana	Oleaceae				Y	
Ornithogalum longibracteatum	Hyacinthaceae	PNCO			Y	
Osteospermum sp.	Asteraceae			Y		
Osyris compressa	Santalaceae				Y	
Oxalis imbricata	Oxalidaceae			Y		
Oxalis polyphylla	Oxalidaceae			Y		
Panicum deustum	Poaceae				Y	
Panicum maximum	Poaceae		Y		Y	
Pappea capensis	Sapindaceae				Y	
Passerina sp.	Thymelaeaceae			Y		
Pelargonium pulverulentum	Geraniaceae				Y	
Pelargonium reniforme	Geraniaceae	PNCO	Y	Y		Y
Pennisetum clandestinum	Poaceae		Y			Y
Phyllanthus incurvus	Euphorbiaceae					
Phyllanthus maderaspatensis	Euphorbiaceae				Y	
Pinus sp.	Pinaceae	CARA 2				Y
Pittosporum viridiflorum	Pittosporaceae	NFA			Y	
Plectranthus grandidentatus	Lamiaceae				Y	
Plectranthus madagascariensis	Lamiaceae				Y	
Plumbago auriculata	Plumbaginaceae				Y	
Polygala ericaefolia	Polygalaceae			Y		
Protasparagus densiflorus	Asparagaceae	PNCO			Y	
Protea neriifolia	Proteaceae	PNCO		Y		
Ptaeroxylon obliquum	Rutaceae				Y	
Pterocelastrus tricuspidatus	Celastraceae				Y	
Pteronia incana	Asteraceae				Y	
Putterlickia pyracantha	Celastraceae				Y	
Pycreus polystachyos	Cyperaceae				Y	
Rhoiacarpos capensis	Vitaceae				Y	
Rhoicissus digitata	Vitaceae				Y	
Rhoicissus sp.	Vitaceae				Y	

Botanical Name	Family	Status*	Wetlands/Seeps	Renosterveld/ Fynbos	Thicket	Pastures and Transformed
Rhus glauca	Anacardiaceae				Y	
Rhus incisa	Anacardiaceae				Y	
Rhus longispina	Anacardiaceae				Y	
Rhus lucida	Anacardiaceae				Y	
Rhus pterota	Anacardiaceae				Y	
Rhus refracta	Anacardiaceae				Y	
Rhynchosia capensis	Fabaceae			Y		
Romulea minutiflora	Iridaceae	PNCO		Y		
Rubiaceae sp.	Rubiaceae					
Sansevieria hyacinthoides	Dracaenaceae			Y	Y	
Sarcostemma viminale	Apocynaceae				Y	
Satyrium membranaceum	Orchidaceae	PNCO		Y		Y
Scabiosa columbaria	Dipsacaceae			Y		
Schotia afra var. afra	Fabaceae	NFA		Y	Y	
Scolopia zeyheri	Flacourtiaceae				Y	
Scutia myrtina	Rhamnaceae				Y	
Selago corymbosa	Scrophulariaceae			Y		Y
Senecio chrysocoma	Asteraceae			Y		
Senecio coronatus	Asteraceae			Y		
Senecio crenatus	Asteraceae			Y		
Senecio deltoides	Asteraceae				Y	
Senecio inaequidens	Asteraceae			Y		Y
Senecio pterophorus	Asteraceae			Y		
Senecio radicans	Asteraceae				Y	
Setaria sphacelata	Asteraceae				Y	Y
Sideroxylon inerme	Sapotaceae	NFA			Y	
Solanum tomentosum	Solanaceae					
Sporobolus africana	Poaceae		Y		Y	Y
Stachys aethiopica	Lamiaceae			Y		
Stenotaphrum secundatum	Poaceae		Y			
Stoebe plumosa	Asteraceae			Y		
Struthiola parviflora	Thymelaeaceae			Y		
Sutera microphylla	Scrophulariaceae				Y	
Syncarpha sp.	Asteraceae					
Tarchonanthus camphoratus	Asteraceae				Y	
Tephrosia capensis	Fabaceae			Y		
Thamnochortus sp.	Restionaceae	PNCO		Y		
Themeda triandra	Poaceae		Y	Y	Y	Y
Thesium strictum	Santalaceae					
Thunbergia capensis	Acanthaceae			Y		
Tribolium hispidum	Fabaceae				Y	
Tristachya leucothrix	Poaceae			Y		Y
Tylecodon striatus	Crassulaceae				Y	
Vepris lanceolata	Rutaceae				Y	

Botanical Name	Family	Status*	Wetlands/Seeps	Renosterveld/ Fynbos	Thicket	Pastures and Transformed
Viscum rotundifolium	Viscaceae				Y	
Wahlenbergia sp.	Campanulaceae			Y		
Watsonia pillansii	Iridaceae	PNCO		Y		
Zehneria scabra	Cucurbitaceae					
TOTAL						

Appendix 5.2. Fauna Species List

List of species recorded or likely to occur in the general study area, together with the conservation status. * **CE**: Critically endangered; **E**: Endangered; **VU**: Vulnerable; **LC**: Least concern.

Taxon(Scientific name)	Common Name	Conservation Status*	Presence
Amphibians			
Amietophrynus pardalis	Eastern leopard toad	LC	D
Amietophrynus rangeri	Raucous toad	LC	D
Vandijkophrynus angusticeps	Cape sand toad	LC	L
Hyperolius marmoratus	Painted reed frog	LC	L
Hyperolius horstockii	Arum lily frog	LC	L
Kassina senegalensis	Kassina	LC	L
Semnodactylus wealii	Rattling frog	LC	D
Breviceps adspersus pentheri	Penthers rain frog	LC	L
Xenopus laevis	Common platanna	LC	D
Cacosternum boettgeri	Common caco	LC	D
Cacosternum nanum	Bronz caco	LC	L
Strongylopus fasciatus	Striped stream frog	LC	D
Strongylopus grayii	Clicking stream frog	LC	D
Tomopterna delalandii	Cape sand frog	LC	L
Reptiles			
Chersina angulata	Angulate tortoise	LC	L
Stigmochelys pardalis	Leopard tortoise	LC	L
Homopus areolatus	Parrot beaked Padloper	LC	L
Pelomedusa subrufa	Marsh terrapin	LC	D
Rhinotyphlops lalandei	Delalandes beaked blind snake	LC	L
Leptotyphlops nigricans	Black thread snake	LC	L
Homorolapse lacteus	Harlequin snake	LC	D
Crotaphopeltis hotamboeia	Herald snake	LC	D
Dasypeltis scabra	Rhombic egg eater	LC	L
Dispholidus typus	Boomslang	LC	L
Duberria lutrix	Slug eater	LC	D
Lamprophis aurora	Aurora house snake	LC	L
Lamprophis capensis	Brown house snake	LC	L
Lamprophis fuscus	Yellow bellied house snake	NT	L
Lamprophis inornatus	Olive house snake	LC	L
Lycodonomorphus rufulus	Brown water snake	LC	L
Lycophidion capense capense	Cape wolf snake	LC	L
Philothamnus hoplogaster	Green water snake	LC	L
Philothamnus natalensis occidentalus	Natal green snake	LC	L
Philothamnus semivariegatus	Spotted bush snake	LC	U
Prosymna sundevallii	Sundavilles shovel snout	LC	U

Psammophis crucifer	Crossed marked sand snake	LC	D
Psammophis notostictus	Karroo whip snake	LC	L
Psammophylax rhombeatus	Rhombic skaapsteker	LC	D
Pseudaspis cana	Mole snake	LC	D
Aspidelapse lubricus lubricus	Cape coral snake	LC	U
Hemachatus haemachatus	Rinkhals	LC	D
Naja nivea	Cape cobra	LC	L
Bitis atropos	Berg adder	LC	L
Bitis arietans	Puff adder	LC	D
Causus rhombeatus	Night adder	LC	L
Acontias gracilicauda gracilicauda	Thin tailed legless skink	LC	L
Acontias percivali tasmani	Tasman's legless skink	LC	L
Acontias lineicauda	Algoa legless skink	NC	D
Acontias meleagris orientalis	Eastern legless skink	LC	L
Scelotes anguineus	Algoa dwarf burrowing skink	LC	L
Scelotes caffer	Cape dwarf burrowing skink	LC	L
Trachylepis capensis	Cape skink	LC	C
Trachylepis homalcephala	Red sided skink	LC	C
Trachylepis varia varie	Variable skink	LC	L
Nucras lalandii	Delalande's sandveld lizard	LC	C
Pedioplanis pulchella	Pulchell's sand lizard	LC	L
Tropidosaura montana montana	Common mountain lizard	LC	L
Gerrhosaurus flavigularis	Yellow throated plated lizard	LC	L
Tetradactylus fitzsimonsi	FitzSimon's long tailed seps	VU	L
Tetradactylus seps	Short legged seps	LC	L
Chamaesaura anguina anguina	Cape grass lizard	NT	L
Cordylus cordylus	Cape girdled lizard	LC	D
Cordylus tasmani	Tasman's girdled lizard	VU	L
Pseudocordylus m. microlepidotus	Cape crag lizard	LC	L
Agama atra	Southern rock agama	LC	D
Bradypodion ventrale	Southern dwarf chameleon	LC	D
Bradypodion taeniabronchum	Elandsberg dwarf chameleon	EN	L
Varanus albigularis albigularis	Rock monitor	LC	U
Varanus niloticus	Water monitor	LC	U
Afrogecko porphyreus	Marbled leaf toed gecko	LC	U
Hemidactylus mabouia (ALIEN)	Tropical house gecko	LC	L
Lygodactylus capensis capensis	Cape dwarf gecko	LC	C
Pachydactylus maculatus	Spotted thick toed gecko	LC	C
Mammals			
Amblysomus corriae	Fynbos golden mole	NT	L
Amblysomus hottentotus	Hottentot golden mole	DD	L
Chlorotalpa duthieae	Duthie's golden mole	LC	L

Macroscelides proboscideus	Round eared elephant shrew	LC	L
Orycteropus afer	Aardvark	LC	L
Procavia capensis	Rock hyrax	LC	L
Lepus saxatilis	Scrub hare	LC	D
Pronolagus saundersiae	Hewitt's red rock rabbit	LC	U
Cryptomys hottentotus	African mole rat	LC	L
Georychus capensis	Cape mole rat	LC	L
Hystrix africaeaustralis	Cape porcupine	LC	D
Graphiurus murinus	Woodland dormouse	LC	L
Graphiurus ocularis	Spectacled dormouse	LC	D
Dendromus melanotis	Grey climbing mouse	LC	L
Dendromus mesomelas	Brant's climbing mouse	LC	L
Mastomys natalensis	Natal multimammate mouse	LC	U
Micaelamys namaquensis	Namaqua rock mouse	LC	L
Mus minutoides	Pygmy mouse	LC	L
Mus musculus	House mouse	Alien	L
Otomys irroratus	Vlei rat	LC	D
Otomys unisulcatus	Bush vlei rat	LC	L
Rattus rattus(EXOTIC)	House rat	LC	D
Rhabdomys pumilio	Four-striped grass mouse	LC	D
Saccostomus campestris	Pouched mouse	LC	L
Cercopithecus pygerythrus	Vervet monkey	LC	D
Papio cynocephalus ursinus	Chacma baboon	LC	D
Crocidura cyanea	Reddish-grey musk shrew	DD	L
Crocidura flavescens	Greater red musk shrew	DD	L
Myosorex varius	Forest shrew	DD	L
Caracal caracal	Caracal	LC	
Felis cattus	Feral cat	Feral (Alien)	L
Felis silvestris	African wild cat	LC	L
Panthera pardus	Leopard	LC	U
Genetta genetta	Small spotted genet	LC	D
Genetta tigrina	Large spotted genet	LC	L
Atilax paludinosus	Marsh mongoose	LC	L
Cynictis penicillata	Yellow mongoose	LC	L
Galerella pulverulenta	Cape grey mongoose	LC	D
Herpestes ichneumon	Large grey mongoose	LC	L
Canis vulgaris	Domestic dog	Feral(Alien)	D
Otocyon megalotis	Bat eared fox	LC	D
Vulpes chama	Cape fox	LC	D
Aonyx capensis	African clawless otter	LC	L
Ictonyx striatus	Striped polecat	LC	L
Mellivora capensis	Honey badger	NT	L
Poecilogale albinucha	African striped weasel	DD	L

Potamochoerus larvatus	Bush pig	LC	D
Philantomba monticola	Blue duiker	VU	L
Raphicerus campestris	Steenbok	LC	L
Raphicerus melanotis	Grysbok	LC	D
Sylvicapra grimmia	Common duiker	LC	D
Tragelaphus scriptus	Bush buck	LC	D

Appendix 5.3 Indemnity and conditions relating to this project

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and the author reserves the right to modify aspects of the report including the recommendations if and when new information becomes available from ongoing research or further work in this field, or pertaining to this investigation.

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Mr Mark Marshal of Sandula Conservation assisted with the faunal survey and assessment (Terrestrial Mammals, Reptiles and Amphibians).

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Environmental Impact Assessment for the proposed Ubuntu Wind Energy Project near Jeffrey's Bay, Eastern Cape: Draft Environmental Impact Assessment Report

Chapter 6: Impact on Birds

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CHAPTER 6. IMPACT ON BIRDS

6.1 INTRODUCTION

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

This report should be seen as work in progress as the full results of the pre-construction monitoring programme will only become available later in 2011 when the spring monitoring has been completed. The final results of the current baseline monitoring will then be available to feed into the final lay-out of the turbines. It should also be noted that the current proposed lay-outs of the turbines are already informed by prior work done at the site. This work resulted in the exclusion of certain avifaunally-sensitive areas of the property from development because of potential impacts on avifauna.

6.1.2 Terms of Reference

The **scope** of the report comprises the assessment of the avifaunal impacts associated with the construction and operation of the proposed 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 Draft 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 January 2011. The objective of the programme is to gather baseline data on bird usage of the site, and covers three seasons, namely summer, winter and spring. The seasons are defined as follows:

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

The specific objectives are to record the following:

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

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

- A transect was identified totalling 17.7 km which covers the majority of the proposed turbine area (see Figure 6.1). This is referred in the report as the "survey area".
- Two observers travelling slowly in a vehicle record all priority species along the transect. Each transect is travelled six times per season.
- Point counts are conducted every 500m, where all birds are recorded for a 5 minute period.
- The following variables are recorded:
  - Species;
  - Number of birds;
  - Date;
  - Start time and end time;
  - Distance from transect or point (0-50 m, 50-100 m, >100 m);
  - Wind direction;
  - Wind strength (calm; moderate; strong);
  - Weather (sunny; cloudy; partly cloudy; rain; mist);
  - Temperature (cold; mild; warm; hot);
  - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground); and
  - Co-ordinates (priority species only).

- Four vantage points were selected from which the majority of the proposed turbine area can be observed (the "VP area"), to record the flight altitude and patterns of priority species. A total of 18 hours of observations per vantage point per season is being conducted. The following variables are recorded:
  - Species;
  - Number of birds;
  - Date;
  - Start time and end time;
  - Wind direction;
  - Wind strength (calm; moderate; strong);

  - Weather (sunny; cloudy; partly cloudy; rain; mist);
  - Temperature (cold; mild; warm; hot);
  - Flight altitude (high i.e >150m; 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).

- Focal point monitoring is also conducted for the nests of priority species. Incidental sightings are also recorded.

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

- Bird distribution data of the Southern African Bird Atlas Project (SABAP – Harrison *et al,* 1997) obtained from the Animal Demography Unit of the University of Cape Town, as a means to ascertain which species occur within the study area. A data set was obtained for the QDGC (quarter degree grid cell) within which the development will take place, namely 3324DD. A QDGC corresponds to the area shown on a 1:50 000 map (15' x 15') and is approximately 27 km long (north-south) and 23 km wide (east-west).
- The SABAP data were supplemented with SABAP2 data for the relevant QDGC. These data are much more recent, as SABAP2 was only launched in May 2007, and should therefore be more representative. For SABAP, QDGCs were the geographical sampling units. For SABAP2 the sampling unit has been reduced to pentad grid cells (or pentads); these cover 5 minutes of latitude by 5 minutes of longitude (5'× 5'). Each pentad is approximately 8 × 7.6 km. This finer scale has been selected for SABAP2 to obtain more detailed information on the occurrence of species and to give a clearer and better understanding of bird distributions. There are nine pentads in a QDGC.
- Additional information on large terrestrial avifauna and habitat use was obtained from the Coordinated Avifaunal Roadcounts (CAR) project of the Animal Demography Unit (ADU) of the University of Cape Town (Young 2003).
- The conservation status of all bird species occurring in the aforementioned QDGC was determined with the use of the *Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland* (Barnes 2000).
- A classification of the vegetation types in the QDGC from an avifaunal perspective was obtained from SABAP1.
- Detailed satellite imagery from Google Earth was used in order to view the study area on a landscape level and to help identify bird habitat on the ground.
- Information on the micro habitat level was obtained through several site visits in the course of 2010 and 2011, before the monitoring commenced. An attempt was made to investigate the total study area as far as was practically possible, and to visit potentially sensitive areas identified from Google Earth imagery.
- Priority species were identified using the (draft) BLSA Avian Wind Farm Sensitivity Map for South Africa (Retief *et al* 2011).

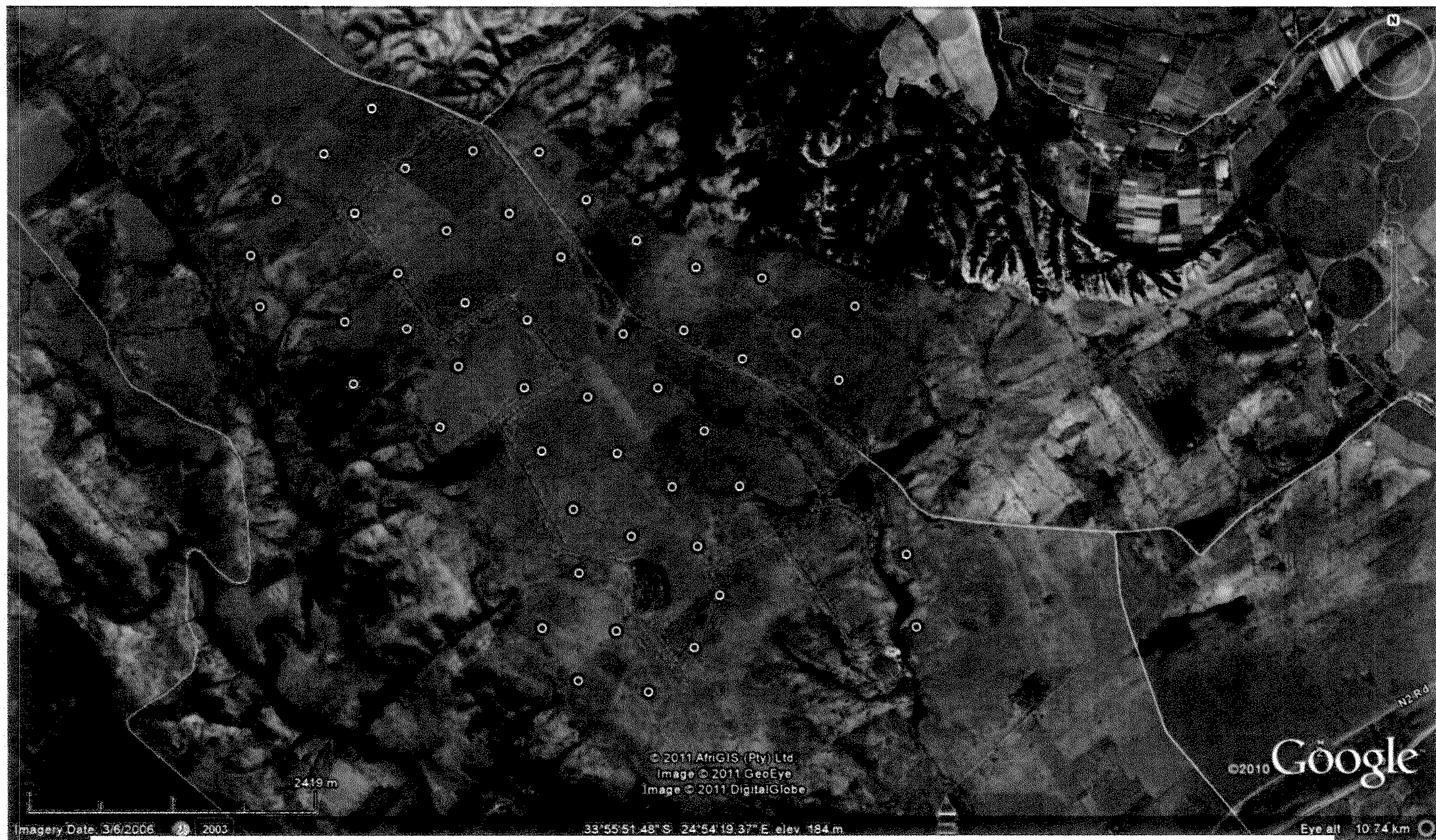


Figure 6.1: The 17.7km transect that is used to count birds in the study area, overlaid on the Vestas 90 turbine lay-out.

6.1.4 Assumptions and limitations

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

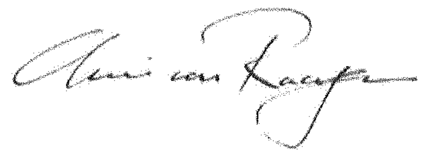
- Since the avifaunal impact studies commenced on this site in 2010, a number of important developments have taken place. The most important development from an avifaunal impact perspective was the publication of *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"* (Jenkins *et al* 2011) by the Endangered Wildlife Trust (EWT) and BirdLife South Africa (BLSA). This document was placed in the public domain on 31 March 2011 and is attached as Appendix 6.1. This protocol proposes a much expanded survey for wind farm developments, including a pre-construction period that should cover a minimum of 12 months and should include all major periods of bird usage in that period, as well as a compulsory post-construction component. The monitoring protocol used in this study was designed before the publication of this document (Jenkins *et al.* 2011), but was subsequently, after the publication of the guidelines, adapted to conform more to the published guidelines.
- For the reasons explained in the previous paragraph, monitoring of non-priority species did not take place during the first monitoring period, i.e. summer 2011. Initially, data were only gathered on priority species, and only two seasons were included, namely summer and winter. Following the publication of *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"* on 31 March 2011 the monitoring was expanded to also include non-priority species, although the emphasis is still on priority species, especially as far as collision risk is concerned. An additional season, namely spring, was also added after consultation with the project proponent. Summer monitoring was performed in January 2011, and winter monitoring in June and July 2011. Spring monitoring will be conducted from September 2011 onwards.
- At present (July 2011), only two seasons of monitoring data are available for the study site. An additional season of monitoring is still to happen, namely spring. The results presented in this report therefore should be seen as preliminary. The final analysis will be conducted after the spring monitoring period.
- With certain classes of birds, particularly cranes and bustards, very little research has been conducted on potential impacts with wind facilities worldwide. The precautionary principle was therefore applied throughout. The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle. The principle was implemented in an international treaty as early as the 1987 Montreal Protocol and, among other international treaties and declarations, is reflected in the 1992 Rio Declaration on Environment and Development. Principle 15 of the 1992 Rio Declaration states that: "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, **lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation."**
- No comprehensive studies, and published, peer-reviewed scientific papers, are available on the impacts wind farms have on birds in South Africa. It is therefore inevitable that,

because of the lack of any research on this topic in South Africa, an element of speculation will enter the conclusions in this report.

6.1.5 Declaration of Independence

BOX 6.1: DECLARATION OF INDEPENDENCE FOR BIRD IMPACT ASSESSMENT

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 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.



CHRIS VAN ROOYEN

6.2 DESCRIPTION OF AFFECTED ENVIRONMENT

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

The proposed development site is situated within the Fynbos Biome (Harrison *et.al.* 1997). The Fynbos Biome is characterized by a high diversity of plant species composition and a high level of endemism. This diversity is not paralleled in its avifaunal composition, and fynbos is regarded as relatively poor in avifaunal diversity compared to other southern African biomes. However, whilst some of the distribution and abundance of the bird species in the study area is related to the occurrence of natural fynbos, it is more important to examine the micro-habitats available to birds, most of which are the result of human-induced transformation. These are generally evident at a much smaller spatial scale than the natural vegetation communities.

The following habitat classes were defined within the survey area (see examples below):

- Thicket: Clumps of thicket of various densities with grassland in between (Figure 6.2). Also contains small trees;
- Grassland: Open grassland up to about 0.5m metre in height (Figure 6.3);
- Wetlands: Includes both man-made dams and natural seasonal wetlands (seeps) (Figure 6.4) which, when dry, consist of short grassland (< 30cm); and
- Scrub: Natural fynbos of various densities up to a 1 metre in height (Figure 6.5).

Figure 6.2: An example of thicket

Figure 6.3: An example of grassland

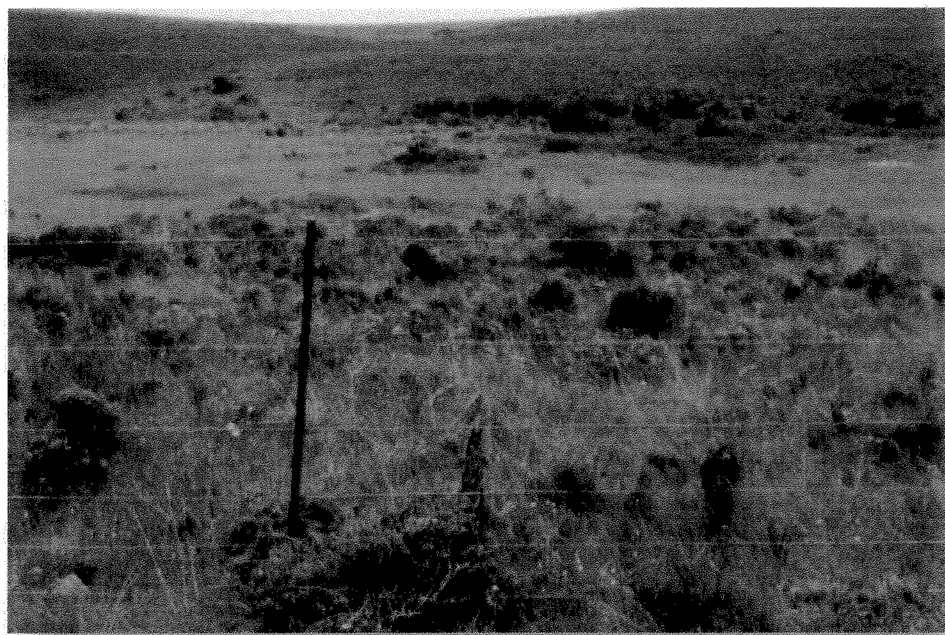


Figure 6.4: An example of wetland habitat which is covered by short grass.

Figure 6.5: An example of scrub

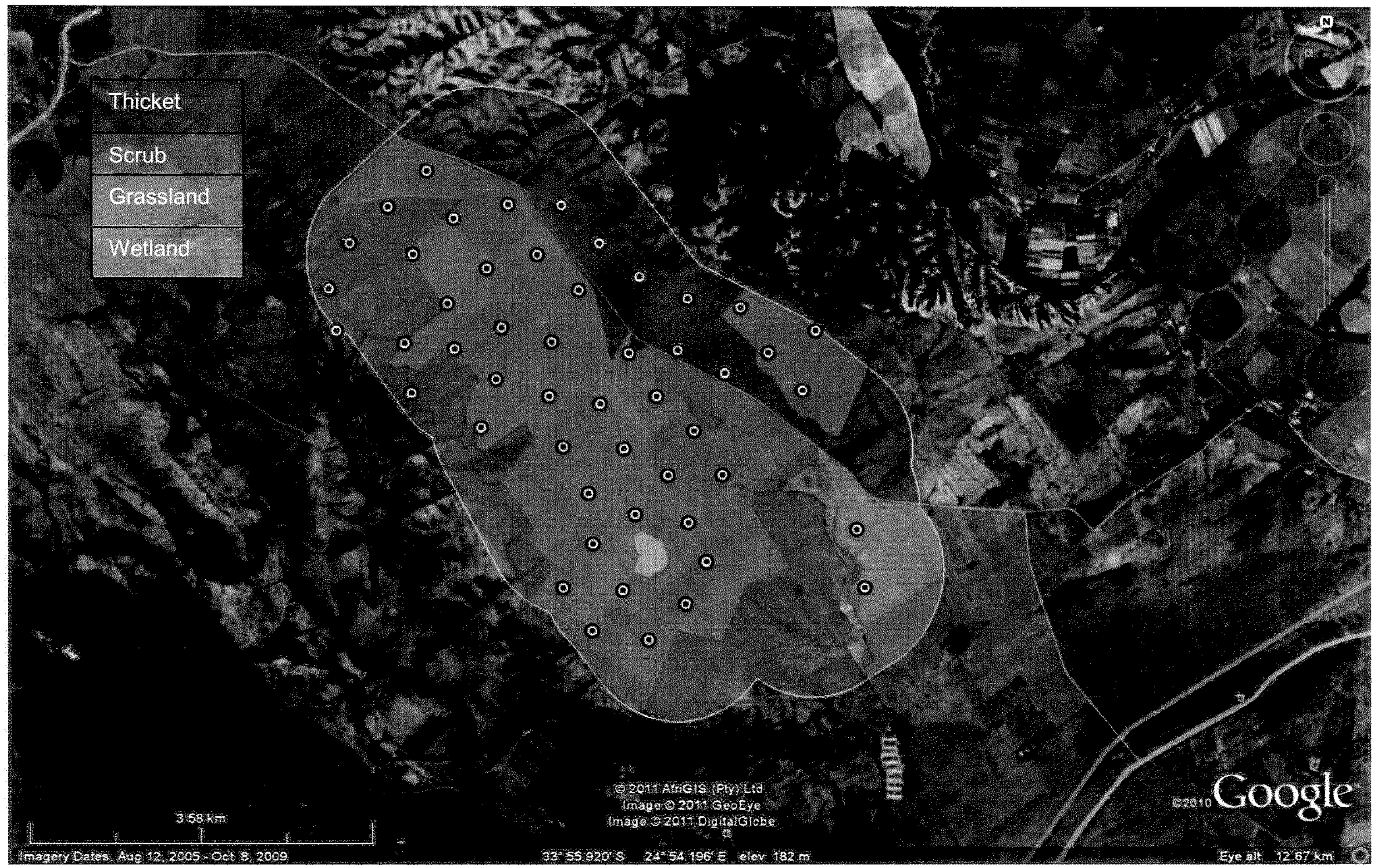


Figure 6.6: The bird habitat classes in the survey area, together with proposed V90 turbine lay-out.

Within the survey area 6% of the habitat is classified as wetland, 21% as thicket, 22% as scrub and 50% as grassland.

The priority bird species that have been recorded on the site during the two seasons of transect monitoring are listed in Table 6.1 below. The following abbreviations are used to indicate conservation status:

- VU-Nationally Vulnerable (Barnes 2000)
- NT-Nationally Near Threatened (Barnes 2000)

Table 6.1: Priority bird species recorded during summer and winter transect surveys

Common Name	Scientific Name	Conservation status (Barnes 2000)	Summer IKA = Index of Kilometric Abundance, or birds/km	Winter IKA = Index of Kilometric Abundance, or birds/km
African Marsh Harrier	*Circus ranivorus*	VU	0.01	0.01
Amur Falcon	*Falco amurensis*	Common non-breeding Palearctic migrant	0.35	-
Black Harrier	*Circus maurus*	NT	0.08	-
Blue Crane	*Anthropoides paradiseus*	VU	0.32	0.06
Denham's Bustard	*Neotis denhami*	VU	0.68	0.7
Hottentot Buttonquail	*Turnix hottentotus*	Rare and localised endemic	0.01	-
Jackal Buzzard	*Buteo rufofuscus*	Common endemic	0.07	0.01
Southern Pale Chanting Goshawk	*Melierax canorus*	Near endemic	0.03	0.04
Rock Kestrel	*Falco rupicolus*	Resident	0.05	0.01
Secretarybird	*Sagittarius serpentarius*	NT	0.04	0.1
Steppe Buzzard	*Buteo vulpinus*	Common non-breeding Palearctic migrant	0.10	-
White Stork	*Ciconia ciconia*	Common non-breeding Palearctic migrant	0.01	-
White-bellied Korhaan	*Eupodotis senegalensis*	VU	0.08	0.3
Southern Tchagra	*Tchagra tchagra*	Common to rare endemic	-	0.02

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; and
- Habitat loss due to the footprint of the wind farm.

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 analyzed all of the research done to date on various causes of avian mortality, including commercial wind farm turbines. It reports that "data collected outside California indicate an average of 1.83 avian fatalities per turbine (for all species combined), and 0.006 raptor fatalities per turbine per year. Based on current projections of 3,500 operational wind turbines in the US by the end of 2001, excluding California, the total annual mortality was estimated at approximately 6,400 bird fatalities per year for all species combined". The NWCC report states that its intent is to "put avian mortality associated with windpower development into perspective with other significant sources of avian collision mortality across the United States". It further reports that: "Based on current estimates, windplant related avian collision fatalities probably represent from 0.01% to 0.02% (i.e. 1 out of every 5,000 to 10,000) of the annual avian collision fatalities in the United States". That is, commercial wind turbines cause the direct deaths of only 0.01% to 0.02% of all of the birds killed by collisions with man-made structures and activities in the USA.

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

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

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

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

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

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

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

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

A review of 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).

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). Indications are that Great Bustard *Otis tarda* (a species related to the Denham's Bustard) are displaced by wind farms within one kilometre of the facility (Langgemach 2008).

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

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

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

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

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 Management actions

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

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

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

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

Unfortunately, the record of mitigation management in the wind industry is not particularly encouraging. Despite the fact that wind power has been a feature of the energy industry in the developed world for more than a decade, best practices with regard to bird mitigation are still far from clear and universally accepted. In the USA, for example, best practices are sorely lacking

(Smallwood 2008). Mitigation measures would be more effective if based on scientifically founded conclusions of factors affecting bird collisions with wind turbines. It is essential to perform scientifically rigorous pre- and post-construction monitoring of bird fatalities and flight behaviour in wind farms, as well as ecological investigations. These types of investigations have not been performed at most wind farms in the USA so the scientific basis for mitigation measures remains weak (Smallwood 2008). Avoidance and minimisation measures will be the most effective mitigation at wind farms, but these have yet to be implemented at USA wind farms. Adaptive management is often promised in environmental review documents, but in practice it seldom happens. Off-site compensation may be the only substantial means of mitigating impacts following wind farm development. A scientifically defensible nexus between project impacts and mitigation benefits still needs to be established for compensation ratios directed toward wind farms (Smallwood 2008).

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

6.4 PERMIT REQUIREMENTS

No specific legal requirements are applicable that pertain to avifauna. The applicable environmental legal requirements are covered in Chapter 4 of this report.

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 ...".

The Convention on the Conservation of Migratory Species of Wild Animals (http://www.unep-aewa.org) is also applicable. 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.

6.5 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

6.5.1 Mortalities from collisions with wind turbines

A total of 144 hours (72 hours per season) of vantage point watches has been completed to date in order to record flight patterns and altitudes of priority species. For purposes of the analysis, it was assumed that all flights of priority species within a 2 km radius of a vantage point were recorded during the observation periods. For purposes of this report, the combined area taken up by the four vantage points is termed "the VP area".

In the summer observation period, priority species were recorded flying over the VP area for a total of 1 hour 47 minutes and 15 seconds. A total of 162 individuals were recorded. Of these, 88 birds flew at low altitude (below rotor height), 50 flew at medium altitude (i.e. approximately within rotor height) and 24 flew at high altitude (above rotor height). The passage rate for priority species over the VP area (all heights) was 2.16 birds/hour. For medium altitude flights only, the passage rate was 0.69 birds/hour. Figure 6.7 below provides a breakdown of the species and flight heights recorded during the summer vantage point observations.

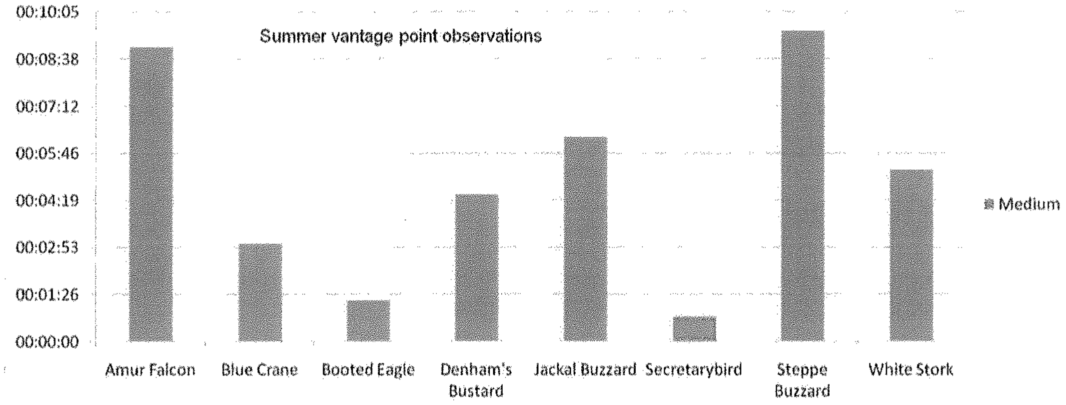


Figure 6.7: Breakdown of priority species vantage point observations (medium height flights only) for summer season. Time is hours: minutes: seconds.

An indication of the influence of wind direction on the flight patterns of the priority species during the summer observation period is provided in Figure 6.8.

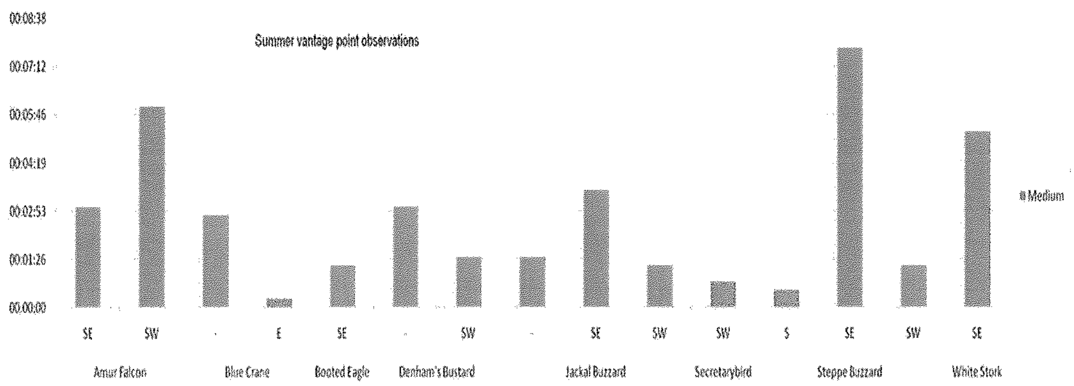


Figure 6.8: Duration of medium flight heights of priority species in various wind directions in summer.

An indication of the influence of wind strength on the flight patterns of the priority species during the summer observation period is provided in Figure 6.9.

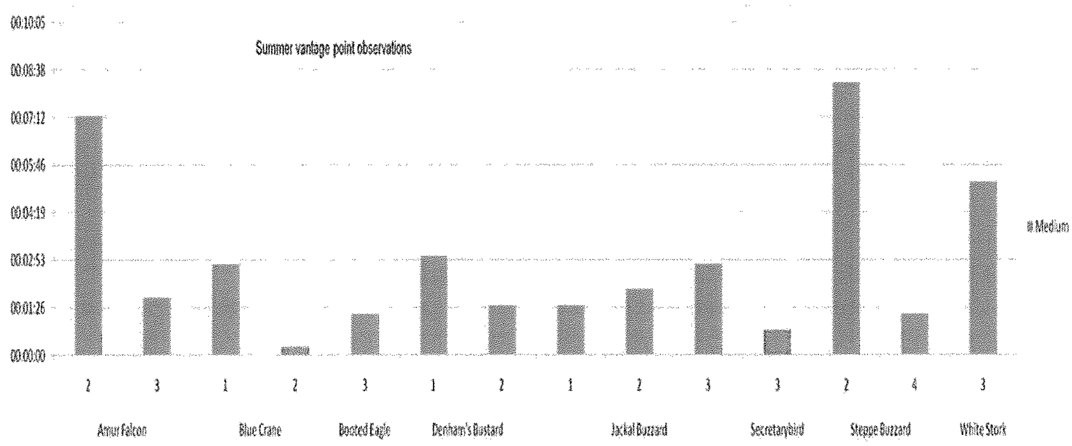


Figure 6.9: Medium flight heights and duration of priority species in various wind strengths (1 = calm; 2 = light; 3 = moderate; 4 = strong) in summer.

The data collected for priority species for the **summer** period show that:

- Soaring species, e.g. Amur Falcon, Booted Eagle, Steppe Buzzard and White Stork may be most at risk of collision with the turbines;
- Black Harriers spend most of their flying time below rotor height, which is typical of their foraging behaviour;
- Large terrestrial species, e.g. Blue Crane and Denham's Bustard (but not Secretarybirds, which seems to fly very seldom) flies more during calm conditions than during windy conditions. No flights for White-bellied Korhaan were recorded in summer, although the species is definitely present (see Table 6.4);
- Most flights take place during light and moderate wind conditions; and
- Most flights take place during south-easterly and south-westerly winds.

Calculating an estimated collision rate (ECR) is a risky venture, because of the many assumptions that inevitably need to be made in order to arrive at a figure, due to the lack of actual data. In this instance, an ECR for priority species per turbine for summer was calculated in the following manner: The number of birds which could be flying at medium altitude in the VP area during the summer period (mid-November to mid-March) was estimated. This was done by multiplying the passage rate for medium altitude (0.69 birds/h) with the potential flying time available for that period, assuming that each day will have an average of 8 hours potential flying time. The following formula was used: (120 days x 8 hours) x 0.69 = 662 birds. The total surface area that is covered by the VP area comes to 3160 hectares, and within this area, the total surface area covered by the turbine rotors footprint (taken as a 50 m radius around the centre column) amounts to approximately 32 hectares i.e. about 1%, which means that 99% of the airspace in the VP area can be considered safe from a collision risk perspective. Based on this, it was conservatively assumed that at least 90% of all birds flying through the VP area at turbine height medium altitude would therefore be travelling through "safe" airspace, or conversely, it was assumed that no more than 66 birds (10%) would potentially collide with turbines, if they take no evasive action. This figure was then multiplied by 0.02, on the assumption that 98% of these birds will take evasive action to avoid the turbines (SNH 2010). This gives an ECR of 1.3 birds for the VP area, or 0.02 birds per turbine for the summer season (V 90 layout = 50 turbines). This figure should be qualified in the following manner:

- It does not take into account variations in bird numbers from year to year, which is likely to be considerable, depending on rainfall;
- It does not take into account rainy weather conditions, when most birds, particularly soaring species, do not fly;
- It does not take into account the fact that all the turbines will not be operating for the full 8 hours for 365 days per year;
- The figure includes flights of Denham's Bustard and Blue Crane which took place during calm conditions when the turbines will not be operating;
- It does not take into account that some species, e.g. Denham's Bustards, could be displaced from the area, therefore reducing the risk of collisions with the turbines;
- It does not take nocturnal species into account;
- It assumes that each turbine poses an equal risk of collision, which, based on actual observations (see Figure 6.10) is not the case; and
- The assumption that there is a linear relationship between air space taken up by rotors and the size of the collision risk may be too simplistic.

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

In order to form a picture of the spatial distribution of priority species flights over the turbine area, a distribution map of flights was prepared. This was done by overlaying a 100 m x 100 m grid over the survey area. Each grid square was then given a weighting score taking into account the length of individual flight lines and the number of individual birds crossing the square (see Figure 6.10 for the map of medium altitude flights recorded during the summer observation period).

Figure 6.10: Map of medium height flights recorded at VP points in summer.

In the 72 hour winter observation period, priority species were recorded flying over the turbine area for a total of 41 minutes and 45 seconds. A total of 84 individuals were recorded. Of these, 49 birds flew at low altitude (below rotor height), 23 flew at medium altitude (i.e. approximately within rotor height) and 12 flew at high altitude (above rotor height). The passage rate for priority species over the turbine area (all altitudes) was 1.16 birds/hour. For medium altitude flights only, the passage rate was 0.31 birds/hour. A breakdown of the species and flight heights recorded during the winter vantage point observations is provided in Figure 6.11.

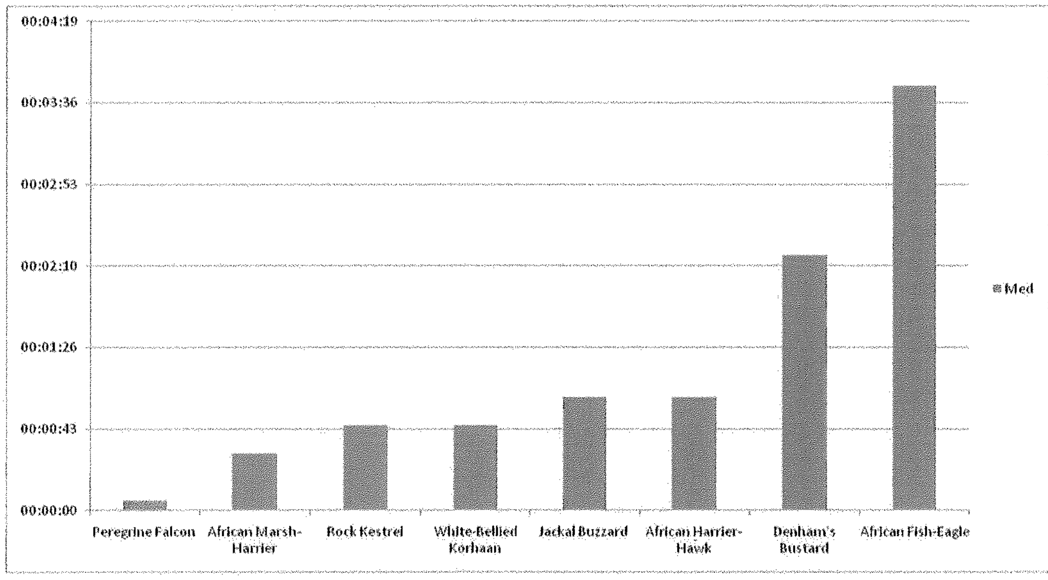


Figure 6.11: Breakdown of priority species vantage point observations (medium flight height only) for winter season. Time is hours: minutes: seconds.

An indication of the influence of wind direction on the flight patterns of the priority species during the winter observation period is provided in Figure 6.12.

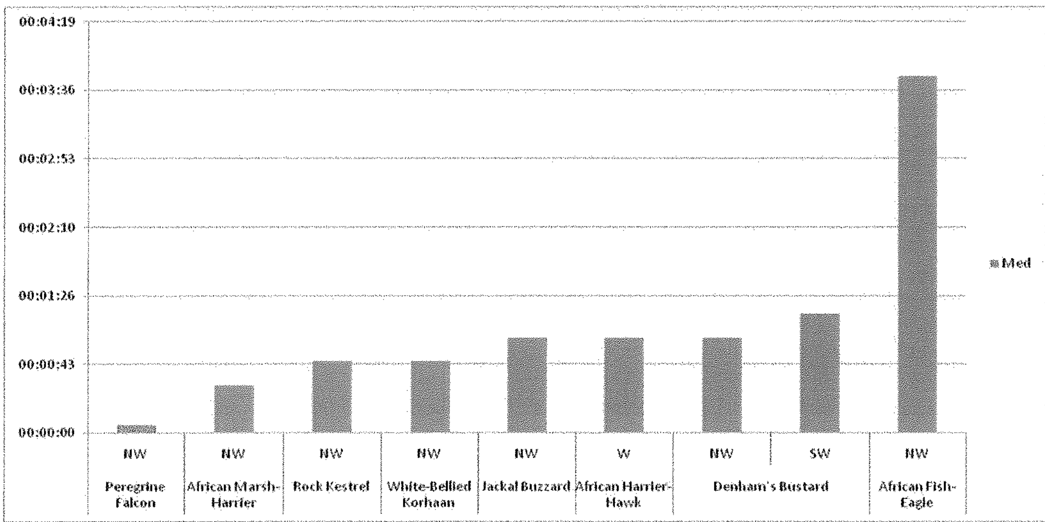


Figure 6.12: Flight heights and duration of priority species in various wind directions in winter.

An indication of the influence of wind strength on the flight patterns of the priority species during the winter observation period is provided in Figure 6.13.

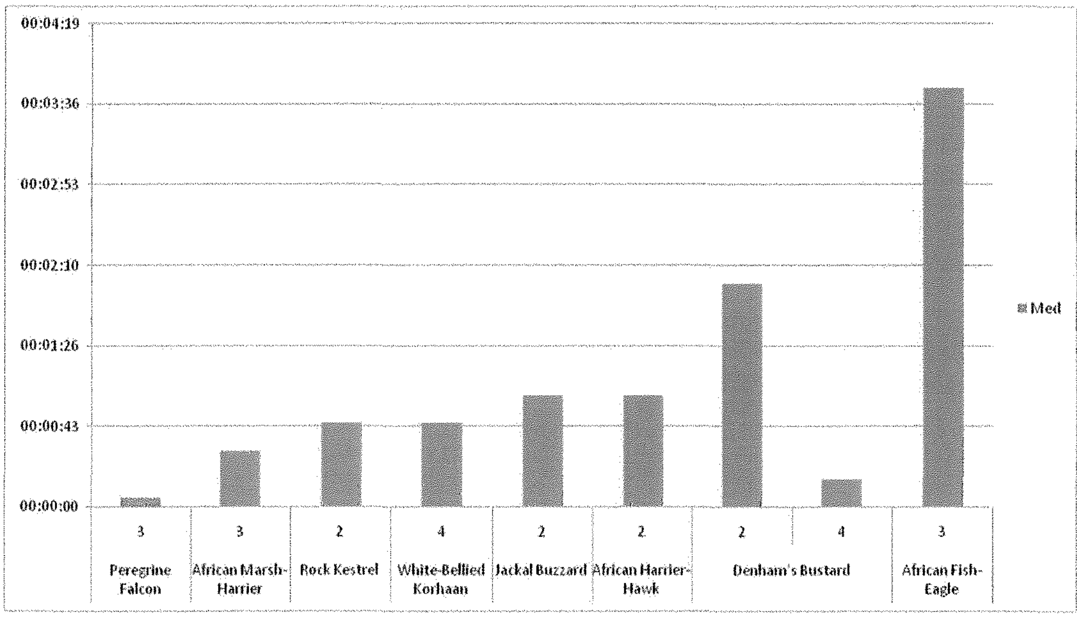


Figure 6.13: Medium flight heights and duration of priority species in various wind strengths (1 = calm; 2 = light; 3 = moderate; 4 = strong) in summer.

The data collected for priority species for the **winter** period shows that:

- Soaring species e.g. African Fish-Eagle, African Harrier-Hawk, African Marsh-Harrier, and Jackal Buzzard may be most at risk of collision with the turbines. Secretarybird, despite being a soaring species as well, was not recorded at medium or high flight heights at all;
- Black Harriers spend most of their flying time below rotor height, which is typical of their foraging behaviour. Southern Pale Chanting Goshawks generally fly below rotor height, which is also typical foraging behaviour;
- No clear pattern emerged for large terrestrial species. Blue Crane and Denham's Bustard flew during light and strong wind conditions, with no flights recorded in calm and moderate wind conditions. White-bellied Korhaan flew in all wind conditions, with most flights in strong wind conditions;
- Most flights take place during light and moderate wind conditions and
- Most flights take place during north-westerly winds.

In this instance, an ECR for priority species per turbine for winter was calculated in the same manner as for summer, with the same caveats. The number of birds which could be flying at medium altitude in the turbine area during the winter period (mid-May to mid-August) was estimated. This was done by multiplying the passage rate for medium altitude (0.31 birds/h) with the potential flying time available for that period, assuming that each day will have an average of 8 hours potential flying time. The following formula was used: (92 days x 8 hours) x 0.31 = 228 birds, and it was assumed that a maximum of 22 birds (10%) potentially could collide with the turbines if they take no evasive action. This figure was then multiplied by 0.02, on the assumption that 98% of these birds will take evasive action to avoid the turbines (SNH 2010). This gives an ECR of 0.44 birds for the total turbine area, or 0.008 birds per turbine for the winter season (V 90 layout = 50 turbines). This figure should be qualified in the same manner as the summer figure, as the same factors could play a role.

In order to form a picture of the spatial distribution of priority species flights over the turbine area, a distribution map of flights was also prepared for the winter period in the same manner as for summer (see Figure 6.14 below).

Figure 6.14: Map of medium height flights for the winter period.

Finally, an ECR for the combined summer and winter season was calculated, which amounts to 0.028 birds/turbine/year.

In summary the following preliminary conclusions can be drawn as far as priority species are concerned, subject to further monitoring:

- Soaring species are most at risk of collisions, with the exception of Secretarybirds, which seem to fly very seldom;
- Terrestrial species i.e. Blue Cranes, White-bellied Korhaan and Denham's Bustard, based purely on the number of medium height flights recorded, may also be at risk, but in the case of Denham's Bustard, the risk could be reduced due to the potential of displacement when the farm is operational;
- Collision risk is higher in summer than in winter, when passage rates are higher, largely because of an influx of migrants;
- Flight patterns of priority species at medium height recorded to date do not indicate any distinct flight corridors which will necessitate the relocation of any of the proposed turbine locations. This is subject to further monitoring being conducted; and
- The overall collision risk estimates per turbine per year for priority species (summer and winter data only) as a group is low.

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

- Once the turbines have been constructed, post-construction monitoring as per the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011) should be implemented to compare actual collision rates with predicted collision rates. If actual collision rates indicate unsustainable mortality levels, the following mitigation measures will have to be considered:
    - Negotiating appropriate off-set compensation for turbine related collision mortality;
    - As a last resort, halting operation of specific turbines during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality

6.5.2 Displacement due to disturbance

The transect was counted 6 times per season. In the summer observation period, a total of 25 hours and 31 minutes was spent counting to record priority species, and a total of 193 records of priority species was collected. In winter, a total of 24 hours and 13 minutes was spent counting and a total of 134 records of priority species was collected. For each season, an Index of Kilometric Abundance (IKA = birds/km) was calculated for each species, and also a figure for all priority species combined (see Tables 6.2 and 6.3 below).

Table 6.2: Index of Kilometric Abundance (IKA = birds/km) for priority species in the summer season

Priority spp	Mean per count	total length	IKA
African Marsh-Harrier	0.17	17.7	0.01
Amur Falcon	6.17	17.7	0.35
Black Harrier	1.50	17.7	0.08
Blue Crane	5.67	17.7	0.32
Denham's Bustard	12.00	17.7	0.68
Hottentot Buttonquail	0.17	17.7	0.01
Jackal Buzzard	1.17	17.7	0.07
Southern Pale Chanting Goshawk	0.50	17.7	0.03
Rock Kestrel	0.83	17.7	0.05
Secretarybird	0.67	17.7	0.04
Steppe Buzzard	1.83	17.7	0.10
White Stork	0.17	17.7	0.01
White-bellied Korhaan	1.33	17.7	0.08
Total	**32.17**	**17.7**	**1.82**

Table 6.3: Index of Kilometric Abundance (IKA = birds/km) for priority species in the winter season

Priority spp	Mean per count	total length	IKA
African Marsh-Harrier	0.17	17.7	0.01
Blue Crane	1.00	17.7	0.06
Denham's Bustard	12.33	17.7	0.70
Jackal Buzzard	0.17	17.7	0.01
Lanner Falcon	0.33	17.7	0.02
Rock Kestrel	0.17	17.7	0.01
Secretarybird	1.83	17.7	0.10
Southern Pale Chanting Goshawk	0.67	17.7	0.04
Southern Tchagra	0.33	17.7	0.02
White-bellied korhaan	5.33	17.7	0.30
Total	**22.33**	**17.7**	**1.26**

The habitat in which birds were counted was also recorded, to get an indication of the relative importance of habitat classes from a bird usage perspective. An indication of habitat usage by priority species in summer and winter is given in Tables 6.4 and 6.5. Within the survey area (defined as a 1 km buffer around the transect – see Figure 6.6), 6% of the habitat is classified as wetland, 21% as thicket, 22% as scrub and 50% as grassland.

Table 6.4: Priority species habitat use in the survey area in summer.

Priority spp	Grassland	Scrub	Thicket	Wetland	Total
African Marsh-Harrier	0.52%	0.00%	0.00%	0.00%	0.52%
Amur Falcon	17.62%	1.04%	0.00%	0.52%	19.17%
Black Harrier	2.59%	1.04%	1.04%	0.00%	4.66%
Blue Crane	17.62%	0.00%	0.00%	0.00%	17.62%
Denham's Bustard	36.79%	0.52%	0.00%	0.00%	37.31%
Hottentot Buttonquail	0.00%	0.52%	0.00%	0.00%	0.52%
Jackal Buzzard	3.11%	0.52%	0.00%	0.00%	3.63%
Southern Pale Chanting Goshawk	1.04%	0.52%	0.00%	0.00%	1.55%
Rock Kestrel	2.59%	0.00%	0.00%	0.00%	2.59%
Secretarybird	2.07%	0.00%	0.00%	0.00%	2.07%
Steppe Buzzard	4.15%	1.04%	0.00%	0.52%	5.70%
White Stork	0.52%	0.00%	0.00%	0.00%	0.52%
White-bellied Korhaan	4.15%	0.00%	0.00%	0.00%	4.15%
Total	**92.75%**	**5.18%**	**1.04%**	**1.04%**	**100.00%**

Table 6.5: Habitat use by priority species in the survey area in winter.

Priority spp	Grassland	Scrub	Thicket	Wetland	Total
African Marsh-Harrier	0.75%	0.00%	0.00%	0.00%	0.75%
Blue Crane	4.48%	0.00%	0.00%	0.00%	4.48%
Denham's Bustard	44.03%	7.46%	2.24%	1.49%	55.22%
Jackal Buzzard	0.75%	0.00%	0.00%	0.00%	0.75%
Lanner Falcon	0.75%	0.00%	0.75%	0.00%	1.49%
Rock Kestrel	0.75%	0.00%	0.00%	0.00%	0.75%
Secretarybird	0.00%	2.24%	5.97%	0.00%	8.21%
Southern Pale Chanting Goshawk	1.49%	1.49%	0.00%	0.00%	2.99%
Southern Tchagra	0.00%	0.00%	1.49%	0.00%	1.49%
White-bellied Korhaan	20.90%	2.99%	0.00%	0.00%	23.88%
Total	**73.88%**	**14.18%**	**10.45%**	**1.49%**	**100.00%**

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

- The survey area is particularly well suited for Denham's Bustard and White-bellied Korhaan;
- Grassland is the most important habitat for priority species – it comprises 50% of the habitat in the survey area, but it contained almost 93% and 74% of birds recorded in summer and winter respectively; and
- For reasons not quite clear at this stage, Blue Cranes were recorded more regularly in summer than in winter.

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

In addition to transect surveys and point counts, focal point monitoring of suspected nest sites of priority species was also undertaken. In the course of the monitoring, a suspected nest of a Secretarybird was located (33 55 35.33 S; 24 52 29.70 E), which is about 340 m from the nearest proposed turbine (see Figure 6.15 below).

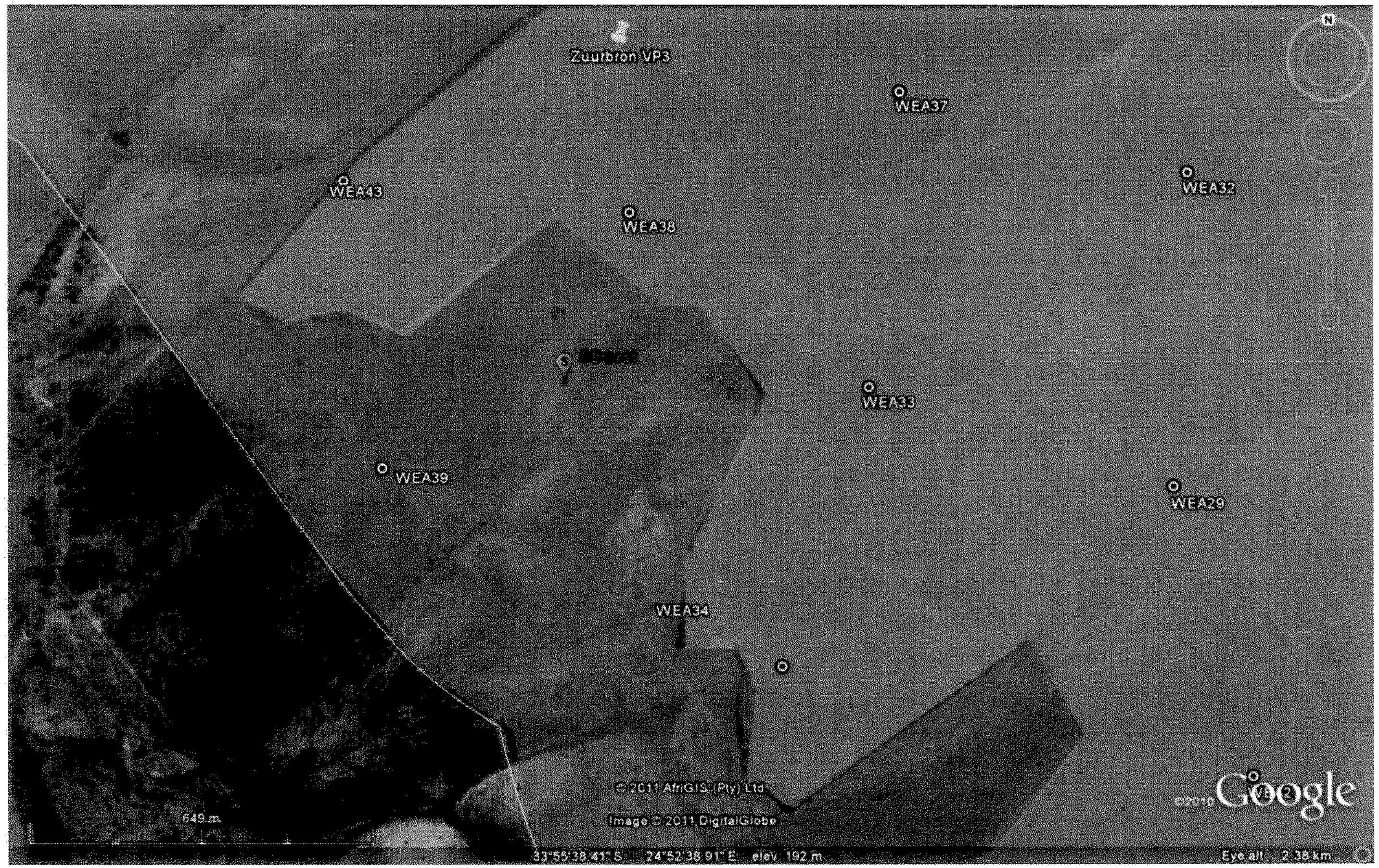


Figure 6.15: Location of potential Secretarybird breeding activity in 2011 breeding season.

Although Secretarybirds have been reported to re-use nest sites (Kemp (1995) recorded 6 re-use of nests in 26 breeding attempts), according to Dawie de Swardt, ornithologist at the National Museum in Bloemfontein and acknowledged authority on Secretarybirds, he has never encountered a pair re-using a nest in 23 years of ringing the species at the nest. It may be that the potential re-use of a nest is linked to scarcity of suitable nesting trees in an area, which is not the case in the study area. The critical period where nest abandonment is most likely due to disturbance, is when there are eggs or young chicks on the nest i.e in the period August – October (De Swardt pers.comm). It is unlikely that the proposed wind farm will adversely affect the breeding activity of the Secretarybirds **at this specific nest site**, as construction activities will only commence after the 2011 breeding season, and breeding is likely to take place at this specific nest only for one season (i.e. before wind farm construction commences). It is not yet clear at this stage whether this nest will indeed be active in 2011, as Secretarybirds are known to go through pseudo-breeding behaviour without actually breeding (Hockey et al 2005; De Swardt pers.comm.). Additional monitoring will be conducted during the spring monitoring period to establish the status of the nest.

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

- 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 monitoring protocol as is currently implemented. Thereafter, the need for further monitoring will be informed by the results of the initial 12-month period;

- The breeding activity of the pair of Secretarybirds at the site must be carefully monitored. If the birds actually commence with breeding at the nest site, their nesting activity must continue to be monitored throughout 2011. In the unlikely case of them re-using the nest in 2012, appropriate mitigation must be agreed upon between the avian specialist and the project proponent to ensure that the birds are not disturbed during the critical nesting period of August to October;

- Should the results of the post-construction monitoring indicate significant displacement of priority species, appropriate off-set compensation should be negotiated with the project proponent to compensate for the loss of priority species habitat; and

- During the construction period, activity should be restricted to the construction footprint itself. Access to the rest of the properties must be strictly controlled to prevent unnecessary disturbance of birds.

6.5.3 Habitat change and loss

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

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

6.5.4 Cumulative impacts

It is impossible to say at this stage what the cumulative impact of all the proposed wind developments will be on birds, firstly because there is no baseline to measure it against, and secondly because the extent of actual impacts will only become known once a few wind farms are developed. It is therefore imperative that pre-construction and post-construction monitoring is implemented at all the new proposed sites, in accordance with the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011), which was released by the Endangered Wildlife Trust and Birdlife South Africa in March 2011. This will provide the data necessary to improve the assessment of the cumulative impact of wind development on priority species. At this stage, indications are that displacement may emerge as a significant impact, particularly for species such as Denham's Bustard, White-bellied Korhaan and Secretarybird.

6.5.5 Impact assessment

The criteria for the assessment of impacts are fully explained in the Chapter 4 of this report. The tables below provide a summary of the envisaged impacts. A summary of the impact assessment is provided below in Table 6.6.

Table 6.6: Impact summary

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
CONSTRUCTION PHASE									
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 unnecessary habitat destruction (i.e. more than is inevitable), the recommendations of the specialist ecological study must be strictly adhered to.	Low	High
OPERATIONAL PHASE									

Continued/...

Nature of impact	Status (negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
OPERATIONAL PHASE									
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 need for further monitoring will be informed by the results of the initial 12-month period. ▪ The breeding activity of the pair of Secretarybirds at the site must be carefully monitored. If the birds actually commence with breeding at the nest site, their nesting activity must continue to be monitored throughout 2011. In the unlikely case of them re-using the nest in 2012, appropriate mitigation must be agreed upon between the avian specialist and the project proponent to ensure that the birds are not disturbed during the critical nesting period of August to October. Should the results of the post-construction monitoring indicate significant displacement of priority species, appropriate offset compensation should be negotiated with project proponent to compensate for the loss of priority species habitat.	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 regional but international in the case of migratory species.	Long term	High	Probable for soaring species, unknown for Blue Cranes, Secretarybirds korhaans and bustards.	Low - medium	▪ Once the turbines have been constructed, post-construction monitoring as per the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa – Version 1* (Jenkins *et al* 2011) should be implemented to compare actual collision rates with predicted collision rates. If actual collision rates indicate unsustainable mortality levels, the following mitigation measures will have to be considered: ○ Negotiating appropriate off-set compensation for turbine related collision mortality; ○ As a last resort, halting operation of specific turbines during peak flight periods, or reducing rotor speed, to reduce the risk of collision mortality	Low	Low - medium

6.6 CONCLUSIONS

This report should be seen as work in progress since the full results of the pre-construction monitoring programme will only become available later in 2011, when the spring monitoring has been completed. The final results of the current baseline monitoring will then be available to feed into the final lay-out of the turbines. In the meantime, based on the available data, the following preliminary conclusions have been drawn:

- Soaring species are most at risk of collisions, with the exception of Secretarybirds, which seem to fly very seldom;
- Terrestrial species i.e. Blue Cranes, White-bellied Korhaan and Denham's Bustard, based purely on the number of medium height flights recorded, may also be at risk, but in the case of bustards and korhaans, the risk could be reduced due to the potential of displacement when the farm is operational;
- Collision risk is higher in summer than in winter, when passage rates are higher, largely because of an influx of migrants;
- Flight patterns of priority species at medium height recorded to date do not indicate any distinct flight corridors which will necessitate the relocation of any of the proposed turbine locations. This is subject to further monitoring being conducted;
- The overall collision risk estimates per turbine per year for priority species (summer and winter data only) as a group is low;
- The survey area is particularly well suited for Denham's Bustard and White-bellied Korhaan;
- Grassland is the most important habitat for priority species – it comprises 50% of the habitat in the survey area, but it contained almost 93% and 74% of birds recorded in summer and winter respectively;
- At this stage, one can only speculate about the likelihood of potential displacement of large terrestrial birds in the study area, particularly Denham's Bustard, White-bellied Korhaan, Blue Crane and Secretarybird as this will only become apparent once the post-construction monitoring commences. If the birds are displaced, this could potentially be the most significant impact of the wind farm on the avifauna; and
- The potential for habituation always exists, but due to lack of research results, no unequivocal predictions can be made. As far as raptors are concerned, the chances of displacement are low, based on research results elsewhere. This trend also seems to be supported by the results of the limited post-construction monitoring conducted at the existing 4 turbines at the Darling Wind Farm. Blue Cranes might also be more tolerant, based on general observations in the study area where Blue Cranes breed and forage in close proximity to agricultural operations.

Appendix 6.1: Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa

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Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa

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Executive summary

1. The wind energy industry is poised for rapid expansion into many areas of southern Africa. While experiences in other parts of the world suggest that this industry may be detrimental to birds (through the destruction of habitat, the displacement of populations from preferred habitat, and collision mortality with wind turbines and power lines), these effects are highly site- and taxon-specific in operation. Raptors, large terrestrial species and wetland birds are thought to be most susceptible, and areas of higher topographic relief are often implicated in negative impact scenarios.

2. In order to fully understand and successfully mitigate the possible impacts of wind farms on the region's birds (and to bring the local situation into line with international best practice in this field), it is essential that objective, structured and scientific monitoring of both resident and passing avifauna be initiated as soon as possible at all proposed development sites.

3. The Birds & Wind Energy Specialist Group, convened by the Wildlife & Energy Programme of the Endangered Wildlife Trust, and BirdLife South Africa, proposes the following guidelines and monitoring protocols for evaluating wind energy development proposals, including a 3-4 tier assessment process: (i) Reconnaissance (scoping) – a brief site visit informs a desk-top assessment of likely avifauna and possible impacts, and the design of a site-specific survey and monitoring project, (ii) Baseline monitoring (EIA) – a full assessment of the significance of likely impacts and available mitigation options, based on the results of systematic and quantified monitoring as specified at scoping, (iii) Post-construction monitoring – duplication of the baseline work, but including the collection of mortality data, to develop a complete before:after picture of impacts, and refine the mitigation effort, and (iv) if warranted, more detailed and intensive research on affected threatened species.

4. To streamline this approach, a shortlist of priority species (threatened or rare birds, in particular those unique to the region, and especially those which are possibly susceptible to wind energy impacts and which occur in the given development area at relatively high densities) should be drawn up at the scoping stage, and these should be the primary focus of all subsequent monitoring and assessment.

5. Similarly, the amount of monitoring effort required at each site should be set in terms of the anticipated sensitivity of the local avifauna and the prevalence of contributing environmental conditions (for example, the diversity and relative abundance of priority species present, proximity to important flyways, wetlands or other focal sites, and topographic complexity).

6. On-site work must be coupled with the collection of directly comparable data at a nearby, closely matched control site. This will provide much needed context for the analysis of pre- *vs* post-construction monitoring data.

7. In some situations, where proposed wind energy developments are likely to impinge on flyways used by relatively large numbers of threatened and impact sensitive birds, and particularly where these movements are likely to take place at night or in conditions of poor visibility (e.g. the Cape Columbine Peninsula), it may be necessary to use radar to gather sufficient information on flight paths to fully evaluate the development proposal and inform mitigation requirements.

8. Baseline monitoring will require periodic visits to both the development and control sites, sufficient in frequency to adequately sample all major variations in environmental conditions, and spanning a total study period of not less than 12 months. Variables measured/mapped on each site visit should include (i) density estimates for small terrestrial birds (in most cases not priority species, but potentially

affected on a landscape scale by multiple developments in one area), (ii) absolute counts, density estimates or abundance indices for large terrestrial birds and raptors, (iii) passage rates of birds flying through the proposed development area, (iv) occupancy/numbers/breeding success at any focal raptor sites, (v) bird numbers at any focal wetlands, and (vi) full details of any incidental sightings of priority species.

9. Post-construction monitoring should effectively duplicate the baseline work, with the addition of surveys for collision and electrocution victims under the turbines and ancillary power infrastructure.

10. While analysis and reporting on an individual development basis will be the responsibility of the relevant avifaunal specialist, all data emanating from the above process should also be housed centrally by the Birds & Wind Energy Specialist Group to facilitate the assessment of results on a multi-project, landscape and national scale.

1. Introduction

The wind energy industry is in the process of rapid expansion in southern Africa (and more broadly on the continent, as well as globally – World Wind Energy Association 2010). A short-list of credible, scientific studies done or ongoing in other parts of the world (Drewitt & Langston 2006, 2008 and references therein, Jordan & Smallie 2010) have established that the most prevalent impacts of wind energy facilities (WEFs) on birds are displacement of sensitive species from development areas, and mortality of susceptible species, primarily in collisions with development hardware. However, the nature and extent of these impacts is highly dependent on both site- and species-specific variables (Drewitt & Langston 2006, 2008 and references therein, Jordan & Smallie 2010), and there is no empirically based understanding of the likely effects of wind energy development on southern African birds. The South African Birds & Wind Energy Specialist Group (BAWESG) therefore recognizes the need to measure these effects as quickly as possible, in order to identify and mitigate any detrimental impacts on threatened or potentially threatened species. BAWESG also recognizes the need to gather these data in a structured, methodical and scientific manner, in order to arrive at tested and defensible answers to critical questions (Stewart *et al.* 2007).

This should be done by means of an integrated programme of pre- and post-construction monitoring projects, set up at all the proposed development sites. Each such project should broadly comply with the guidelines provided here, although the scale of each project, the level of detail and technical input, and the relative emphasis on each survey and monitoring component, will vary from site to site in terms of the risk potential identified by the initial scoping or environmental impact assessment (EIA) studies. In principle, each project should be as inclusive and extensive (both spatially and temporally) as possible, but kept within reasonable cost constraints, consistent with the anticipated conservation significance of the site and its avifauna. In general, the detail and rigor required in any given monitoring project will be proportional to the size of the proposed WEF (*n* turbines and spatial extent), topographic and/or habitat heterogeneity on site, the relative importance of the local avifauna (in terms of diversity, abundance and threat status), and the anticipated susceptibility of these birds to the potential negative impacts of a wind energy development (Table 1).

In this context, a three to four tier system of survey and monitoring, which has been applied in both Europe and North America (e.g. Scottish Natural Heritage 2005, Kuvlevsky *et al.* 2007), is probably a good approach to use here. The current South African EIA process provides the first tier product in such a system in the form of what is presently considered as a full specialist impact assessment report, but which is actually no more than a reconnaissance or scoping study. Should this initial scoping report endorse the development, a full avian impact assessment (AIA) should then be based on the second tier of work, comprising baseline survey and monitoring. Should the AIA also endorse the proposed development and it goes ahead, a third tier of work would consist of a comparative post-construction survey and monitoring effort. Note that while the more general development impacts associated with the actual construction of each wind energy facility are not a primary focus of this document, BAWESG acknowledges that these may be severe. The scale and mitigation of these impacts should be referred to explicitly in scoping level and AIA reports, should be integral to the ultimate Record of Decision (RoD), and should be monitored and mitigated under the development construction management plan.

In each instance, pre- and post-construction monitoring should be undertaken at at least one nearby control site, matched as closely as possible to the proposed development site, to validate before:after comparisons of bird populations and movements. Lastly, at selected sites where bird impacts are expected to be particularly direct and severe (in terms of the relative biodiversity value of the affected avifauna, and/or the inherent risk potential of the proposed facility), additional, more customized and experimental research initiatives may be required, such as intensive, long-term monitoring of marked or even satellite tagged populations (e.g. Nygård *et al.* 2010).

The overarching aims of this multi-tiered approach would be:

(i) To develop our understanding of the effects of WEFs on southern African birds.

(ii) To develop the most effective means to mitigate these impacts.

Given the rate and extent of proposed wind energy development, this should be done as quickly as possible, but using scientific methods to generate accurate, comparable information. The current set of best practice guidelines presents the means and standards required to achieve these aims. This is intended to be a living document that will be corrected, updated, and supplemented over time, as local specialist and research practitioners gain much-needed experience in this field.

2. Recommended protocols

Time, human capacity and finances are all legitimate constraints on the extent and intensity of monitoring work possible, but cannot at any stage be allowed to override the need to maintain the levels of coverage required to thoroughly evaluate the sustainability of a proposed WEF. Bird density and activity monitoring should focus data collection on a shortlist of priority species, defined in terms of (i) threat status or rarity, (ii) uniqueness or endemism, (iii) susceptibility to disturbance or collision impacts, and (iv) relative abundance on site. These species should be identified in the scoping/AIA report and/or by the BAWESG sensitivity mapping exercise. This will generally result in a strong emphasis on large, red-listed species (e.g. cranes, bustards and raptors – Drewitt & Langston 2006, 2008, Jenkins *et al.* 2010).

Factors which might motivate for intensified monitoring effort include high densities or diversity of threatened and/or endemic species, or the proximity of known and important avian flyways or wetlands, all of which add substantially to the potential impact of a given development (Table 1). Conversely, the absence of such factors would indicate reduced survey and monitoring requirements, although the interplay of these variables is likely to be complex and site-specific. Current levels of understanding preclude the establishment of any broadly applicable rules on monitoring intensity at this stage (Table 1).

Table 1. *Qualitative grading of required bird monitoring effort at proposed WEF sites in relation to a sample suite of potentially relevant parameters. Note that the inter-play between these and other contributing factors at each facility is likely to be complex and highly site specific, and is not represented in this table. The quantity of monitoring required in each case should ultimately be determined by the on-site specialist, with input from the Birds & Wind Energy Specialist Group if and when required.*

Required survey effort	Size of proposed WEF	Topography	Threatened species	Flyways	Importance for priority species	Proximity of significant wetlands
Lower	<20 turbines	Flat	No red-listed endemics and only few red-listed species are present	Site does not impinge on a known avian flyway	No priority species breeding or roosting communally within the affected area	No regionally or nationally significant wetlands within the affected area
Medium	20-100 turbines	Undulating	At least one red-listed endemic and some red-listed species are present	No information available on avian flyways in the area	One priority species breeding or roosting communally within the affected area	One regionally or nationally significant wetland within the affected area
Higher	>100 turbines	Hilly with prominent and defined ridges	Multiple red-listed endemics and many red-listed species are present	Site impinges on a known avian flyway	>1 priority species breeding or roosting communally within the affected area	>1 regionally or nationally significant wetland within the affected area

While immediate conservation imperatives and practical constraints motivate for focus on priority species, it is also important to account for more subtle, systemic effects of wind energy developments, which may be magnified over very large facilities, or by multiple facilities in the same area. For example, widespread, selective displacement of smaller, more common species by

WEFs may ultimately be detrimental to the status of these birds and, perhaps more significantly, may upset the balance and effective functioning of the local ecosystem. Similarly, the loss of relatively common but ecologically pivotal species (e.g. non-threatened apex predators such as Verreaux's Eagle *Aquila verreauxii*) from the vicinity of a WEF may also have a substantial, knock-on effect. Hence, some level of monitoring of small bird populations will be required at all sites, and certain non-threatened but impact susceptible species will emerge as priority species by virtue of their perceived value to the ecosystem. Also note that quantitative surveys of small bird populations may be the only way in which to adequately test for impact phenomena such as displacement (Devereaux *et al.* 2008, Farfán *et al.* 2009), given that large target species occur so sparsely in the environment that it may not be possible to submit density or abundance estimates to rigorous statistical examination.

Ultimately, each monitoring project should provide much needed quantitative information on the numbers, distributions and risk profiles of key species or groups of species within the local avifauna at a given development site, and serve to inform and improve mitigation measures designed to reduce this risk. The bulk of the work involved should be done by trained observers, under the guidance and supervision of a qualified and experienced specialist ornithologist.

2.1 Stage 1: Reconnaissance (Scoping)

This stage should comprise most of what is currently considered as the EIA stage of the development application process. Local specialists, consulting agencies, developers and (most importantly) the SA Department of Environmental Affairs (DEA) will be required to change their perspectives on the EIA process in order to successfully institute this change, with the full AIA assessment then being compiled in terms of the outcomes of baseline monitoring.

The main aims of a reconnaissance (or scoping) study are:

(i) To define the study area - the core of the area covered by survey and monitoring work done at each proposed development site is determined by the client, and comprises the inclusive area on which development activities (the construction of turbines and associated road and power infrastructure) are likely to take place. However, because birds are highly mobile animals, and because an important potential impact is the effect of the WEF on birds which move through the proposed development area, as well as those which are resident within it, the avian impact zone of any proposed WEF extends well beyond the boundaries of this central core. Of particular concern is that monitored areas are large enough to include the considerable space requirements of large birds of prey, which may reside tens of kilometres outside of the core development area, but regularly forage within it (Walker *et al.* 2005, Madders and Whitfield 2006, Martinéz *et al.* 2010). How far the study area extends in each case should be determined by the on-site specialist, and should be defined at the scoping stage of the assessment process, perhaps with opportunity for subsequent refinement during the AIA stage.

Generally, the extent of the broader impact zone of each project will depend on the dispersal ability and distribution of important populations of priority species that are likely to move into the core impact area with some regularity. It is important that the delineation of this inclusive impact zone, which is the area within which all survey and monitoring work will be carried out, is done realistically and objectively, balancing the potential impacts of the wind farm with the availability of resources to conduct the monitoring.

(ii) To characterize the site in terms of:

- the avian habitats present,
- an inclusive list of species likely to occur there,
- an inclusive list of priority species likely to occur there, with notes on the relative value of the site for these birds,
- input on likely seasonality of presence/absence and/or movements for key species,
- any obvious, highly sensitive, no-go areas to be avoided by the development from the outset.

This should be done by means of:

- a desk-top study of the local avifauna, using relevant, pre-existing information (Hockey *et al.* 2005) and datasets - for example the Southern African Bird Atlas data (SABAP 1 - Harrison *et al.* 1997, and SABAP 2), Coordinated Waterbird Counts (CWAC, Taylor *et al.* 1999), Coordinated Avifaunal Roadcounts (CAR, Young *et al.* 2003), the Birds in Reserves project (BIRP) and the Important Bird Areas initiative (Barnes 1998) (for updates on all these datasets see http://adu.org.za/), as well as data from the Endangered Wildlife Trust's programmes and associated specialist research studies, and
- a short (2-4 day) site visit to the area to search for key species and resources, and to develop an on-site understanding of where (and possibly when) priority species are likely to occur and move around the site (note that such a visit will not allow for seasonal variation in the composition and behaviour of the local avifauna, and such

variation must therefore be estimated in terms of the existing information for the site or region, and the experience of the consulting specialist).

(iii) To provide an initial estimation of likely impacts of the proposed WEF, and to assess the nature and scale of baseline monitoring required to measure these impacts, and to provide input on mitigation.

In summary, the reconnaissance exercise should yield a scoping report describing the avifauna at risk detailing the nature of that risk and options for mitigation, as well as outlining the baseline monitoring effort required to inform the AIA report. As a useful by-product of this work, specialists should be encouraged to register with the SABAP 2 project (http://sabap2.adu.org.za/), and to complete atlas cards for the pentads (5 x 5 minute squares) making up each development site, on every site visit (including those made during baseline and post-construction monitoring).

2.2 Stage 2: Baseline monitoring (EIA)

The products of this stage in the process should substantially inform the AIA report, and be the basis upon which the RoD is issued by DEA.

The primary aims of baseline monitoring are:

(i) To estimate the number/density of birds regularly present or resident within the broader impact area of the WEF before its construction.
(ii) To document patterns of bird movements in the vicinity of the proposed WEF before its construction (e.g. Erickson *et al.* 1999).
(iii) To estimate predicted collision risk (the frequency with which individuals or flocks fly through the future rotor swept area of the proposed WEF – Morrison 1998, Band *et al.* 2007) for key species.
(iv) To inform comment on the merits of the application in the AIA report in terms of points (i) to (iii).
(v) To establish a pre-impact baseline of bird numbers, distributions and movements.
(vi) To mitigate impacts by informing the final design, construction and management strategy of the development.

Control sites

Monitoring data should be generated for both the broader impact zone of the proposed WEF, and for one or more comparable control sites. In this way, a comparison of data from pre- and post-construction monitoring can be calibrated in terms of an equivalent comparison for a suitable control area, and the effects of regional variation in environmental conditions can be filtered out of the resulting quantification of the actual impacts of the WEF (Anderson *et al.* 1999, Scottish Natural Heritage 2005, Stewart *et al.* 2007, Pearce-Higgins *et al.* 2009). Note that, whenever possible, close neighbouring WEF development areas could use a common control site to minimize the time taken to locate a suitable area and acquire data, and the corresponding costs to the client.

Suitable control sites should:

- match the range of habitats and topography of the proposed WEF site,
- host a similar mix of bird species to those present on the WEF site,
- be at least half the size of the wind farm area,
- be located on ground with a similar mix of habitats and similar topography and aspect (Pearce-Higgins *et al.* 2009),
- be situated as close as possible to the wind farm area, but far enough away to ensure that resident birds on the control site are not directly affected by the wind farm operations once they start, and also that there is little, if any, localised movement of key species between the two areas.

Duration and frequency of monitoring

Monitoring data also should be collected over at least a 12 month period (at both WEF and control sites), and include sample counts representative of the full spectrum of prevailing environmental conditions likely to occur on each site in a year (Drewitt & Langston 2006). This time-span may not have direct biological relevance, but presents a useful compromise between the extremes of either attempting to accommodate inevitable (and probably significant) variation between years, or just distilling the process into a sampling window of only six months, spanning the period between mid-winter and mid-summer. The former option is practically impossible, while the latter is too simplistic and abbreviated to be worthwhile. Within a 12 month sampling period, the frequency of site visits should be determined by the perceived sensitivity of the site, modulated by practical constraints (human capacity, size and accessibility of the site, time, finances). Note that the quality and utility of the monitoring data is generally proportional to sampling frequency, so the number of iterations of each sampling technique per site visit, and the number of site visits per year, should always be kept at a practical maximum.

Equipment and mapping

Field workers should operate in pairs, and will require a number of specialized items of equipment in order to gather monitoring data accurately, quickly and efficiently. In many cases, each team will require the use of an off-road vehicle (ideally a 4x4) to make maximum use of the available road infrastructure on site. Each team member will need a pair of good quality binoculars, and each team will need a spotting scope and a recent regional bird identification guide. A GPS, a digital camera and a means to capture data – a notebook, datasheets, or generic or customized PDA – are also essential equipment. Electronic data capture devices, digital video cameras, hand-held weather stations and laser range-finders are useful, optional extras, that will facilitate the rapid acquisition, collation and processing of the maximum amount of relevant and accurate information on each site visit.

Before sampling and counting commence, the avian habitats available on both the project and the control sites should be mapped using a combination of satellite imagery (Google Earth) and GIS tools. These maps can later be subject to ground-truthing and refinement according to on site experience and/or the findings of scoping phase botanical surveys. Each field team should have at least one set of hard-copy maps (at a minimum scale of 1:50 000) covering the full study area for accurate navigation and plotting of sightings. Digital maps of the area, on which sightings can be plotted directly in digital format, are useful, optional extras, which should facilitate the accurate capture of spatially explicit information.

2.2.1 Bird numbers or densities

Bird population monitoring at southern African WEF development sites presents some unique challenges. Monitoring protocols from Europe and the USA are mostly designed for estimating population densities of small passerines, and/or for use in relatively small development areas (Anderson *et al.* 1999, Erickson *et al.* 1999, Scottish Natural Heritage 2005, Smallwood *et al.* 2009). In southern Africa, many of the proposed developments cover very large areas, many of the priority species are large birds (cranes, bustards, eagles, vultures), with proportionally large space requirements and sparse distributions (Jenkins 2011), and some of the key species are nomadic, with fluctuating densities related to highly stochastic weather events that drive local habitat conditions. These different dispersion parameters render many traditional approaches to monitoring inappropriate and/or ineffective. Furthermore, some of the proposed development sites are situated in remote and rugged terrain, and access limitations may preclude uniform and/or random sampling of all habitats. Hence sampling methods and sample sizes may be determined as much by what is practically possible as by what is required for statistical rigor (although every effort should be made to cover a representative cross-section of the available habitats, or at least to sample those areas most likely to hold priority species). Lastly, there is currently a dearth of suitably experienced people available to do this monitoring, so the quality of the work done is likely to be limited by capacity shortfalls, at least in the short term.

In this context, and within these limitations, it remains a stringent requirement that bird numbers, distributions and activities are monitored as accurately as possible at all proposed WEF and control sites, including data for a representative range of avian guilds.

Sample counts of small terrestrial species

While the emphasis of any monitoring project should be on the priority species identified at the scoping stage (and any other threatened and/or restricted range endemics seen and added to this list subsequently), there is a perceived need to monitor particularly the displacement effects of WEFs on small bird populations, even when these do not include species prioritized by the scoping exercise. This is more to further our understanding of the general effects of WEFs, and in particular the possible cumulative impacts of widespread WEF development on the broader avifauna, than to fulfill any immediate and localized conservation requirement. Given the potentially very large area put to wind energy development in 10-20 years time (http://www.sawea.org.za/), we need to assess now whether or not components of small bird communities are likely to be displaced, before we effect landscape-scale distributional changes, with the longer-term ecological damage that such changes could bring.

Most WEF developments are proposed for open, quite homogeneous terrain, in which small bird populations are relatively visible and uniformly distributed. Such conditions favour the use of walked, linear transect methods over other survey techniques (Bibby *et al.* 2000). The length, number and distribution of these transects on each site may vary according to site size, habitat diversity, and the richness and relative significance of the small terrestrial avifauna. Ideally, all the major habitat types present should be sampled approximately in proportion to their availability on site. Transects should be positioned at varying distances away from the proposed turbine arrays to maximize the value of the data in comparison with post-construction survey results,.

Transects should be walked slowly and carefully, and work should commence from as soon as it is light enough to see clearly in the early morning and extend only until mid-morning, avoiding the warmer middle of the day when birds are less active and vocal, and hence less conspicuous (Bibby *et al.* 2000). If it is not possible to compress all transects into this time period, it is important to otherwise standardize for time of day in project design and/or subsequent data analysis to minimize the possible effect of this factor on survey results. As a general rule, transects should not be walked in adverse conditions, such as heavy rain, strong winds or thick mist. The species, number and perpendicular distance from the transect line of all birds seen should either be measured (preferably using a laser range-finder), estimated by eye, or estimated in terms of pre-selected distance bands (0-10 m, 11-50 m, 51-200 m, >200 m), and recorded for subsequent analysis using DISTANCE (Buckland *et al.* 2010, http://www.ruwpa.st-and.ac.uk/distance/distanceabout.html) or equivalent approaches (Bibby *et al.* 2000). Alternatively, transects can be done with a fixed maximum width, and only birds seen or heard within this distance on either side of the transect line should be recorded (e.g. Leddy *et al.* 1999). These methods yield estimates of density (birds.km^{-2}) for all open country passerines and most other small species, although these estimates are crude for the latter approach as it assumes that the detection rate for different species is constant across the width of the transect (grossly underestimating densities of inconspicuous species). Even distance-based line transects will underestimate actual densities if only a proportion of the population is detected (e.g. singing males). The main concern for comparative studies is that the same technique (and ideally the same observer(s) is used for all counts throughout the pre- and post-implementation monitoring.

The variables recorded for each transect should include:

- Project name
- Transect number
- Date
- Observer/s
- Start/finish time
- GPS location at start and finish
- Distance covered (m)
- Habitat type/mix of habitat types
- Gradient of slope (flat, gentle, steep)
- Aspect of slope (none, north, north-east, east...)
- Temperature at start
- Cloud cover at start
- Wind strength/direction at start
- Visibility at start (good, moderate, poor)
- Position of sun relative to direction of walk (ahead, above, behind)

And variables to record for each observation should include:

- Time
- Species
- Number (number of adults/juveniles/chicks)
- Activity (flushed, flying-display, flying-commute, perched-calling...)
- Seen or heard?
- GPS on transect line
- Distance and direction from observer
- Perpendicular distance off transect line (m) (if required)
- Distance band off the transect line (if required)

- Fixed transect width (if required)
- Plot on map
- Additional notes

Another acceptable way to measure small bird densities is to use fixed point counts, in which the observer is positioned at one location (chosen either randomly or systematically to ensure coverage of all available habitats), and records the species and sighting/registration distance of all birds seen over a prescribed period of time. This technique is particularly useful for measuring avian densities in closed habitats with raised and/or dense vegetation (Bibby *et al.* 2000), and can include the use of vocal as well as visual cues as evidence of species presence, particularly valuable in conducting surveys of more cryptic and inconspicuous species (Bibby *et al.* 2000). Again, survey locations should be selected to represent the habitats covered more or less in proportion to their availability. The duration of each count period should be long enough to detect all the birds within the survey area, but short enough to avoid including birds that were not present in the area at the start. As with line transects, the distance from the static observer to each bird or flock of birds registered can either be measured directly (by estimation or using a laser range-finder), or allocated to a range of circular bands of distance from the observer, or else the count can be done with a fixed detection radius, including only the birds seen within this distance (Bibby *et al.* 2000).

The variables recorded for each such fixed point count should include:

- Project name
- Fixed point number
- Date
- Observer/s
- Start/finish time
- GPS location
- Habitat type/mix of habitats
- Gradient of slope (flat, gentle, steep)
- Aspect of slope (none, north, north-east, east…)
- Temperature at start
- Cloud cover at start
- Wind strength/direction at start
- Visibility at start (good, moderate, poor)

And variables to record for each observation should include:

- Time
- Species
- Number (number of adults/juveniles/chicks)
- Activity (flushed, flying-display, flying-commute, perched-calling…)
- Seen or heard?
- Distance to bird (m) (if required)
- Distance band containing bird (if required)

- Fixed radius of count (m) (if required)
- Additional notes

Counts of large terrestrial species and raptors

Large terrestrial birds, e.g. cranes, bustards, storks, and most raptors, cannot easily be surveyed using walked transects for reasons discussed above. Populations of such birds should be estimated on each visit to the project area either by means of an 'instantaneous' absolute count (only possible at relatively small proposed WEFs) or by means of vehicle-based sampling (best applied at relatively large proposed WEFs, especially those with good networks of roads and tracks). Any obvious breeding pairs and/or nest sites located during this survey work should be plotted and treated as focal sites for subsequent monitoring (see below).

Absolute counts of key species involves searching as much of the broader impact area of the WEF (or the control site) as possible in the course of a day, using the available road infrastructure (or otherwise walking) and prominent vantage points to access and scan large areas, and simply tallying all the individuals observed. This is only practical for the largest and most conspicuous species, and probably is only effective for cranes and bustards. If necessary, counts can be standardized for observer effort (time, area scanned, methods used), but ideally they will be working estimates of the absolute number of each target species present within the study area on that sampling day.

The variables recorded for each absolute count of large, priority species should include:

- Project name
- Count number
- Date
- Observer/s
- Start/finish time
- Temperature at start
- Cloud cover at start
- Wind strength/direction at start
- Visibility at start (good, moderate, poor)

And variables to record for each observation should include:

- Time
- Species
- Number (number of adults/juveniles/chicks)
- Activity (flushed, flying-display, flying-commute, perched-calling…)
- Flight direction (if required)
- Flying height (if required - <30m, 30-150m, >150m)
- GPS location of observer
- Distance and direction from observer
- Plot birds sighted on map

- Habitat type/mix of habitats
- Gradient of slope (flat, gentle, steep)
- Aspect of slope (none, north, north-east, east…)
- Seen close to (feedlot, dam, river course, ridge or cliff-line…)
- Seen while driving/walking/scanning
- Additional notes

Sample counts of large terrestrial birds and raptors require that one or a number (depending on site size, terrain and infrastructure) of driven transects be established, comprising one or a number of set routes, limited by the existing roadways but as far as possible directed to include a representative cross section of habitats on site. These transects should be driven slowly, and all sightings of large terrestrial birds and raptors should be recorded in terms of the same data capture protocols used for walked transects (above), and in general compliance with the road-count protocols described for large terrestrial species (Young *et al.* 2003) and raptors (Malan 2009). In addition, each transect should include a number of stops at vantage points to scan the surrounding area. If sighting distance is used to delineate the area sampled, this method will yield estimates of density (birds.km^{-2}) for all large terrestrial species and birds of prey. Alternatively, variation in sighting distances (perhaps associated with variable terrain of habitat) may preclude the use of this method, and it may only be possible to determine a simple index of abundance, expressed as the number of birds seen per kilometre driven.

The variables recorded for driven transect count of large terrestrial species and raptors should include:

- Project name
- Transect number
- Date
- Observer/s
- Start/finish time
- GPS location at start/finish
- Odometer reading at start/finish
- Distance covered (km)
- Temperature at start
- Cloud cover at start
- Wind strength/direction at start
- Visibility at start (good, moderate, poor)

And variables to record for each observation should include:

- Time
- Species
- Number (number of adults/juveniles/chicks)
- Activity (flushed, flying-display, flying-commute, perched-calling…)
- Flight direction (if required)

- Flying height (if required - <30m, 30-150m, >150m)
- Seen while driving/scanning?
- Habitat type/mix of habitat types
- Gradient of slope (flat, gentle, steep)
- Aspect of slope (none, north, north-east, east...)
- Seen close to (feedlot, dam, river course, ridge or cliff-line...)
- GPS on transect line
- Perpendicular distance off transect line (m) (if required)
- Distance band off the transect line (if required)
- Fixed transect width (if required)
- Plot on map
- Additional notes

Focal site surveys and monitoring

Any habitats within the broader impact zone of the proposed WEF, or an equivalent area around the control site, deemed likely to support nest sites of key raptor species (including owls) - cliff-lines or quarry faces, power lines, stands of large trees, marshes and drainage lines - should be surveyed using documented protocols (Malan 2009) in the initial stages of the monitoring project. All such sites should be mapped accurately, and checked on each visit to the study area to confirm continued occupancy, and to record any breeding activity, and the outcomes of such activity, that may take place over the survey period (Scottish Natural History 2005). Any nest sites of large terrestrial species (e.g. bustards and especially cranes) that may be located should be treated in the same way, although out of season surveys are unlikely to yield results as these birds do not hold year-round territories.

The variables recorded for each nest site survey should include:

- Project name
- Date
- Observer/s
- Species
- Site name, number or code
- Type of site (nest, roost, foraging...)
- Time checked
- Temperature
- Cloud cover
- Wind strength/direction
- Visibility (good, moderate, poor)
- Signs of occupation (fresh droppings, fresh food remains, freshly moulted feathers...)
- Signs of breeding activity (adults at nest, adult incubating or brooding, eggs or nestlings...)
- Number of adults/eggs/nestlings/juveniles seen
- Additional notes

The major wetlands on and close to the development area should also be identified, mapped and surveyed for waterbirds on each visit to the site, using the standard protocols set out by the CWAC initiative (Taylor *et al.* 1999).

The variables recorded for each wetland survey should include:

- Project name
- Date
- Observer/s
- Wetland name, number or code
- Time at start/finish of count
- GPS location at observation point
- Temperature
- Cloud cover
- Wind strength/direction
- Visibility (good, moderate, poor)

  And variables to record for each species counted should include:

  - Species
  - Number (number of adults/juveniles/chicks)
  - Direction of arrival/departure from wetland (if applicable)
  - Additional notes

Incidental observations

All other, incidental sightings of priority species (and particularly those suggestive of breeding or important feeding or roosting sites or flight paths) within the broader study area should be carefully plotted and documented. These could include details of nocturnal species (especially owls) heard calling at night.

The variables recorded for each incidental observation of priority species should include:

- Project name
- Date
- Observer/s
- Time
- Temperature
- Cloud cover
- Wind strength/direction
- Visibility (good, moderate, poor)
- Species
- Number (number of adults/juveniles/chicks)
- Activity (flushed, flying-display, flying-commute, perched-calling...)
- Flight direction (if required)
- Flying height (if required - <30m, 30-150m, >150m)

- GPS location of observer
- Plot birds sighted on map
- Habitat type/mix of habitats
- Gradient of slope (flat, gentle, steep)
- Aspect of slope (none, north, north-east, east…)
- Seen close to (feedlot, dam, river course, ridge or cliff-line…)
- Seen while driving/walking/scanning
- Additional notes

2.2.2 Bird movements

A spatially explicit understanding of bird movements in and around a proposed WEF site may be more important to determining the sustainability of the project, and to informing an effective mitigation strategy, than knowledge of the numbers of key species present. Developing such an understanding requires a significant investment of time and effort, and may require the use of expensive, highly technical remote sensing equipment.

Figure 1. *The location of properties included in WEF development proposals in the Saldanha Bay/Velddrif area in relation to key wetland and coastal bird sites on the Lower Berg River, and at Saldanha Bay and Langebaan Lagoon. Anticipated, large-scale, nocturnal movements of birds between these resource areas, and through the proposed wind energy development area, necessitate the use of radar for effective baseline monitoring.*

Radar

The state of the art in monitoring bird movements in relation to WEFs involves the use of custom-built radar installations (e.g. http://www.detect-inc.com/wind.html). When set up correctly, these systems can provide round-the-clock coverage of a sizeable area in all weather conditions. They are expensive, and cannot easily distinguish between different species, types or even sizes of birds, but when used in combination with limited direct observation (primarily to calibrate and ground-truth remotely collected information), they are likely to provide the most comprehensive and accurate data possible describing the frequency, height and direction of bird flight paths through a proposed or operational wind farm. The use of a radar system is likely to add significant value to any monitoring project, but may be essential and non-negotiable for use at certain sites as the only means to obtain critical data on large scale movements of birds, or movements of significant numbers of highly threatened species, thought or known to take place at night or in conditions of poor visibility.

Such a situation pertains in the Cape West Coast area between Vredenburg and Velddrif, and including the Cape Columbine Peninsula. This relatively small area lies directly between the West Coast National Park (including Langebaan Lagoon and the Saldanha Bay islands) and the Lower Berg River estuary. Both these locations are listed as Important Bird Areas (Barnes 1998), and between them support 10 000s of waterbirds, and 100 000s of coastal seabirds (including large numbers of red-listed and/or endemic species such as Great White Pelican *Pelecanus onocrotalus*, Greater Flamingo *Phoenicopterus ruber*, Lesser Flamingo *Phoeniconaias minor*, Cape Cormorant *Phalacrocorax capensis* and Caspian Tern *Hydroprogne caspia*).

At present, at least eight wind energy projects are proposed for this area, possibly covering 1000s of hectares and comprising 100s of turbines. The cumulative impact (Masden *et al.* 2009) of these multiple, close-neighbouring WEFs may be substantial, with a strong likelihood that at least some of the proposed turbine arrays impinge on preferred flight lines of wetland and coastal birds between prime resource areas to the north or south (Figure 1). Many of the larger scale movements made by water birds occur at night, so current understanding of the routes used is extremely poor, and is likely to remain so without the strategic deployment of radar to determine if, when, how and how many birds make these potentially hazardous flights, and under what weather conditions (note that radar functionality is reduced in conditions of heavy rainfall). Such information is vital to ensuring that wind energy development in this area proceeds sustainably.

Direct observation

The use of observers positioned on site is the low-tech, labour intensive alternative to radar. The main advantage of this method is that birds are sighted and identified directly by observers in the field, adding greater species specificity to the information collected. The disadvantages include the tedium of spending hours in the field collecting data, the resulting constraints on the quantities of such data that can be accumulated, the inability of observers to gather meaningful movement data at night or in daytime conditions of low visibility, and the risk that sampling periods will miss or under-represent episodic mass movements of birds (Scottish Natural Heritage 2005).

Counts of bird traffic over and around a proposed/operational facility should be conducted from suitable vantage points which together provide overview of as much of development area as possible (Scottish Natural Heritage 2005). Ideally, vantage points should be spaced a maximum of 2 km apart (Scottish Natural Heritage 2005), but capacity constraints are likely to stretch this distance, particularly at very large WEF sites. GIS can be used to facilitate the identification of vantage points with the best inclusive viewsheds, bearing in mind that ready accessibility for observers is also a significant factor in the final selection. Observation and data collection should ideally be focused in the direction of the proposed development area from the vantage point, extending to 90° on either side of that focal point. Bird movement taking place further 'behind' the observers may be relevant, and should be included at the discretion of the site specialist or the fieldworkers at the time, but not at the expense of effective 'forward' coverage.

Vantage point watches should extend alternately from before dawn to midday, or from midday to after dusk, so that the equivalent of at least one full day of counts is completed at each vantage point for each site visit. Alternatively, watches can be divided into three hour shifts distributed through the day (early morning, midday, late afternoon), although this may prove impractical at vantage points that are relatively difficult to reach. Either way, scheduling should always allow for the detrimental effects of observer fatigue on data quality. When extended across the 12 month monitoring period, these sorts of regimens should provide an adequate (if minimal) sample of bird movements around the facility in relation to a representative cross-section of conditions and times of day (Erickson *et al.* 1999, Scottish Natural Heritage 2005, Krijgsveld *et al.* 2009). Note that nighttime watches coincident with clear, moonlit conditions would also be valuable at sites where nocturnal activity is considered likely or possible.

The purpose of vantage point watches is to collect data on priority species to allow estimation of:

- The time spent flying over the proposed development area
- The relative use of different parts of the development area

- The proportion of flying time spent within the upper and lower height limits as determined by the rotor diameter and rotor hub height of the turbines to be used
- The flight activity of other bird species using the development area.

The variables recorded for each vantage point survey should include:

- Project name
- Vantage point name/number
- Date
- Observer/s
- Start/finish time
- GPS location
- Temperature at start
- Cloud cover at start
- Wind strength/direction at start
- Visibility at start (good, moderate, poor)

  And variables to record for each observation should include:

  - Time sighted
  - Species
  - Number (number of adults/juveniles/chicks) at start and end of observation
  - Temperature
  - Cloud cover
  - Wind strength/direction
  - Visibility (good, moderate, poor)
  - Initial sighting distance (m)
  - Flight mode (direct commute-flapping, direct commute-gliding, slope soaring…)*
  - Underlying habitat*
  - Gradient of underlying slope (flat, gentle, steep)*
  - Aspect of slope (none, north, north-east, east…)*
  - Flight direction*
  - Flying height (<30m, 30-150m, >150m)*
  - Identifiable flight path indicators (valley, neck or saddle, ridge line, thermal source…)
  - Time lost
  - Plot on map
  - Additional notes

  Note, variables marked * should be recorded at 15-30 second intervals from the initial sighting, or at least with every change in flight mode, until the bird/flock of birds is lost.

Data gathered in this way can be used to model collision mortality risk (Scottish Natural Heritage 2009, Band *et al* 2007), assuming that birds included in measures of passage rate through the proposed rotor-swept area will take no avoiding action once the turbines are erected and operational.

Such models can then be refined as information on actual avoidance rates in key species is accumulated during post-construction observations at working WEFs.

2.3 Stage 3: Post-construction monitoring

The primary aims of post-construction monitoring are to:

(i) Estimate the numbers/densities of birds regularly present or resident within the broader impact area of the operational WEF.
(ii) Document patterns of bird movements in the vicinity of the operational WEF.
(iii) Compare these data with baseline figures and hence quantify the impacts of displacement and/or collision mortality.
(iv) Quantify and qualify bird collisions with the turbine arrays, as well as additional mortality associated with power lines and other ancillary infrastructure (e.g. Anderson 2001, Lehman *et al.* 2007, Jenkins *et al.* 2010, Shaw *et al.* 2010a & b).
(v) Mitigate impacts of the development by informing ongoing management of the WEF.

2.3.1 Bird numbers and movements

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

2.3.2 Avian collisions

The primary aims of avian collision monitoring are to:

(i) Record and document the circumstances surrounding all avian collisions with the turbines, and all bird mortalities caused by ancillary infrastructure of the WEF.

(ii) To quantify the direct effects of the WEF on collision susceptible species.

(iii) To mitigate impacts by informing final operational planning and ongoing management.

Collision monitoring should have two components: (i) experimental assessment of search efficiency and scavenging rates of bird carcasses on the site, (ii) regular searches of the vicinity of the wind farm for collision casualties (Morrison 2002, Barrios & Rodríguez 2004, Krijgsveld *et al.* 2009).

Assessing search efficiency and scavenging rates

The value of surveying the area for collision victims only holds if some measure of the accuracy of the survey method is developed (Morrison 2002). To do this, a sample of suitable bird carcasses (of similar size and colour to a variety of the priority species – e.g. Egyptian Goose *Alopochen aegyptiaca*, domestic waterfowl and pigeons) should be obtained and distributed randomly around the site without the knowledge of the field teams, some time before the site is surveyed. This process should be repeated opportunistically (as and when suitable bird carcasses become available) for the first two-three visits to the site post-construction, with the total number of carcasses set out not less than 20, but not so plentiful as to saturate the food-supply for the local scavengers (Smallwood 2007). The proportion of the carcasses located in surveys will indicate the relative efficiency of the survey method (Morrison 2002, Barrios & Rodríguez 2004, Krijgsveld *et al.* 2009). The location of all carcasses not detected by the survey team should be checked subsequently to discriminate between error due to search efficiency (those carcasses still in place which were missed) and scavenge rate (those immediately removed from the area).

Simultaneous to this process, the condition and presence of all the carcasses positioned on the site should be monitored throughout the initial surveys period, to determine the rates at which carcasses are scavenged, or decay to the point that they are no longer obvious to the field workers. This should provide an indication of scavenge rate that should inform subsequent survey work for collision victims, particularly in terms of the frequency of surveys required to maximise survey efficiency and/or the extent to which estimates of collision frequency should be adjusted to account for scavenge rate (Osborn *et al.* 2000, Morrison 2002). Scavenger numbers and activity in the area may vary seasonally so, ideally, scavenge and decomposition rates should be measured at least twice over a monitoring year, once in winter and once in summer.

Collision victim surveys

The area within a radius of at least 80-120 m of each of the turbines (depending on rotor length) at the facility should be checked regularly for bird casualties (e.g. Anderson *et al.* 1999, Morrison

2002, Smallwood & Thelander 2008, de Lucas *et al.* 2008). The frequency of these surveys should be informed by assessments of scavenge and decomposition rates conducted in the initial stages of the monitoring period (see above), but they should be done at least weekly over the first two months of the study. The area around each turbine, or a larger area encompassing the entire facility, should be divided into quadrants, and each should be carefully and methodically searched for any sign of a bird collision incident (carcasses, dismembered body parts, scattered feathers, injured birds). All suspected collision incidents should be comprehensively documented, detailing the following variables:

- Project name
- Date
- Time
- Species
- Number adults/juveniles
- GPS location/s
- Condition of remains
- Nearest turbine number
- Distance to nearest turbine
- Compass bearing to nearest turbine
- Habitat type/mix of habitats
- Gradient of slope (flat, gentle, steep)
- Aspect of slope (none, north, north-east, east...)
- Plot on map
- Photograph the collision site as it was located

All physical evidence should then be collected, bagged and carefully labeled, and refrigerated or frozen to await further examination. If any injured birds are recovered, each should be contained in a suitably-sized cardboard box. The local conservation authority should be notified and requested to transport casualties to the nearest reputable veterinary clinic or wild animal/bird rehabilitation centre. In such cases, the immediate area of the recovery should be searched for evidence of impact with the turbine blades, and any such evidence should be fully documented (as above), including outcome and possible post-mortem.

In tandem with surveys of the wind farm for collision casualties, sample sections of any new lengths of power line associated with the development should also be surveyed for collision and/or electrocution victims using established protocols (Anderson 2001, Shaw *et al.* 2010 a, b).

3. Inputs to the Environmental Management Plan

Avian monitoring projects should be integral to the Environmental Management Plan (EMP) for each proposed facility, in order to ensure that the resulting WEF is sustainable in terms of its impact on local avifauna.

Important issues relevant to avian monitoring to consider in developing the EMP:

- Getting the monitoring protocols right – i.e. customizing the generic guidelines to suite the specific issues at each site.
- Securing adequate budget from the developer to cover the costs of monitoring.
- Securing the strategic use of radar (should this be required).
- Selecting and training a good monitoring team.
- Collecting and collating sufficient accurate baseline survey and monitoring data.
- Analysing the baseline survey data to inform the final site selection, turbine layout and construction schedule for the proposed WEF.
- Collecting and collating sufficient accurate monitoring and survey data post-construction.
- Analysing the post-construction survey data to inform the sustainable management of the facility.

Important actions relevant to avian monitoring for inclusion in the EMP:

- Appointing an advising scientist and a monitoring agency to conduct pre- and post-construction monitoring.
- Refining the monitoring protocol and determining the extent of radar deployment required.
- If radar use is warranted, acquiring/hiring hardware, software and relevant expertise including appointing radar technologists to service the project.
- Starting baseline monitoring.
- Periodically collating and analysing baseline monitoring data.
- Compiling a report reviewing the full year of baseline monitoring, and integrating these findings into the construction EMP and the broader mitigation scheme.
- Ensuring that the construction EMP is applied.
- Refining the post-construction monitoring protocol in terms of the baseline work, and determining the extent of radar deployment required.
- Start post-construction monitoring.

- Periodically collating an analysing post-construction monitoring data.
- Compiling a report reviewing the full year of post-construction monitoring, and integrating findings into the operational EMP and the broader mitigation scheme.
- Reviewing the need for further post-construction monitoring.

4. Data Management

While analysis and reporting on an individual WEF basis will be the responsibility of the relevant avifaunal specialist, all data emanating from the above process should also be housed centrally by EWT/BirdLife South Africa (with BAWESG guidance) to facilitate the assessment of results on a multiple WEF, landscape and national scale. Permission to publish the findings of such analysis in the relevant media by EWT/BirdLife South Africa, BAWESG or by accredited academic institutions should be obtained from the developer before the onset of monitoring (and hopefully will not be unreasonably withheld). This pooling of information is in the interests of collective understanding and building a sustainable renewable energy industry in southern Africa.

5. References

Anderson, M.D. 2001. The effectiveness of two different marking devices to reduce large terrestrial bird collisions with overhead electricity cables in the eastern Karoo, South Africa. Draft report to Eskom Resources and Strategy Division. Johannesburg. South Africa.

Anderson, R., Morrison, M., Sinclair, K. & Strickland, D. 1999. Studying wind energy/bird interactions: a guidance document. National Wind Coordinating Committee, Washington.

Band, W., Madders, M. & Whitfield, D.P. 2007. Developing field and analytical methods to assess avian collision risk at wind farms. In: De Lucas, M., Janss, G.F.E. & Ferrer, M. (eds). Birds and Wind Farms – Risk Assessment and Mitigation. Quercus, London.

Barnes, K.N. (ed.) 1998. The Important Bird Areas of Southern Africa. BirdLife South Africa, Johannesburg.

Barrios, L. & Rodríguez, A. 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. *Journal of Applied Ecology* 41: 72-81.

Bibby, C.J, Burgess, N.D., Hill, D.A. & Mustoe, S.H. 2000. Bird Census Techniques: 2nd edition. Academic Press, London.

Buckland, T.L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. & Burnham, K.P. 2010. Distance software: desiogn and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology* 47: 5-14.

De Lucas, M., Janss, G.F.E., Whitfield, D.P. & Ferrer, M. 2008. Collision fatality of raptors in wind farms does not depend on raptor abundance. *Journal of Applied Ecology* 45: 1695-1703.

Devereaux, C.L., Denny, M.J.H. & Whittingham, M.J. 2008. Minimal effects of wind turbines on the distribution of wintering farmland birds. *Journal of Applied Ecology* 45: 1689-1694.

Drewitt, A.L. & Langston, R.H.W. 2006. Assessing the impacts of wind farms on birds. *Ibis* 148: 29-42.

Drewitt, A.L. & Langston, R.H.W. 2008. Collision effects of wind-power generators and other obstacles on birds. *Annals of the New York Academy of Science* 1134: 233-266.

Erickson, W.P., Johnson, G.D., Strickland, M.D., Kronner, K. & Becker, P.S. 1999. Baseline avian use and behaviour at the CARES Wind Plant Site, Klickitat County, Washington. Unpublished report to the National Renewable Energy Laboratory. NREL, Colorado.

Farfán, M.A., Vargas, J.M. & Duarte, J. 2009. What is the impact of wind farms on birds. A case study in southern Spain. *Biodiversity Conservation* 18: 3743-3758.

Harrison, J.A., Allan, D.G., Underhill, L.G., Herremans, M., Tree, A.J., Parker, V & Brown, C.J. (eds). 1997. The Atlas of Southern African Birds. Vols 1 & 2. BirdLife South Africa, Johannesburg.

Hockey, P.A.R., Dean, W.R.J., Ryan, P.G. (Eds). 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Jenkins, A.R. 2011. Winds of change: birds and wind energy development in South Africa. *Africa – Birds & Birding* 15(6): 35-38.

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. *Bird Conservation International* 20: 263-278.

Jordan, M. & Smallie, J. 2010. A briefing document on best practice for pre-construction assessment of the impacts of onshore wind farms on birds. Endangered Wildlife Trust – Wildlife & Energy Programme, Johannesburg.

Krijgsveld, K.L., Akershoek, K., Schenk, F., Dijk, F. & Dirksen, S. 2009. Collision risk of birds with modern large wind turbines. *Ardea* 97: 357-366.

Kuvlevsky, W.P. Jnr, Brennan, L.A., Morrison, M.L., Boydston, K.K., Ballard, B.M. & Bryant, F.C. 2007. Wind energy development and wildlife conservation: challenges and opportunities. *Journal of Wildlife Management* 71: 2487-2498.

Leddy, K.L., Higgins, K.F. & Naugle, D.E. 1999. Effects of wind turbines on upland nesting birds in conservation reserve program grasslands. *Wilson Bulletin* 111: 100-104.

Lehman, R.N., Kennedy, P.L. & Savidge, J.A. 2007. The state of the art in raptor electrocution research: a global review. *Biological Conservation* 136: 159-174.

Madders, M. & Whitfield, D.P. 2006. Upland raptors and the assessment of wind farms impacts. *Ibis* 148: 43-56.

Martinéz, J.E., Calco, J.F., Martinéz, J.A., Zuberogoitia, I., Cerezo, E., Manrique, J., Gómez, G.J., Nevado, J.C., Sánchez, M., Sánchez, R., Bayo, J. Pallarés, A., González, C., Gómez, J.M., Pérez, P. & Motos, J. 2010. Potential impact of wind farms on territories of large eagles in southeastern Spain. *Biodiversity and Conservation* 19: 3757-3767.

Malan, G. 2009. Raptor survey and monitoring – a field guide for African birds of prey. Briza, Pretoria.

Masden, E.A., Fox, A.D., Furness, R.W., Bullman, R. & Haydon, D.T. 2009. Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework. *Environmental Impact Assessment Review* 30: 1-7.

Morrison, L. 1998. Avian risk and fatality protocol. National Renewable Energy Laboratory NREL/SR-500-24997. California State University, Sacramento.

Morrison, M.L. 2002. Searcher bias and scavenging rates in bird/wind energy studies. National Renewable Energy Report SR-500-30876. NREL, Colorado.

Nygård, T., Bevanger, K., Lie Dahl, E., Flagstad, Ø., Follestad, A., Hoel, P.L., May, R. & Reitan, O. 2010. A study of the White-tailed Eagle *Haliaeetus albicilla* movements and mortality at a wind farm in Norway. In: BOU Proceedings - Climate Change and Birds. British Ornithologists' Union. http://www.bou.org.uk/bouproc-net/ccb/nygard-etal.pdf.

Osborn, R.G, Higgins, K.F., Usgaard, R.E., Dieter, C.D. & Nieger, R.D. 2000. Bird mortality associated with wind turbines at the Buffalo Ridge wind resource area, Minnesota. *American Midland Naturalist* 143:41-52.

Pearce-Higgins, J.W., Stephen, L., Langston, R.H.W., Bainbridge, I.P. & Bullman, R. 2009. The distribution of breeding birds around upland wind farms. *Journal of Applied Ecology* 46: 1323-1331.

Scottish Natural Heritage. 2005. Survey methods for use in assessing the impacts of onshore windfarms on bird communities. Unpublished Report.

Scottish Natural Heritage. 2009. Guidance on methods for monitoring bird populations at onshore Wind Farms. Unpublished Report.

Shaw, J., Jenkins, A.R. & Ryan, P.G. 2010a. Modelling power line collision risk in the Blue Crane *Anthropoides paradiseus* in South Africa. *Ibis* 152: 590-599.

Shaw, J.M., Jenkins, A.R., Ryan, P.G. & Smallie, J.J. 2010b. A preliminary survey of avian mortality on power lines in the Overberg, South Africa. *Ostrich* 81: 109-113.

Smallwood, K.S. 2007. Estimating wind turbine-caused bird mortality. *Journal of Wildlife Management* 71: 2781-2791.

Smallwood, K.S. & Thelander, C. 2008. Bird mortality in the Altamont Pass Wind Resource Area, California. *Journal of Wildlife Management* 72: 215-223.

Stewart, G.B., Pullin, A.S. & Coles, C.F. 2007. Poor evidence-base for assessment of windfarm impacts on birds. *Environmental Conservation* 34: 1-11.

Taylor, P.B., Navarro, R.A., Wren-Sargent, M., Harrison, J.A. & Kieswetter, S.L. 1999. Total CWAC Report: Coordinated waterbird counts in South Africa, 1992-97. Avian Demography Unit, Cape Town.

Walker, D., McGrady, M., McCluskie, A., Madders, M. & McLeod, D.R.A. 2005. Resident Golden Eagle ranging behavior before and after construction of a windfarm in Argyll. *Scottish Birds* 25: 24-40.

World Wind Energy Association. 2010. World Wind Energy Report 2009. WWEA, Bonn.

Young, D.J., Harrison, J.A., Navarro, R.A., Anderson, M.D. & Colahan, B.D. (eds). 2003. Big birds on farms: Mazda CAR report 1993-2001. Avian Demography Unit, Cape Town.

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Chapter 7:
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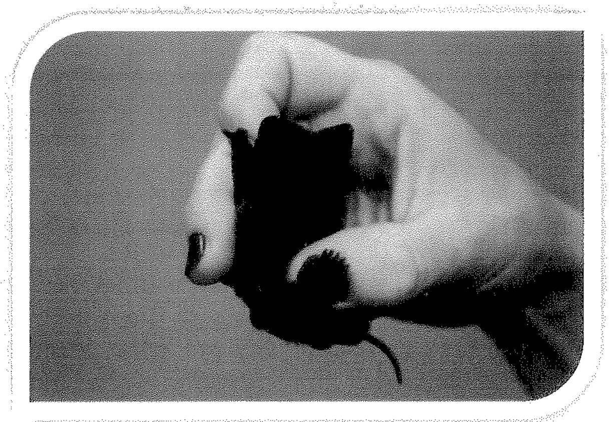


CHAPTER 7. IMPACT ON BATS

This chapter presents the findings of the specialist study on bats that was conducted by Stephanie Dippenaar, in collaboration with Anna Doty (Nelson Mandela Metropolitan University), for CSIR as part of the EIA for the Ubuntu Wind Energy Project, in the Eastern Cape, close to Jeffrey's Bay.

7.1 INTRODUCTION

7.1.1 Approach to the study

The approach adopted included:

- A review of available literature to establish which species could occur in the area;
- Site visits to investigate the environment and availability of suitable bat habitat, as well as recording echolocation of bats on site;
- Incorporating available bat monitoring data in the EIA report;
- Identification of potential impacts that the development could have on bats;
- Evaluation of predicted impact on bats, including those of a cumulative nature; and
- Recommending mitigation measures and monitoring requirements.

7.1.2 Terms of reference

The Terms of Reference for the bat specialist study are:

- Identify which species may occur in the area and their relevant conservation status;
- Conduct field work to assess the likelihood of bats occurring in the area;
- Identify the potential impacts of the wind project on bats and bat mortality; and
- Identifying potential management actions to reduce the impact of the wind farm on the local bat community and propose monitoring actions.

7.1.3 Assumptions and limitations

The following limitations apply to this study:

- Two sets of monitoring data are included in the EIA: A comprehensive bat survey would require monitoring of bats in all habitats, during all seasons, from dusk until dawn. Furthermore, although bat monitoring is in process, no monitoring has yet been done during the 'migration periods' in autumn and spring when some species, not resident at the proposed sites, may migrate through the area.
- Given the lack of comprehensive site monitoring data, the confidence in the assessment is therefore shown as "medium" in the assessment tables.
- Most research regarding the impacts of wind turbines on bats is found in studies conducted in North America, Canada and parts of Europe. As limited knowledge exists on the impact of wind farms on bats in South Africa, information from international sources is used in this study.
- Therefore no verified information on a micro-habitat level was available on bat occurrence, densities or migration patterns. Shortcomings arising from these limitations

can be addressed through acquisition of data from a period of site-specific monitoring. Until such data are available, the application of the precautionary principle will prevail.

7.1.4 Information sources

Information was gathered from the following sources in order to investigate the existing situation that would be affected by the project:

- Sowler, S and S Stoffberg, 2011: *South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments*, Endangered Wildlife Trust;
- Other existing literature, including journal papers and the recently compiled bat atlas for southern and central Africa (Monadjem *et al.*, 2010);
- Project information as provided by WKN Windcurrent;
- Bat occurrence data from existing studies in the Jeffrey's Bay area and wider region;
- Site visits on 19 January 2011 and 20 May 2011 to the proposed site and a review of surrounding habitats; and
- Monitoring data from May and June 2011, which were available at the time of submission of the bat specialist study.

The assessment methodology applied in this chapter is presented in Chapter 4 (Approach to the EIA).

7.1.5 Declaration of Independence

DECLARATION OF INDEPENDENCE

In terms of Chapter 5 of the National Environmental Management Act of 1998, I, Stephanie C Dippenaar, do hereby declare that I have no conflicts of interest related to the work of this report. I have no personal financial interest in the proposed development and/or properties and have no personal or financial connections to the relevant property owners, developers, planners, financiers or consultants of the development.

....

Stephanie C Dippenaar

7.2 DESCRIPTION OF ASPECTS OF THE PROJECT THAT POTENTIALLY COULD CAUSE IMPACTS ON BATS

For further detail on the project components, refer to Chapter 2 (Project Description). Only those aspects that could affect bats are described below.

7.2.1 Importance of bats

In general, bats play important functional roles as insect predators and as pollinators and seed dispersers. Except for mortality and disturbance resulting from wind turbine developments, the major threats faced by bats include habitat destruction and change, cave disturbance, natural disasters and the introduction of exotic species.

7.2.1.1 Economic

The economic consequences of losing bat populations could be substantial. Although the loss of bats in southern Africa has not been quantified in economic terms, in Indiana (USA) a single colony of 150 big brown bats (*Eptesicus fuscus*) has been estimated to eat nearly 1.3 million pest insects each year, possibly contributing to the disruption of population cycles of agricultural pests (Boyles, *et al*, 2011). Other estimates suggest that a single little brown bat can consume 4 to 8 g of insects each night during the active season. Even if the southern African situation is different from that of the USA, this clearly shows how bats have an enormous potential to influence the economics of agriculture and forestry.

7.2.1.2 Ecological

Fruit bats play a major role in the dissemination of forest tree seeds and habitat regeneration and restoration. In areas where fruit bats have been locally extirpated a reduction can be measured in the ability of forests to redevelop naturally after disturbance. Recent research has indicated that bats play an even greater role in ecosystem functioning than previously realised.

7.2.1.3 Disease control

The consumption of insects by insectivorous bats also play a role in the control of diseases that afflict humans, such as malaria and dengue. Some species consume a large number of mosquitoes and flies, the most important vectors in the transmission of these diseases. Monadjem, *et al*, 2010, mention that "some species of bats can consume up to 500 insects per night and, hence, a colony of 1000 individuals devours 500 000 insects per night or approaching 200 million per year." On a larger scale, malaria afflicts millions of people in Africa and the contribution bats make to reduce the number of insects that transmit diseases should not be underestimated.

7.2.2 Components of the project which could impact on bats

Components of wind energy projects which could impact on bats, directly through mortality during the operational phase, and indirectly, through the loss of foraging habitat, are the following:

- *Wind turbines* — WKN Windcurrent proposes to establish 33 to 50 wind turbines across the proposed site with an approximate power generation capacity of between 2 MW and 3 MW each, with a total combined generation capacity of approximately 100 MW.
- Any clearance of natural vegetation for electrical connections, upgrading of access roads and creating hard standing areas.

The potential impact on bats includes the following:

- Loss of foraging habitat;
- Direct collisions with the rotating turbine blades; and
- Fatalities from barotrauma, which is usually the most important impact of wind turbine developments on bats. Barotrauma may occur when the rotating turbine blades cause a change in air pressure that affects the lungs of bats and causes internal bleeding or total collapse of the lungs.

Bats are long-lived mammals and females often produce only one pup per year, resulting in a life-strategy characterized by slow reproduction (Barclay & Harder 2003). Because of this, bat populations are sensitive to changes in mortality rates and their populations tend to recover slowly from declines. Although the impact of wind farms on birds has been studied for years, it is only recently that attention has been given to the impact of wind farms on bats. In some studies, bat fatalities have outnumbered bird fatalities by 10 to 1 (Barclay *et al.* 2007).

The following aspects of the project that will affect bats have been identified:

7.2.3 Loss of habitat

Some of the bat species that occur on the proposed site are known to roost in hollow trees, on tree trunks and under the bark of trees (see Table 7.1). The removal of the limited natural vegetation during the construction phase might alter the foraging habitat of some species.

Disturbance resulting from construction activities, such as noise after sunset from engines or generators, might also deter bats resulting in loss of feeding habitat.

7.2.4 Construction of new buildings

The presence of new buildings within the study area may provide additional roost sites for those species making use of man-made structures (e.g. roofs of buildings; Table 7.1), especially if roofs are not properly sealed. If possible buildings should not be placed close to wind turbines. However, this may be unavoidable in some instances in which case all openings around the roofs must be closed to prevent bats from roosting.

7.2.5 Operation of wind turbines

The most important aspect of the project that would affect bats adversely are the wind turbines themselves, and in particular, the operational turning blades. Bat mortality has been attributed to direct collisions with the turbine blades, but 90% of fatalities involve internal bleeding consistent with barotrauma (Baerwald *et al.* 2008). As the air moves over the turning turbine blades, an area of low pressure is created. Barotrauma occurs when bats experience a sharp decrease in atmospheric pressure near rotating turbine blades. This pressure drop causes a rapid expansion of the lungs, which is unable to be remedied through proper exhalation (the decompression hypothesis) (Baerwald, *et al.* 2008) thus resulting in haemorrhaged lungs and ultimately mortality.

Bats approach turbines (rotating or not), follow or get trapped in the blade-tip vortices, and make regular and repeated passes close to turbines. However, it is not yet known *why* bats approach moving turbines. Various hypotheses and questions have been established and are being tested to inform researchers, developers and decision makers (Kunz *et al.* 2007). These hypotheses include: Acoustic attraction (bats are attracted to sounds produced by wind turbines); Heat attraction (insects are attracted to the heat produced by the nacelles and bats are pursuing the insects); Echolocation failure (bats cannot acoustically detect moving blades or miscalculate rotor velocity); Electromagnetic field disorientation (moving turbine blades produce a complex electromagnetic field, causing bats to become disoriented); and Thermal inversion (thermal inversions create dense fog in cool valleys, concentrating insects, and bats, on ridge tops).

7.3 DESCRIPTION OF AFFECTED ENVIRONMENT

Maps showing the various turbine layouts for the proposed windfarm are provided in Chapter 2 (Project Description).

Although the site itself does not seem to have habitat that is attractive to bats such as caves, ridges with rock crevices or dense foliage, the broader areas surrounding the site are potentially attractive to bats habitat. The open grassland situated at an elevation of more than 200m also provides good foraging habitat for bats feeding in the open air.

Cultivated cereal croplands dominate this site, and the little remaining natural vegetation occurs mostly along drainage lines. The proposed turbine positions all fall within disturbed Fynbos Biome vegetation which is utilised for cattle grazing. The little natural vegetation left occurs mostly along drainage lines. Invasive plants, mainly rooikrans, occur along the dry river beds. Bats usually don't roost in rooikrans, but isolated aloes and occasional clumps of indigenous vegetation on site might be utilised by bats.

One semi-inhabited house and some dilapidated farm buildings are present on the farm. Bat species, such as *Taphozous mauritianus,* a species that has been confirmed on the site, could use such buildings for roosting. The buildings on site were investigated during the field visit in January and no bats or bat remnants were found. During future monitoring surveys, a bat specialist will investigate these buildings again.

A large farm dam is situated just west of the proposed site. Movement of bats takes place between water bodies and the foraging and roosting areas. Bats roosting on the cliff overhangs on the northern side of the proposed site might cross locations of the proposed turbines to drink water at the dam.

7.3.1 Bat Species Potentially Affected by the Proposed Project

Bats can be classified into three broad functional groups on the basis of their wing morphology and echolocation call structure. Clutter foragers are bats that have a wing design and echolocation call that enables them to fly slowly and manoeuvre easily within vegetated areas. Clutter-edge foragers include bats that fly close to or around vegetation. Open-air foragers are bats that have a wing design and echolocation call adapted to flying fast, high above the vegetation. Some open-air foragers have been recorded foraging 500 m above ground (Monadjem *et al.* 2010). It is these species that are most likely to be negatively impacted by the turning turbine blades because the blades will be within the range of their foraging altitude. Clutter-edge and clutter foragers are less likely to encounter turning turbine blades because they forage close to the ground and vegetation. However, as a precaution it is important to note that all species may be negatively impacted by the turning turbines at some stage e.g. whilst migrating through the proposed site, or moving between foraging sites and water bodies within the proposed site.

The proposed turbine site falls within the distributional ranges of 13 species that have been recorded in the area. This follows the most recent distribution maps of Friedmann & Daly (2004) and Monadjem *et al.* (2010). Of the 13 species which have been confirmed in the area, five have a conservation status of Near Threatened in South Africa, while one, *Miniopterus natalensis*, a clutter-edge feeder, has a global conservation status of Near Threatened. The other species have all been classified as Least Concern. *Rhinolophus capensis* is endemic to South Africa and has, mostly due to agricultural activities, limited suitable habitat left.

A summary of bat species distribution, their feeding behaviour, preferred roosting habitat, and conservation status is presented in Table 7.1. This information shows that the three open air feeders likely to occur at the proposed sites are all identified as a conservation status of being of *Least Concern*. This classification, however, does not mean that no attention should be given to these species. As indicated in section 7.2.4, bats are of ecological and economic importance, regardless of their Red Data Conservation status. The presence of a wind farm, and particularly the cumulative effect of several wind farms situated in a sensitive bat area, might not only be the cause of a disruption of the ecological balance, but also a reduction in the positive contribution bats make to the economy, besides the potential to play a role in the extinction of a species.

Table 7.1: Review of bat species that could occur at the Ubuntu

Species	Common Name	SA conservation status	Global conservation status (IUCN)	Roosting habitat	Functional group (type of forager)	Migratory behaviour
Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	Least Concern	Least Concern	Dense foliage of large leafy trees	Clutter: Fruit, nectar, pollen, flowers	Not known, foraging trips up to 13 km from roost
Eptesicus hottentotus	Long-tailed serotine (endemic)	Least Concern	Least Concern	Caves, rock crevices, rocky outcrops	Clutter-edge, insectivorous	Not known
Kerivoula lanosa	Lesser woolly bat	Near Threatened	Least Concern	Not known, although individuals found roosting in weaver and sunbird nests	Clutter, insectivorous	Not known
Miniloptersu fraterculus	Lesser long-fingered bat	Least Concern	Least Concern	Caves	Clutter-edge, insectivorous	Not known
Miniopterus natalensis	Natal long-fingered bat	Near Threatened	Near Threatened	Caves	Clutter-edge, insectivorous	Seasonal, up to 150 km
Myotis tricolor	Temminck's myotis	Near Threatened	Least Concern	Caves	Clutter-edge, insectivorous	Seasonal
Neoromicia capensis	Cape serotine	Least Concern	Least Concern	Roofs of houses, under bark of trees, at bases of aloes	Clutter-edge, insectivorous	Not known
Nycteris thebaica	Egyptian slit-faced bat	Least Concern	Least Concern	Cave, aardvark burrows, road culverts, hollow trees. Night roosts used.	Clutter, insectivorous, carnivorous	No known
Rhinolophus capensis	Cape horseshoe bat (endemic)	Near Threatened	Least Concern	Caves, old mines. Night roosts used	Clutter, insectivorous	Not known
Rhinolophus clivosus	Geoffroy's horseshoe bat (endemic)	Near Threatened	Least Concern	Caves, old mines. Night roosts* used	Clutter, insectivorous	Up to 13 km from roost nightly
Rousettus aegyptiacus	Egyptian Rousette (endemic)	Least Concern	Least Concern	Caves	Open-air; insectivorous	Not known
Taphozous mauritianus	Mauritian tomb bat	Least Concern	Least Concern	Rock faces, tree trunks, walls	Open air, insectivorous	Not known
Tadarida aegyptiaca	Egyptian free-tailed bat	Least Concern	Least Concern	Roofs of houses, caves, rock crevices, under exfoliating rocks, hollow trees	Open-air, insectivorous	Not known
Species that might occur in the area, but have not been recorded as far south as Jeffrey's Bay						
Rhinolophus simulator	Bushveld horseshoe bat	Least Concern	Least Concern	Caves, mines, rocky outcrops	Clutter, insectivorous	Not known
Rhinolophus swinnyi	Swinny's horseshoe bat	Near threatened	Near threatened	Caves, old mines	Clutter, insectivorous	Not known

From: Monadjem, et al (2010) and Friedmann and Daly (2004)

7.3.2 Site visit during January

During the site visit on 19 January 2011 few bat calls were recorded. A Magenta Bat5 Heterodyne Detector, for which the primary use is presence of species rather than identify species, was used after sunset. Nevertheless species identification using this bat detector is approximately 80 percent accurate. Five species listed in Table 7.2, were identified. These species correlated with the species which have distribution ranges overlaying the proposed site, as well as species recorded at other wind developments in the vicinity of Jeffrey's Bay. Of the five bat species found on the proposed site two, *Taphozous mauritianus and Tadarida aegyptiaca,* are open air feeders.

Table 7.2: Bat species recorded on the site during January 2011

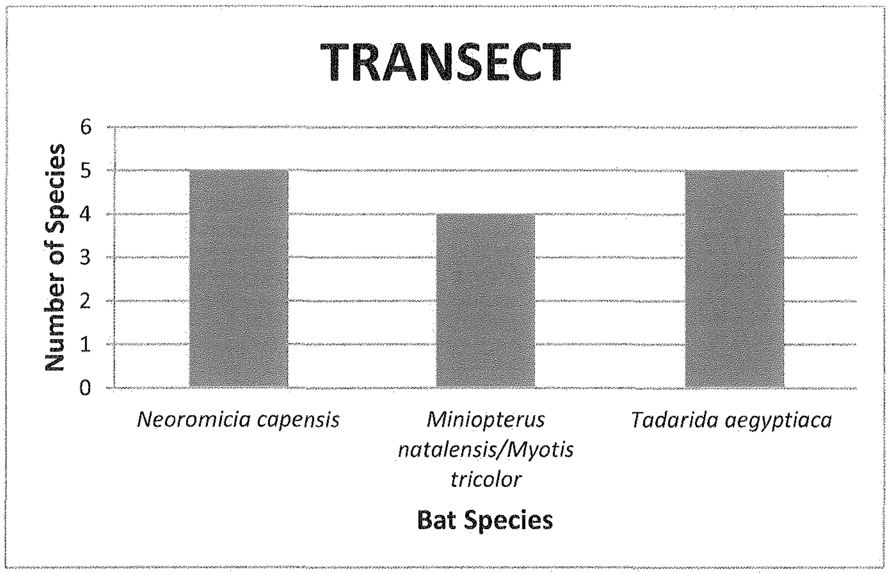
Species	Common Name
Taphozous mauritianus	Mauritian tomb bat
Tadarida aegyptiaca	Egyptian free-tailed bat
Miniopterus natalensis	Natal long-fingered bat
Neoromicia capensis	Cape serotine bat
Myotis tricolor	Temminck's hairy bat

7.3.3 Site visit during May

A second site visit took place on the evening of 19 May 2011. A transect (see Figure 7.1) was done using aSM2 bat recorder, which records the echolocation sounds emitted by the bats which is then analysed afterwards; This allows for more accurate species identification. As indicated in Table 7.3, three species were recorded. *Tadarida aegyptiaca* was recorded again, as well as *Miniopterus natalensis/Myotis tricolor* and *Neoromicia capensis*. It must be noted that the recordings were done towards the end of autumn and the temperature was already fairly low. Bat activity declines towards the colder winter months. As expected, the number of bat species recorded was less than during the January field visit.

Figure 7.1: The transect route and the positions of the three Anabat bat detecting recorders, A, B and C.

Table 7.3: Bat species recorded on the site during the transect on 19 May 2011



7.3.4 Installation of Anabats and monitoring data of May and June

During the site visit in May three Anabat recorders were installed on the proposed Ubuntu site (see Figure 7.1 for the positions of the Anabat recorders). Anabat A is situated at a height of 50 m up the wind monitoring mast so as to record high-flying bats on site. Anabat B is situated on a water tank, where bats might go to drink water, and Anabat C is situated at a cattle kraal, where cow dung attracts insects, which could attract bats. The bat detectors were positioned approximately 2km apart, so as to provide a fairly accurate account of species visiting the site.

The *South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments* prescribes seven days recording per month, for a period of a year. These recordings started in May 2011 and two months' data, May and June, have been incorporated in this report.

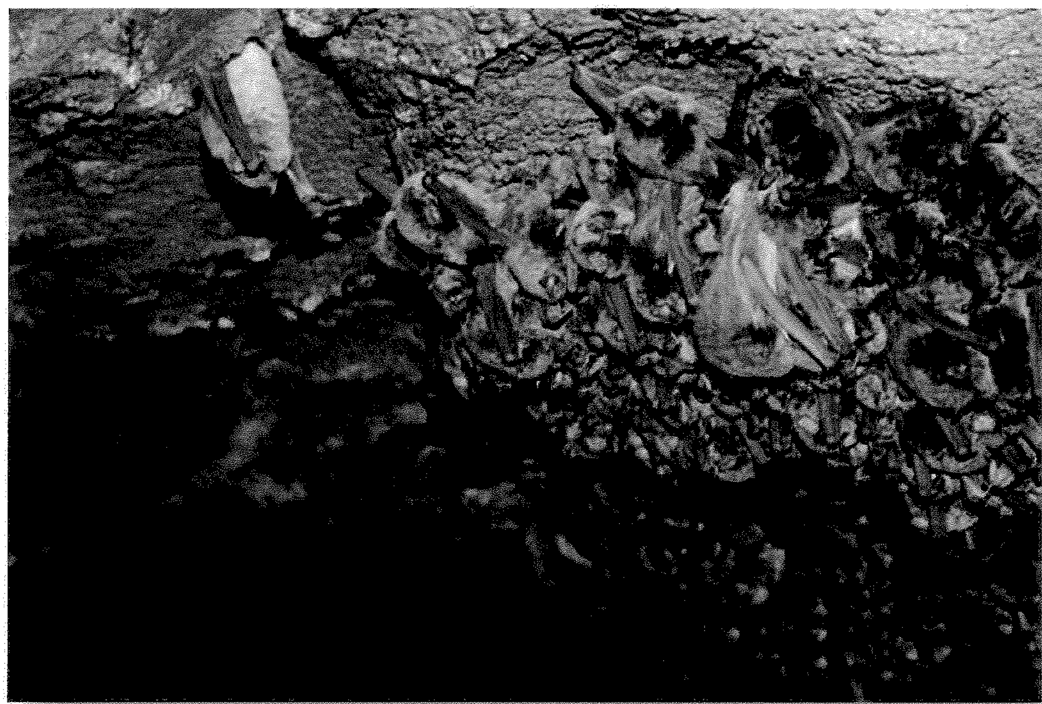
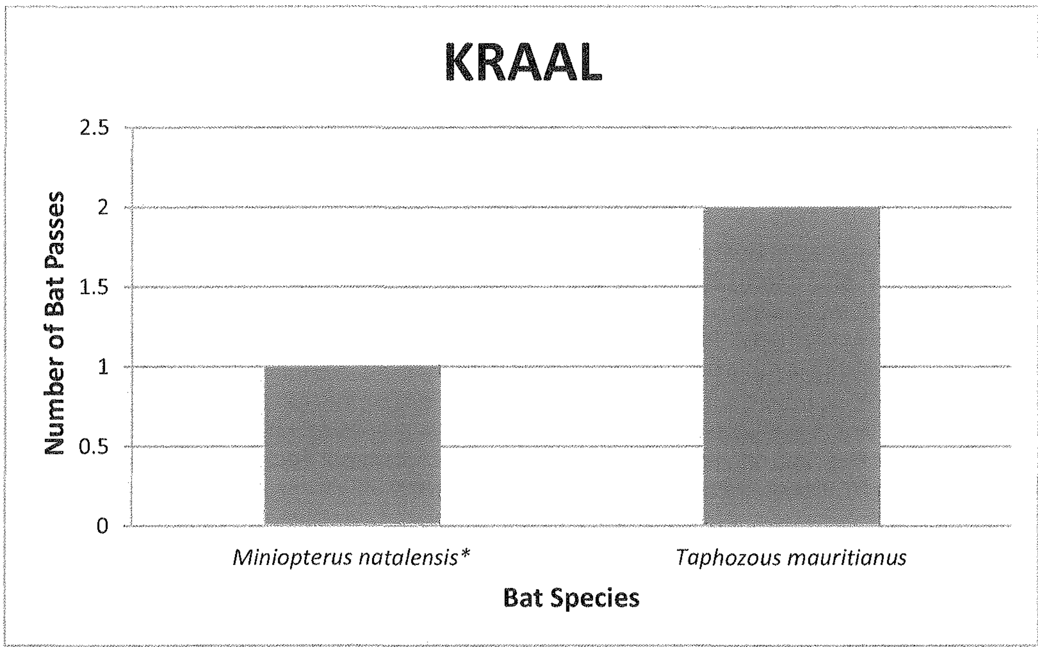


Figure 7.2: ***Miniopterus natalensis*, the Natal Long-fingered bat**

Though other countries have years of data from bat recordings concerning bats and wind developments it must be noted that using Anabat recordings for wind turbine developments is a fairly new concept in South Africa. Some calls are faint, and species identification will become more accurate as experience in this method is gained. Dr. Samantha Stoffberg was approached to assist with species identification, but there is still some uncertainty where calls of species overlap, such as *Miniopterus natalensis* and *Myotis tricolor*. These species have overlapping call parameters and often roost together; therefore daily flight paths also have similarities. Consequently these species have been grouped together until more clarity has been gained. Both these species are clutter-edge foragers and therefore it is predicted that the impact of the wind turbines to a large extent might be similar for both species.

During May no bats were recorded on site and three bats passed the recorders during June. In total only three bats were recorded for the two months monitoring at the proposed site. No call recognition software was used; therefore all calls have been looked at individually. Anabat B was not functional during June, otherwise all the monitoring equipment was fully functional during the two months period. The Anabat on the wind data recording mast, Anabat A, recorded no bats. Anabat C, situated at the cattle kraal, recorded two species, *Miniopterus natalensis*, a clutter-edge forager, *Taphozous mauritianus*, an open-air forager (see Table 7.4). The calls of *Taphozous mauritianus* were not very clear and further verification is needed.

Table 7.4: Bat species recorded on the site at Anabat C during June 2011



*Calls are closely related to *Myotis tricolor*

7.4 IDENTIFICATION OF ISSUES AND IMPACTS

Direct issues related to wind farms that are of importance to bats include the following:

- The direct loss of roosting, flight paths and foraging habitat;
- Bat mortality through collisions with turbines or barotrauma from turning turbine blades; and
- The cumulative effect of bat fatalities associated with wind farms and the density of wind farms in any particular geographic area. Although the species most likely to be negatively impacted (open-air foragers such as *Tadarida aegyptiaca*) are listed as *Least Concern* in terms of their conservation status and are fairly common, numerous wind farms erected in a particular geographic area could contribute to a drastic decline in population numbers through the cumulative effect of bat fatalities. The review of EIAs for wind farm applications in the vicinity of the proposed Ubuntu site should carefully consider the bat situation in order to avoid a localised decline in certain bat species resulting from the cumulative impact of these farms.

Indirect issues related to wind farms include the consequences of a large scale loss of bats as discussed in Section 7.2.1.

7.5 PERMIT REQUIREMENTS

No permits are required for removing bats or killing them, unless for the purpose of research. If bats are to be collected, a permit from the Province of the Eastern Cape: Economic Development and Environmental Affairs is required to undertake research or collection of biological material on privately owned land in the Eastern Cape Province.

7.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The impact assessment applied the standard impact assessment criteria (see Chapter 4: Approach to the EIA), with a summary assessment provided in Table 7.5. As mentioned in Section 7.1.3 the confidence in the predictions concerning the impact of the operation of the wind farm is 'medium', as only two months of bat monitoring has been done and no site-specific data from a full autumn, spring or summer season are available. These are the times when bats migrate and when they would be more active. Bat monitoring commenced when temperatures were already dropping. The second half of May, when the bat recorders were in operation, was characterised by windy and stormy conditions, which are not conducive to bat activity. Furthermore, the use of a bat detector or recorder confirms bat activity (or non-activity) at that particular time and season. Further monitoring might confirm the presence of more bat species on site. A comprehensive species list of the site, will only become available in May 2012 once the full year monitoring has been complete

Different turbine sizes and generator types were taken into consideration for the impact assessment. Four alternatives were provided as follow:

- 33 Vestas V112, 3 MW turbines;
- 50 Vestas V90, 2 MW turbines;
- 40 Nordex N100, 2,5 MW turbines; and
- four alternative turbine positions on the south eastern part of the property.

Bat buffers were taken into account during the design phase of the project, so that the present turbine layouts are not situated within high risk areas for bats. Barcley, et al (2007) suggests that bat fatalities increased exponentially with tower height, suggesting that larger turbines are reaching the airspace of migrating bats. As limited bat activity has been recorded on the site up to now, all turbine sizes are acceptable. If it is established, after 12 months of pre-construction monitoring that the wind project is situated within an area that has high bat activity during certain times of the year, turbine size will be discussed with a bat specialist. .

Although a reliable impact assessment cannot be done by visiting a site once or twice, it does provide a sense of the suitability of the site for bats. As mentioned in section 7.3, the open grassland, where the turbines will be situated, provides good foraging habitat for bats feeding in the open air. Limited numbers of *Thaphozous mauritianus* and *Tadarida aegyptiaca* were recorded on site. According to the data available at present, the proposed site has low bat activity.

7.6.1 Loss of habitat

Farm buildings provide bat habitats suitable for daytime roosting, but no bats were observed in the dwellings on the Ubuntu site. There are no other dwellings in close proximity to the wind farm development. The main attractions to bats are open water bodies and the escarpment on the north eastern side of the property. Bats may traverse a wider territory when travelling to their primary feeding locations during dusk and dawn. It is probable that bats visiting the proposed development site roost along the cliff sides of the escarpment, in the limited clumps of indigenous trees and aloes, in rock crevices and aardvark burrows, or fly in from roosts in the surrounding area. It is not expected that trees will be removed during construction, but construction activities might cause some disturbance to bats and the foraging habitat of some species might be affected.

During construction, the impact on bat fauna at the proposed project site is expected to be low to insignificant.

During operations, as a precautionary measure, the developer must avoid attracting bat colonies to the vicinity of the wind farm site. Therefore, old buildings within the study area should be investigated, and if there are no bats roosting, the roofs should be sealed. This will avoid bats being attracted to the area in future. One could consider roost boxes (to attract bats) to "safe" areas, away from any turbine developments, when more is known of the bat population. Pre-construction monitoring should inform the potential placement of bat roost boxes, if necessary, and the potential need to seal off existing buildings.

7.6.2 Mortality during the operation of wind turbines

The most important aspect of the project that would affect bats are the turning blades when the turbines are operating. Bat mortality has been attributed to direct collisions with the turbine blades, but approximately 90% of fatalities involve internal bleeding consistent with barotrauma

(Baerwald *et al.* 2008), see Section 7.2.4). Open air foragers that might be present on site, such as *Rousettus aegyptiacus, Taphozous mauritianus* and *Tadarida aegyptiaca,* are expected to be the most affected. *Tadarida aegyptiaca* was recorded at the site in January and May and *Taphozous mauritianus* was recorded during June.

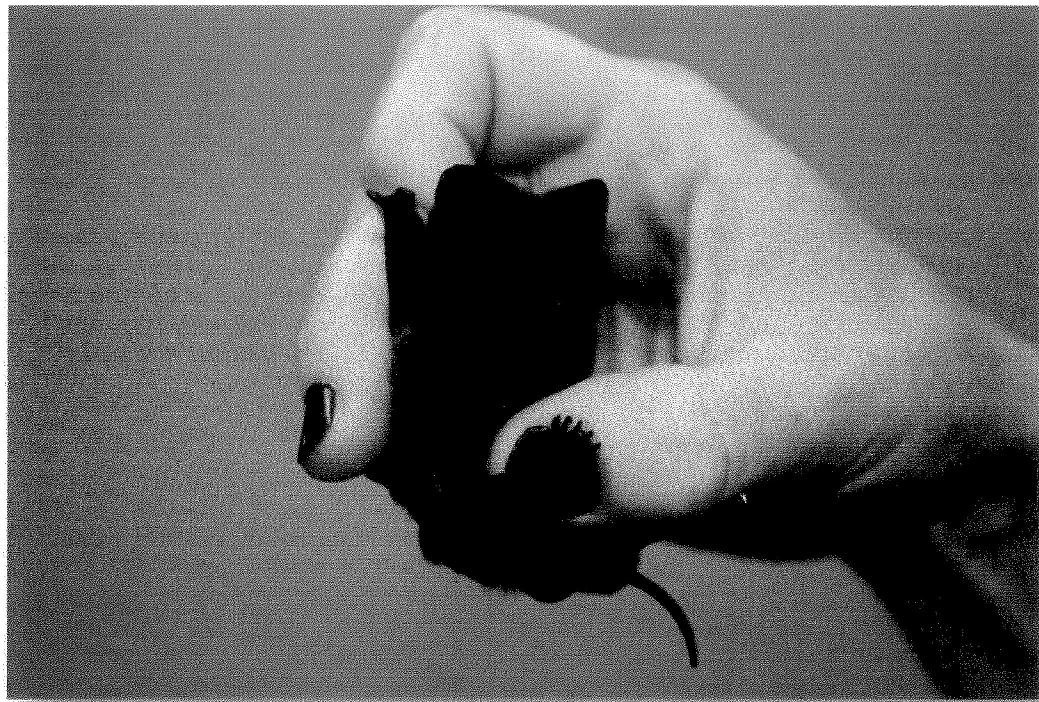


Figure 7.3: *Tadarida aegyptiaca* (Egyptian Free-tailed bat), rescued from a wind turbine injury in Coega near Port Elizabeth. It is predicted that this species will be affected by the wind turbine development as it is an open-air forager.

7.6.3 Management actions to avoid or reduce negative impact

Management actions are proposed for the following stages of the project:

- Detailed design (pre-construction);
- Construction; and
- Operations.

7.6.3.1 Actions to inform the detailed design (pre-construction)

a) Pre-construction monitoring

According to the *SA Good Practice Guidelines for Surveying Bats in Wind Farm developments* (Sowler and Stoffberg, 2011) the EIA should allow for 12 months of bat monitoring. This guideline was published in May 2011, at which time the Ubuntu EIA process was well advanced. Nevertheless, the client decided to progress with the monitoring while the EIA is in progress. Available monitoring results will be incorporated into the Draft and Final EIA Reports. The full 12 months of pre-construction monitoring will be completed and the monitoring report submitted to DEA before construction will be permitted to start. At present it appears that there is low bat activity on site. If the monitoring data show high activity, the client and a bat specialist should investigate possible ways to minimise bat mortality. The findings of this monitoring must be incorporated into the EMP for the project and inform the following actions:

- potential need to seal off existing buildings within the study area;
- possible need to refine turbine operational procedures (described below);
- possible need to re-look at the turbine layout; and
- potential placement of bat roost boxes in safe areas away from turbines.

7.6.3.2 Actions to reduce impacts during construction

a) *Protect existing bat habitat*

Destruction of trees, especially limited stands of indigenous trees in the drainage lines and the few aloe plants on site, must be avoided as they may provide existing roosts.

b) *Avoid creating new habitat close to turbines*

Care needs to be taken to completely seal off roofs of new buildings (e.g. substations) within the study area to prevent bats from moving in, thus making them more prone to coming into contact with the turbines in the surrounding area.

The presence of old building structures within the study area may provide roost sites for species such as *Neoromicia capensis* that make use of man-made structures, particularly if roofs are not properly sealed. Species which use walls and/or roofs for roosting habitats need rough surfaces on which to grip and thus by modifying these surfaces potential bat colonies can be either attracted or detracted. Buildings which do not house bats within the study area at present need to be sealed off so as to avoid bats to use the buildings as roosting sites. Consideration should be given to demolishing existing redundant or dilapidated buildings which could house bat roosts.

c) *Set-back from waterbodies and structures*

Bats visit waterbodies to drink and therefore it is recommended that the turbines be located at least 200 m away from any permanent waterbodies (e.g. dams) on site to reduce the risk of collision/barotrauma. If the monitoring data show a high bat occurrence and/or high bat mortality rates, a bat specialist should be contacted and these setbacks should be increased as is appropriate.

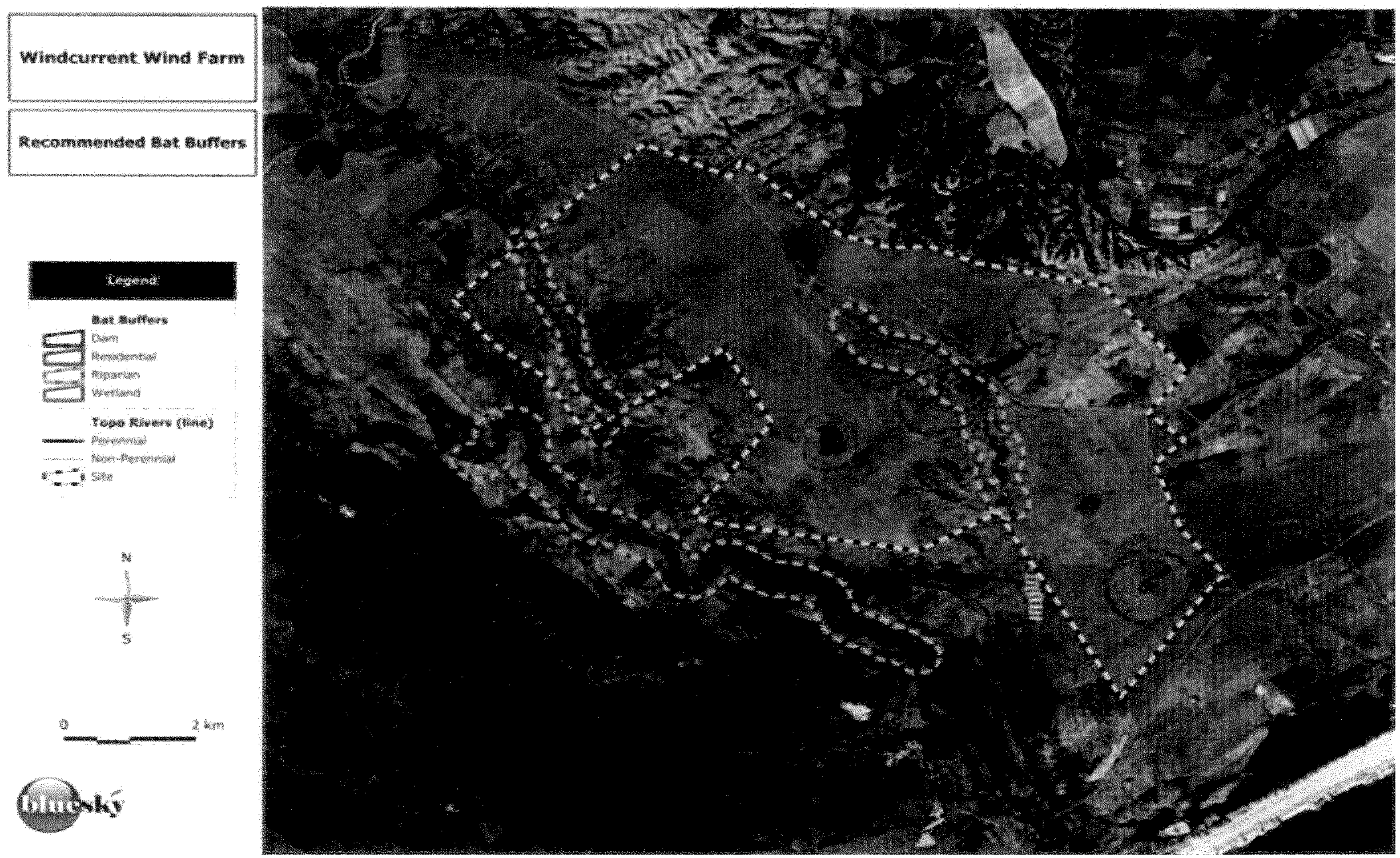


Figure 7.4: Recommended bat buffers

7.6.3.3 Actions to reduce impacts during operations

a) ***Operational management of blade speeds***

Nights with low wind speeds are associated with increased mortality as bats are most active under these conditions (Hoso and Hayes, 2010). If during monitoring bat occurrence is found to be high, there are mitigation measures for the turbine operations that could be applied. An effective and tested mitigation at present is changing cut-in speeds (Huso and Hayes, 2010). For example, the cut-in speed of the turbines could be increased, to 5 m per second, so that turbines start operating under slightly stronger wind conditions when bats are less likely to be active. This mitigation measure is costly in terms of energy efficiency, and is not recommended if not necessary. It may also only be applicable at certain times of year such as during bat migration periods.

b) ***Attract bats away from turbines***

If a high number of bats are recorded during the following ten months monitoring, bat roost sites could be established (e.g. roost boxes) as a trade-off to offset potential mortalities during turbine operation. It is not certain though, as to whether bats will move into the artificial bat roosts.

7.6.3.4 Pre-construction

At national and project scale, research is needed to provide more information on specific impacts and novel mitigation measures that might reduce impacts of wind turbines on South African species of bats. *The South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments* (Sowler and Stoffberg, 2011) was finalised during May 2011 and it recommends monitoring of at least "7 consecutive days (during good weather conditions) per month over a period of 12 consecutive months." As the EIA commenced before the Guidelines were published, the client did not do any bat monitoring at the beginning of the project. Consequently monitoring only commenced in May 2011. Three Anabat bat detecting recorders were installed on site and the monitoring data for May and June are included in this report (see Section 7.3.4). This monitoring will continue until April 2012 and a monitoring report will be submitted to DEA. It is understood that DEA will continue with the decision making process for the EIA, but that the bat monitoring report, as well as the outcome of the results of the bat monitoring, will be a pre-requisite before construction can commence.

7.6.3.5 Post-construction/operational monitoring

It is recommended that operational monitoring be undertaken to determine the extent of bat fatalities, and the species affected, if any. Although it is expected not to be as successful in South Africa as in European countries, carcass searches are the standard method employed to determine the level of bat mortality. Monitoring is especially important during the periods April to May and August to September, when bats are migrating between summer and winter roosts. Carcass searches should be done early in the morning to minimize the effect of scavengers (which remove carcasses). Carcasses should be frozen and sent to a bat specialist for identification purposes. This information is critical to improve the understanding of the effect of wind farms on bat populations in South Africa.

7.6.4 Cumulative effect of various wind farms in the area

Apart from the Ubuntu Wind Energy Project seven other wind development projects are in progress in the Jeffrey's Bay-Humansdorp vicinity. None of these developers have twelve month's bat monitoring data available yet. Furthermore, no bat migration data are available for this area. Although it is not possible to make confident predictions with the limited data available, it is expected that the combined proposed wind developments in the area will have a cumulative impact on the bat population, at least through a loss of habitat. What is of importance is that wind farms are not situated on migration routes of bats. Yearly migration patterns, if there is an inland migration of some bat species, from the coastal areas inland, can easily extent over more than 100 km. This put all the present wind proposals at risk. Current bat monitoring at Ubuntu will indicate whether the proposed development is situated on a bat migration route, and similar requirements are expected from other wind farms in the vicinity so that mass mortality through placing several wind farms on a migratory route is avoided.

The Jeffrey's Bay Wind Project, a 180MW wind farm stretching over more than 3000 ha is situated less than 10 km, as the crow flies, to the west of Ubuntu Wind Energy Project. The Kabeljous River is situated between the two proposed wind farms. It is expected that most bat activity will be found around the riparian vegetation of the Kabeljous and its tributaries. Open air insectivorous feeders, which feed on the plateau to the east (Ubuntu Wind Energy Project) and the west (Jeffrey's Bay Wind Project) of the Kabeljous, such as *Rousettus aegyptiacus, Taphozous mauritianus and Tadarida aegyptiaca,* are mostly at risk. Bats usually don't have a daily migration of more than 5 km per day. They are habitual animals and literature suggests that they tend to return to the same area for feeding and roosting. It is therefore expected that bats will still visit the wind turbine sites after construction. At this stage though, with the limited data available, it is not possible to make confident predictions concerning the effect of the cumulative impact of all these proposed wind farms.

Table 7.5: Impact assessment

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
CONSTRUCTION PHASE									
Scenario: Construction of Wind Turbines									
1.1 Loss of roosts for bat species using trees and aloes as roosts	Negative	Localised	Permanent	Low	Low	Low	Avoid removal of trees and large aloes.	Low	High
1.2. Loss of roosts for bat species using manmade structures as roosts	Negative	Localised	Permanent	Low	Low	Low	Seal all existing buildings within the study area which have not got bat roosts. Seal off all new building structures within the study area.	Low	High
1.3. Construction noise during night time	Negative	Localised	Permanent	Low	Low	Low	Night time activities and noise on the construction site should be minimised.	Low	High
OPERATIONAL PHASE									
Scenario: Operation of Wind Turbines									
Displacement or exclusion from foraging areas and the loss or shifting of flight paths	Negative	Localised	Long Term (life of project)	Low	High	Medium	Setback of 500 m from areas where bats may roost, such as human dwellings or sheds, and a setback of 200 m around water bodies where bats might drink.	Low	Medium
Mortality due to collision with turning turbine blades or due to barotrauma	Negative	Localised and Regional (migratory species)	Permanent	Medium	Highly probable (may be species specific)	Medium	Pre-construction monitoring to confirm turbines not on a migration pathway. Optimise turbine rotation speeds to reduce bat fatalities, if needed, and for specific times of year only.	Low	Medium

Table 7.6: Monitoring programme

Impact	Mitigation/Management action	Monitoring		
		Methodology	*Frequency*	*Responsibility*
CONSTRUCTION PHASE				
1.1 Loss of roosts for bat species using trees and aloes as roosts	Avoid the removal of clumps of indigenous trees and aloes.	Protect existing bat habitat.	During construction	Construction manager and ECO
1.2. Loss of roosts for bat species using manmade structures as roosts	Seal all existing buildings within the study area which have not got bat roosts. Seal off all new building structures within the study area.	Avoid creating any new bat habitat on site	Once off, during construction of building	Construction manager and ECO
1.3. Construction noise during night time	Construction activities should as far as possible take place during daytime.	Avoid disturbance of bat activity after sunset	During construction	ECO
OPERATIONAL PHASE				
Mortality due to collision with turning turbine blades or due to barotrauma	Pre-construction monitoring to confirm turbines not on a migration pathway.	Try to avoid bat fatalities	Monitor bat activity for 7 days per month for one year	Bat specialist and client
	Optimise turbine rotation speeds to reduce bat fatalities, if needed, and for specific times of year only.	Try to avoid bat fatalities	Monitor bat activity for 7 days per month for one year	Client in collaboration with bat specialist

7.7 CONCLUSIONS

Monitoring, which is in progress, is required to determine the extent of bat fatalities, and the species affected. If data collected up to now is taken into account, the impact of the wind turbines on bats on the Ubuntu site is predicted to be of **low** significance with mitigation. Confidence levels are medium, as only two months of monitoring data have been incorporated, but the report will be updated with additional information from the forthcoming monitoring results. A condition of this assessment is that pre-construction monitoring be conducted, in particular to verify that the turbines will not be in an important seasonal migration path for bats. After pre-construction data are available, and if it is confirmed that there is little bat activity on the site, the predicted impact could then be deemed to be low.

Environmental Impact Assessment for the proposed Ubuntu Wind Energy Project near Jeffrey's Bay, Eastern Cape: Draft Environmental Impact Assessment Report

Chapter 8: Visual Impacts

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CHAPTER 8. VISUAL IMPACTS

8.1 INTRODUCTION

The findings of the visual specialist study undertaken by Henry Holland of map(this) as part of the EIA being conducted by CSIR for the proposed Windcurrent project near Jeffrey's Bay are presented in this chapter.

8.1.1 Guiding Concepts for Visual Impact Assessments

This VIA is based on guidelines for visual assessment specialist studies as set out by South Africa's Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) (Oberholzer 2005) as well as guidelines provided by the Landscape Institute of the UK (GLVIA 2002). The DEA&DP guideline recommends that a visual impact assessment consider the following specific concepts (from Oberholzer 2005):

- An awareness that 'visual' implies the full range of visual, aesthetic, cultural and spiritual aspects of the environment that contribute to the area's sense of place;
- The considerations of both the natural and cultural landscape, and their interrelatedness;
- The identification of all scenic resources, protected areas and sites of special interest, together with their relative importance in the region;
- An understanding of the landscape processes, including geological, vegetation and settlement patterns, which give the landscape its particular character or scenic attributes;
- The need to include both quantitative criteria, such as 'visibility', and qualitative criteria, such as aesthetic value or sense of place;
- The need to include visual input as an integral part of the project planning and design process, so that the findings and recommended mitigation measures can inform the final design, and hopefully the quality of the project; and
- The need to determine the value of visual/aesthetic resources through public involvement.

8.1.2 Scope Of Study

8.1.2.1 Terms of Reference

The specific Terms of Reference (CSIR 2011) for the Visual and Landscape Impact Assessment include:

- Conduct a desktop review of available information that can support and inform the specialist study;
- Identify issues and potential visual impacts for the proposed project, which are to be considered in combination with any additional relevant issues that may be raised through the public consultation process;
- Identify possible cumulative impacts related to the visual aspects for the proposed project;
- Assess the potential impact/impacts, both positive and negative, associated with the proposed project for the construction, operation and decommissioning phases; and
- Identify management actions to avoid or reduce negative visual impacts; and to enhance positive benefits of the project.

8.1.2.2 Visual Triggers

(Oberholzer 2005) identifies visual triggers which are used to determine the approach and scope of an impact study. The following triggers, related to the receiving environment, are potentially applicable to this project:

- Areas with protection status, such as national parks or nature reserves;
- Areas with proclaimed heritage sites or scenic routes;
- Areas with important vistas or scenic corridors;
- Areas with visually prominent ridge lines or skylines; and
- Areas of important tourism or recreational value.
- Triggers related to the nature of the project:
- A significant change to the fabric and character of the area; and
- Possible visual intrusion in the landscape.

8.1.2.3 Information Sources

- Documentation supplied by the client and the CSIR;
- ToR for the visual specialist;
- Digital topocadastral data at 1:50 000 scale from the Surveyor General: Surveys and Mapping (including cadastral data such as farm portions and erven);
- South African digital land cover dataset of 2002 (Majeke *et al.* 2002);
- SPOT satellite image mosaic (2007);
- 1:250000 Geology map sheets covering the region;
- Wind turbine model by Pete Young hosted in the Google 3D Warehouse (http://sketchup.google.com/3dwarehouse/details?mid=cc036208d537d6f98967f3aa7f40c33&prevstart=0).
- Google Earth software and data;
- IUCN database of protected areas (http://www.wdpa.org/Download.aspx); and
- STEP vegetation and conservation status data from the South African National Biodiversity Institute (http://bgis.sanbi.org/STEP/project.asp).

8.1.2.4 Assumptions and Limitations

8.1.2.4.1 Spatial Data Accuracy

Spatial data used for visibility analysis originate from various sources and scales. Inaccuracy and errors are therefore inevitable. Where relevant these will be highlighted in the report. Every effort was made to minimize their effect.

8.1.2.4.2 Viewshed calculations

Calculation of the viewsheds does not take into account the potential screening effect of vegetation and buildings. Due to the size and height of the wind turbines, and the relatively low vegetation cover in the region, the screening potential of vegetation is likely to be minimal over most distances.

8.1.2.4.3 Simulated views and Photomontages

In this report a *simulated view* will be defined as a view generated by using 3D computer software using an elevation model and aerial photography. A *photomontage* is a landscape photograph onto which images of the wind turbines are placed using software which maintains the accurate spatial positions of the turbines and their scale in relation to their distance from the point at which the photograph was taken. The photomontage images used in this report were compiled using landscape photographs taken specifically for this purpose. Simulated views were produced using 3D modelling software (Visual Nature Studio 3 from 3D Nature - http://3dnature.com/), and a digital elevation model (DEM) interpolated from 1:50 000 contours.

8.1.3 Methodology

The key steps followed in the visual study are presented below.

8.1.3.1 Site Visit and Photographic Survey

The field survey (conducted on 21 January 2011) provided an opportunity to:

- Determine the actual or practical extent of potential visibility of the proposed development, by assessing the screening effect of landscape features;
- Conduct a photographic survey of the landscape surrounding the development;
- Take photos for use in photomontage images; and
- Identify sensitive landscape and visual receptors.

Viewpoints were chosen using the following criteria:

- High visibility – sites from where most of the wind farm will be visible;
- High visual exposure – sites at various distances from the proposed site; and
- Sensitive areas and viewpoints such as nature reserves and game farms from which turbines will potentially be seen.

Additionally, photo sites were chosen to aid in describing the landscape surrounding, and potentially affected by, the proposed development.

8.1.3.2 Landscape Description

A desktop study was conducted to establish and describe the landscape character of the receiving environment. A combination of Geographic Information System (GIS), literature review and photographic survey was used to analyse land cover, landforms and land use in order to gain an understanding of the current landscape within which the development will take place (GLVIA, 2002). Landscape features of special interest were identified and mapped, as were landscape elements that potentially may be affected by the development.

8.1.3.3 Visual Impact Assessment

A GIS is used to calculate viewsheds for various components of the proposed development. The viewsheds and information gathered during the field survey are used to define criteria such as visibility, viewer sensitivity, visual exposure and visual intrusion for the proposed development. These criteria are, in turn, used to determine the intensity of potential visual impacts on sensitive viewers. All information and knowledge acquired as part of the assessment process are then used to determine the potential significance of the impacts according to the standardised rating methodology as described in the Terms of Reference provided by the CSIR (also shown in Chapter 4 of this report).

8.1.4 Statement of Competence and Independence

Henry Holland has been applying his Geographic Information Systems knowledge and experience to visual impact assessments since 1997, and has conducted a number of assessments for wind farm developments in the Eastern Cape. These include wind farms near Jeffrey's Bay, St Francis Bay, Grahamstown and Cookhouse. He has extensive practical knowledge in spatial analysis, landscape analysis and environmental modelling, and has been involved in many environmental management projects as GIS coordinator and analyst since 1992.

Henry has undertaken this work for the Windcurrent project as an independent visual specialist, working in accordance with international and national guidelines for visual impact assessments. He has no vested interest in the proposed project.

8.2 PROJECT DESCRIPTION

8.2.1 Overview Of Project

WKN-Windcurrent proposes to build a wind energy facility (WEF) of up to 50 wind turbines (depending on the capacity of the turbines) with potential generation capacity of up to 100 MW in an area east of Jeffrey's Bay, Kouga, Eastern Cape. The conceptual layout for the energy facility is shown on the map in Figure 8.1.

8.2.2 Project Components and Activities

8.2.2.1 Construction

The following main components related to construction potentially will cause visual impacts:

- Clearing of land for a construction compound and laydown area. An area will be required to store temporarily up to 150 blades, each 45 to 56 m in length, as well as other large turbine components;
- A site compound for contractors;
- Borrow pits;
- Tall cranes will be required to lift turbine components into position;
- Large trucks will be required to haul turbine components from Port Elizabeth to the site;
- Heavy equipment such as bulldozers, graders, trenching machines and concrete trucks may be required;
- Stable platforms for the cranes need to be constructed;
- Existing roads will be used to access the site; and
- Internal access roads to connect platforms will need to be established.

8.2.2.2 Operational Wind Farm

The following components related to the operation of the wind farm potentially will cause visual impacts:

- Hub heights are between 80 m and 105 m (depending on the capacity of the turbines selected), and rotors are 45 m to 56 m long. The maximum height at blade tip is 150 m high;
- Operations and maintenance building;
- Access roads will follow existing roads where possible;
- Internal access roads to individual turbines; and
- Overhead power lines linking the site to substation (internal power lines will be underground). Overhead lines linking the substation to the existing 132 kV Eskom grid.