South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments

(Third Draft: 2012)

Adapted from:

Hundt, L. (2011) editor, The Bat Conservation Trust's
Bat Surveys – Good Practice Guidelines
2nd Edition
Surveying for onshore wind farms

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EXECUTIVE SUMMARY

These good practice guidelines are based on information gathered and compiled from the United States and Europe. They present a summary of evidence relating to the known threats to bats from wind turbines, the international and national law and legislation that underpins the need to assess the impact of wind farms on ecology, and the importance of bats in the South African context of 'ecosystem services' that they provide. Guidance is provided on assessing the need, preparing, planning and implementing bat pre-construction monitoring/surveys in respect of wind farm developments, survey techniques, interpreting results. Although not dealt with in detail, this document also includes some information on the need for the consideration of cumulative impacts, and post-construction monitoring. It is important to note that this document provides *guidance* and that each assessment should consider the scale of the likely impacts and take a proportionate approach.

Any deviation from recommended survey guidelines should be acknowledged clearly in any reports and accompanied with a clear rationale that is informed by scientific knowledge, evidence and expertise.

1. INTRODUCTION AND SCOPE

This guidance is intended for all types of onshore wind farms for which surveys are required, from single turbines to multi-turbine farms, regardless of size. It is based on, and adapted from the second edition of The Bat Conservation Trust's Bat Surveys - Good Practice Guidelines, Surveying For Onshore Wind Farms (Hundt, L. 2011; editor).

Although the guidance covers single large wind turbines and wind farm facilities (multiple large wind turbines), it is important that any assessment considers the scale of the likely impacts and takes a proportionate approach. The impact of a single large wind turbine will differ from that of a wind farm, not only regarding the likely direct impact on bats, but also because of the area of habitat affected and the infrastructure required. The relatively lower risk of a single or small number of turbines needs to be balanced against the suitability of the site for bats. In large scale schemes, because of the area involved there may be more options for micro-siting (short-distance location adjustments to turbine positions) and also for on- or off-site habitat enhancement schemes.

OFFSHORE WIND FARMS

Offshore wind farms are however excluded from this guidance. Internationally, offshore wind farm survey techniques and standards are currently still in their infancy. Should proposed offshore development occur within South Africa prior to the development of detailed guidance, a proportionate approach should be taken which considers the scale of the likely impact on bat populations. Survey design and effort should be informed by the scale of the likely impact of the development on the relevant bat populations.

THREATS

Internationally the impacts of wind turbines on bats varies depending on site selection, species and season. Bat fatalities may outnumber bird fatalities by 10:1 (Barclay *et al.* 2007) and fatality rates may be affected by turbine height (taller turbines associated with increased mortality; Barclay *et al.* 2007) and wind speed (low-wind nights associated with increased mortality; Arnett 2005; Arnett *et al.* 2008; Horn *et al.* 2008). Recently, it has also been estimated that between 33000 and 111000 bats may be killed annually by wind turbines in the Mid-Atlantic Highlands USA by 2020 (Boyles *et al.* 2011).

Most documented impacts include:

- Direct collision
- Barotrauma (mortality due to damage to bats' lungs caused by sudden change in air pressure close to the turning turbine blade; Baerwald *et al*. 2008)

Other impacts include:

- Loss of foraging habitat (either due to wind farm construction or because bats avoid the wind farm area)
- Barrier to commuting or seasonal movements (migrating routes) and severance of foraging habitat

There have been no systematic studies on the impacts of wind turbines on bats in South Africa. To date two operational wind farms have been constructed (Klipheuwel and Darling, both on the West Coast in the Western Cape Province). Although many are now proposed, no research has been undertaken into the actual impacts of wind turbines on bats and local bat populations, nor on wind turbine generated bat fatalities in South Africa.

Internationally, a large proportion of fatalities are during migration and the majority of bat carcasses recovered have been from migratory species. In North America, 80% of bat fatalities at wind farms involve migratory species (Arnett *et al.* 2008), with fewer fatalities recorded for resident species. Recent studies from Europe also show significant levels of bat mortality associated with wind farms in the summer months (Dubourge-Savage *et al*. 2009).

Very little is known about the migratory behaviours of bats in southern Africa. Seasonal appearances and disappearances of *Eidolon helvum* (Straw-coloured Fruit Bat) are likely to reflect responses of these bats to changing food supplies (Richter & Cumming 2008). Research by Richter and Cumming (2008) - which involved tracking four bats from the Kasanka colony using satellite telemetry - showed that 1) individuals foraged up to 59 km from their roosts, 2) one bat moved 370 km in one night, and 3) one bat travelled a cumulative 2518 km in 149 days. *Miniopterus natalensis* (Natal Long-fingered Bat) is known to migrate up to 260 km (Van der Merwe 1975) between summer maternity caves and caves used for mating and hibernation during the winter months. Similar patterns exist for *Rousettus aegyptiacus* (Egyptian Rousette) which migrates hundreds of kilometres between caves near Tzaneen in Mpumalanga and caves along the KwaZulu-Natal coast (Jacobsen & du Plessis 1976). *Rhinolophus simulator* females also migrate to maternity roosts in spring (Wingate 1983).

The full extent of migratory bat movements across South Africa is not yet fully understood, but is likely to be substantial. It is the potential barrier effect of wind farms, barotrauma and direct collisions with blades that are seen to present the greatest threats to bats, especially migratory species. In South Africa, given the limited knowledge of the ecology and biology of many bat species, the very limited knowledge of migratory behaviour in South Africa and the absence of studies investigating the impact of wind farms on South African bat species, it is recommended that a precautionary approach is adopted until more information has been amassed (e.g. through pre-construction monitoring).

Internationally, guidance has been produced which includes collision risk assessments for the bat species of a particular country. This is not yet possible for South Africa as insufficient information is available regarding flight heights, behaviour and movement patterns for many of the South African bat species. However, bat ecology to some extent, may provide some indication of the level of risk to South African bats from wind turbines, with open air foragers (e.g. *Tadarida aegyptiaca* (Egyptian Free-tailed Bat*)* more likely to encounter turbines because of their higher flying habit, than clutter feeders such as *Nycteris thebaica* (Egyptian Slit-faced Bat) which forage close to vegetation.

Table 1 represents our best assumptions as to which families (or genera) will most likely be affected by wind turbines, through collision risk and barotrauma. It is important to note that this table of risk is not evidence-based, but rather an assumed likelihood of risk based on the foraging and flight ecology of the bats concerned. It is also important to note that daily foraging and flight habits may be very different for species when migrating, and that all migrating species should be assumed to have a high fatality risk.

Table 1. The likelihood of the risk of fatalities affecting bats, based on broad ecological features, excluding migratory behaviour.

Family **Genus**	**Relative status**	**Likely risk of impact from wind turbine blades (direct collision/barotrauma)**
Pteropodidae	Common - restricted distributions Some species known to move large distances	Medium - High
Molossidae	Common - widespread Species fly high enough to come into contact with turbine blades	High
Emballonuridae	Common - restricted distributions Species fly high enough to come into contact with turbine blades	High
Rhinolophidae	Species with restricted distributions	Low
Hipposideridae	Species with restricted distributions	Low
Nycteridae	Common - widespread and restricted distributions	Low
Miniopteridae	Common - widespread and restricted distributions Some species known to move large distances	Medium - High
Vespertilionidae	Common - widespread and restricted distributions	
Pipistrellus	Species with wide or restricted distributions	Medium
Hypsugo	Wide, but sparse distribution	Low
Nycticeinops	Common throughout restricted distribution	Medium
Neoromicia	Species with wide or restricted distributions	Medium - High
Kerivoula	Species with wide but sparse distributions	Low
Scotoecus	Sparse distributions	Medium - High
Cistugo	Restricted distributions - species endemic to Southern Africa or South Africa	Low
Laephotis	Species with restricted distributions	Low
Glauconycteris	Species with restricted distributions	Medium
Myotis	Species with wide or restricted distributions; some species may move large distances	Medium - High
Scotophilus	Species with widespread or restricted distributions	Medium - High
Eptesicus	Wide, but sparse distribution	Medium

PUBLISHED GUIDANCE AND INFORMATION

Much of the existing evidence for adverse impacts comes from the USA and Europe. Useful information, including published research and successful mitigation measures for bats (e.g Baerwald *et al.* 2009; Arnett *et al.* 2011) can be obtained from the Bats and Wind Energy Cooperative (BWEC) www.batsandwind.org.

There are currently several pieces of guidance relating to both survey standards and assessing the impacts of wind farms for bats. One main guidance reference document is EUROBATS.

EUROBATS Guidance

The Advisory Committee of the 'Agreement on the Conservation of Populations of European Bats' (known as EUROBATS), has provided generic guidance for European countries on assessing the impact of wind turbines on bats (Rodrigues 2008). The Eurobats guidance identifies that although most bats have been killed in the migratory periods, resident bats from local populations have also been affected; therefore pre-construction surveys should be undertaken throughout the active bat season. The guidance also states that the pre-construction assessment should identify bat species and any feature used by bats within the landscape. Further details can be found on the EUROBATS website (www.eurobats.org).

SOUTH AFRICAN GOOD PRACTICE GUIDELINES FOR SURVEYING BATS IN WIND FARM DEVELOPMENTS

These guidelines seek to provide technical guidance for consultants charged with carrying out impact assessments for proposed wind farms, in order to ensure that pre-construction monitoring surveys produce the required level of detail and answers for authorities determining applications for wind farm developments.

It outlines basic standards of good practice and highlights specific considerations relating to the pre-construction monitoring of proposed wind farm sites for bats.

INTERNATIONAL ENVIRONMENTAL LAW AND PERTINENT SOUTH AFRICAN LEGISLATION

Global Principles, Convention on Biological Diversity, The South African Constitution and South African Environmental Legislation pertaining to environmental assessment, are all pertinent to the need to assess the impact of wind farms on the ecology (including bats) at a local, national and international level.

- Global Principles - Equator Principles

The globally recognised Equator Principles are applied when countries, such as South Africa, seek external funding for large projects.

The Equator Principles are a set of international principles that are a globally-recognized benchmark for assessing and managing social and environmental risks in project finance. The Equator Principles promote socially responsible conduct and sound environmental practices in relation to project finance initiatives. The benchmark seeks to provide a framework against which lending can be assessed, applying to all new project finance arrangements above

US$10m. By adopting the Equator Principles, financial institutions commit to not providing loans to projects where the borrower cannot or will not comply with the social and environmental standards set out in Equator Principles policies and procedures.

The relevant Principle here is; *Principle 2: Social and Environmental Assessment,* which states:

- For each project the borrower has conducted a Social and Environmental Assessment process to address, as appropriate the relevant social and environmental impacts and risks of the proposed project.
- The Assessment should also propose mitigation and management measures relevant and appropriate to the nature and scale of the proposed project.

- South African Constitution and the Philosophy of Environmental Impact Assessment

The global philosophy of environmental impact assessment (EIA) is that prevention (of environmental effects) is better than cure and that it takes account of concerns to protect human health; contributes, by means of a better environment, to the quality of life; ensures that the diversity of species is maintained, and maintains the reproductive capacity of the ecosystem as a basic resource for life.

> '*The South African Constitution is the supreme law of the country and any law or conduct inconsistent with the Constitution is invalid. Through the inclusion of the environmental right into the Constitution, environmental law found a firm entrenchment into the South African Legal system with a sound basis and constitutional mandate for further development and improvement*.' (taken from van der Linde & Feris 2010).

The relevant section in the South African Constitution Chapter 2 Bill of Rights Section 24. Environment, states that:

> *'Everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development'.*

The Constitutional environmental right not only afforded every person with the entitlement to enjoy a right to an environment which is not harmful to their health and well-being, but also placed a constitutional mandate on government to protect the environment through reasonable legislative and other measures that:

- Prevent pollution and ecological degradation;
- Promote conservation; and
- Secure ecological sustainable development and the use of natural resources while promoting justifiable economic and social development.

In fulfillment of this constitutional mandate, government agencies have over the last decade revised and promulgated various laws pertaining to a range of thematic areas including environmental management, environmental impact assessment, air quality, biodiversity, waste management, mining, forestry, and water management.

- Convention on Biological Diversity 1992

South Africa has ratified the Convention on Biological Diversity (CBD), which means that it has an international obligation to work towards conservation of its biodiversity.
In terms of this Convention, conservation entails:

- o The protection of species and ecosystems that warrant national protection;
- o Sustainable use of indigenous biological resources; and
- o The fair and equitable sharing of its benefits.

- National Environmental Management Act

The National Environmental Management Act (NEMA) creates the fundamental legal framework that gives effect to the environmental right guaranteed in section 24 of the Constitution of the Republic of South Africa, 108 of 1996. NEMA sets out the fundamental principles that apply to environmental decision making, some of which derive from international environmental law and others from the Constitution. The core environmental principle is the promotion of ecologically sustainable development. NEMA also reconfirms the State's trusteeship of the environment on behalf of the country's inhabitants.

- National Environmental Management: Biodiversity Act 10 of 2004

(As last amended by National Environment Laws Amendment Act 14 of 2009)
The objectives of this Act (taken from van der Linde & Feris 2010) are:

(a) within the framework of the National Environmental Management Act, to provide for:

(i) the management and conservation of biological diversity within the Republic and of the components of such biological diversity;

(ii) the use of indigenous biological resources in a sustainable manner; and

(iii) the fair and equitable sharing among stakeholders of benefits arising from bio-prospecting involving indigenous biological resources;

(b) to give effect to ratified international agreements relating to biodiversity which are binding on the Republic;

(c) to provide for co-operative governance in biodiversity management and conservation; and

(d) to provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act.

This Act gives effect to ratified international agreements affecting biodiversity to which South Africa is a party, and which bind the Republic.

- Convention on Migratory Species (also known as the Bonn Convention)

South Africa is a party to the CMS, which aims to conserve terrestrial, marine and avian migratory species throughout their ranges.

BIODIVERSITY PRINCIPLES

Key principles underpin the consideration of biodiversity in EIA, and indicate desired outcomes. They are dictated by international conventions which South Africa has ratified or signed, and reflected in accepted best practice world-wide:

- o A long-term perspective of biodiversity should be adopted to promote intergenerational equity;

- Biodiversity should be protected, and natural capital maintained at or near current levels, with best efforts made to replace or offset loss ("no net loss" principle);
- Prevention of impacts on biodiversity is better than cure in terms of risk and investment of resources;
- Biodiversity issues should be integrated into decision-making;
- An ecosystems-approach to evaluating effects and impacts should be taken, recognizing that humans are a component of ecosystems on which they depend;
- The rights to an environment (including biodiversity) not detrimental to health or well-being must be respected;
- The requirements of international laws and conventions relating to biodiversity, as well as national and provincial legislation, should be met;
- Thorough and early consideration of alternatives is the optimum way to determine the best practicable environmental option to meet proposal objectives whilst preventing or avoiding loss of biodiversity;
- Resource use should operate within the regenerative capacities, whilst pollution/waste outputs operate within assimilative capacities of the natural environment;
- Both biodiversity pattern and process should be conserved;
- Ecosystem services should be safeguarded, giving due consideration to the costs of replacing these services should they fail;
- A risk-averse and cautious approach should be taken where either information and/or the level of understanding is inadequate, where impacts are unprecedented or where there is inherent uncertainty as to the significance of impacts, or there is an element of substantial risk of irreversible impacts which could lead to irreplaceable loss of natural capital;
- Traditional rights and uses of, and access to, biodiversity should be recognised, and any benefits of commercial use of biodiversity should be shared fairly.

APPLICATIONS FOR ENVIRONMENTAL AUTHORISATIONS

Below are the relevant criteria to be taken into account by competent authorities when considering applications (taken from van der Linde & Feris 2010):

> *'If the Minister, the Minister of Minerals and Energy, an MEC or identified competent authority considers an application for an environmental authorisation, the Minister, Minister of Minerals and Energy, MEC or competent authority must:*
>
> *(a) comply with this Act;*
>
> *(b) take into account all relevant factors, which may include:*
>
> *(i) any pollution, environmental impacts or environmental degradation likely to be caused if the application is approved or refused;*
>
> *(ii) measures that may be taken:*
>
> *(aa) to protect the environment from harm as a result of the activity which is the subject of the application; and*
>
> *(bb) to prevent, control, abate or mitigate any pollution, substantially detrimental environmental impacts or environmental degradation;*
>
> *(iii) the ability of the applicant to implement mitigation measures and to comply with any conditions subject to which the application may be granted;*
>
> *(iv) where appropriate, any feasible and reasonable alternatives to the activity which is the subject of the application and any feasible and reasonable*

modifications or changes to the activity that may minimise harm to the environment;

(v) any information and maps compiled in terms of section 24 (3), including any prescribed environmental management frame-works, to the extent that such information, maps and frame-works are relevant to the application;

(vi) information contained in the application form, reports, comments, representations and other documents submitted in terms of this Act to the Minister, Minister of Minerals and Energy, MEC or competent authority in connection with the application;

(vii) any comments received from organs of state that have jurisdiction over any aspect of the activity which is the subject of the application; and

(viii) any guidelines, departmental policies and decision making instruments that have been developed or any other information in the possession of the competent authority that are relevant to the application'.

IN SUMMARY

In summary, together these principles, pieces of international law and domestic legislation make it necessary to assess the impact of developments, such as wind farms and prevent, control, abate or mitigate any substantially detrimental environmental impacts.

2. THE ROLE OF BATS IN SOUTH AFRICA AND THEIR IMPORTANCE TO THE ECONOMY AND ENVIRONMENTAL HEALTH

Bats (Order Chiroptera) comprise one fifth of all mammalian species and are the second largest order of mammal (Simmons 2005). 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.

Bats provide important ecosystem services (Kunz *et al.* 2011). They are major pollinators of fruiting trees, dispersers of seeds and controllers of insects, including agricultural pests. They have contributed substantially to medical research, to our understanding of radar and sonar and their droppings are considered highly prized in some parts of the world as fertiliser. A single small North American Little Brown Bat (*Myotis lucifugus*) can consume up to 1,200 small insects in an hour, almost 5,000 mosquitoes sized insects a night per bat (Taylor 2000). A small colony of bats can therefore consume over 200,000 insects in one night. In a study in Sacramento USA, it was reported that the presence of sufficient numbers of bats reduced fruit crop damage to pears by corn ear moth, by 55% (Long *et al.* 1998).

In South Africa, as in other parts of the world, bats provide essential 'ecosystem services'. Insectivorous bats provide essential pest control services to farmers and frugivorous bats provide seed dispersal (thus aiding forest regeneration) and pollination services. The potential loss of these ecosystem services should be considered when assessing the environmental impact of wind farms. The possible loss of bat colonies could therefore potentially result in increased costs in pesticides and reduced agricultural productivity.

Recent research suggests that the estimated value of bats to the United States agricultural industry is about US $22.9 billion/year and that the loss of bats in North America (due in part to wind turbines and white nose-syndrome) may lead to agricultural losses estimated at more than US $3.7 billion/year (Boyles *et al.* 2011). In the USA wind operators have also been fined US $2.5 million as compensation for the impact on local biodiversity (Cuff 2010).

In the mid 1950s, the then South African Railways supervised the construction of two huge purpose-built structures designed to attract bats to roost in them – in effect 'bat houses'. They were built at Komatipoort on the border of Swaziland and Mozambique as a means of controlling the numbers of mosquitoes and so hopefully the spread of malaria. To this day one 'bat house' is still occupied by a large colony of Angolan Free-tailed bats (*Mops condylurus)* (Taylor 2000).

In most countries in Western Europe, over the past 20 years the protection for bats and their roosts has become very strong and enforced by stringent legislation. Bats and their roosts, even when not occupied, are fully protected and offenders are prosecuted by fines or even custodial sentences. This legislation has been put in place because of the decline in the European bat fauna, and the recognition that bats are a very important part, even vital part of our ecosystem. Bats are a group of mammals which we cannot afford to lose. In Europe, bats have been identified as indicators of the health of our environment and are now considered important indicators of biodiversity (Jones *et al.* 2009). The greater number of bats in terms of numbers and diversity, the healthier our ecosystem is.

3. PREPARATION AND PLANNING OF PRE-CONSTRUCTION MONITORING

In order to adequately assess the likely impact of a wind energy development on local bat populations, appropriate data are required. The overall aim of monitoring at proposed wind farm sites is to identify and assess the potential impacts that the proposed development will have on the species of bats present on and around the proposed site. It is only then that the application can be successfully determined and where necessary, proposals for appropriate mitigation and or compensation drawn up. Box 1 details essential information required from monitoring.

Box 1. Essential information required from monitoring

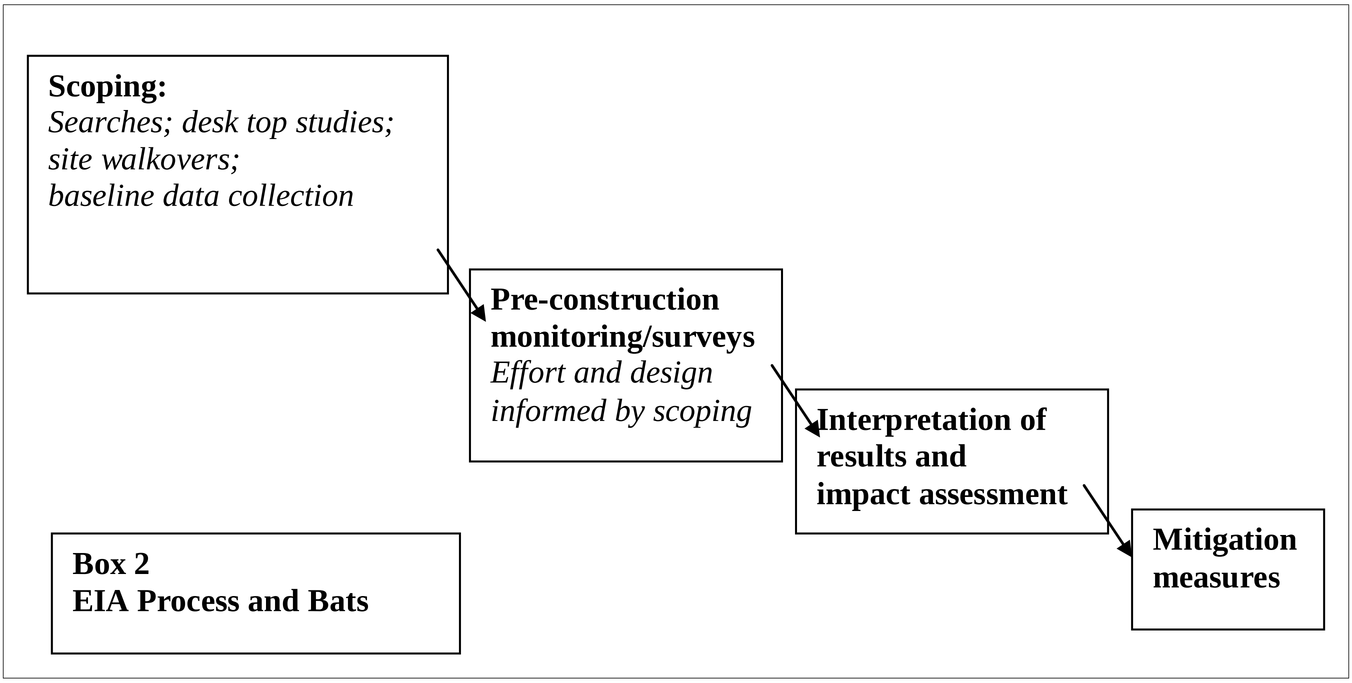
In order to assess the impacts correctly the following information is required:

- Assemblage of bat species using the site (noting higher, medium or lower risk species groups; see Table 1)
- Relative frequency of use by different species throughout the year
- Spatial and temporal distribution of activity for different species
- Locations of roosts within and close to the site

- Details on how the surveys have been designed to determine presence of rarer species
- Type of use of the site by bats - at and away from turbine locations, for example foraging, commuting, migrating, roosting etc.

Monitoring should be designed to gather the information listed in Box 1 and provide all the relevant information needed for appropriate identification and assessment of the impacts of the proposed wind energy development on the local bat population. Pre-construction monitoring design and effort should be site-specific and will depend on the information gathered as part of the scoping study which should be conducted and assessed by the specialist.

Details of the EIA process in relation to bats and the sequence of actions are outlined in Box 2 below:



SCOPING

A key factor influencing the design of pre-construction monitoring methodology is information received from scoping studies: data searches, desktop studies, (including site information from maps and aerial photographs, site walkovers and baseline data collection such as acoustic monitoring). The potential impacts of a wind farm development will be site-specific and will depend on the species and habitats present. The presence of rarer species, species of conservation concern, known roosts, or species that have been identified to be at risk of impacts should be considered from the outset and pre-construction monitoring designed to address any potential impacts related to them. The scoping studies should aim to collate existing information on bat activity, roosts, and landscape features that may be used by bats.

In order to ensure that these aspects are sufficiently covered, a scoping study should *always* be undertaken for a proposed wind farm site. The scoping study should include (whenever possible) the following:

- Collation and review of existing literature (including the latest research undertaken both locally and internationally); maps and aerial photographs; and habitat data (if available) to identify habitats which may be used by bats; data on bat distributions, roosts, bat sightings, migration routes, and likely foraging and commuting areas on or close to the proposed wind farm site.
- Search for any designated Protected Areas within 10km of the site.
- Where possible, the scoping study should also include the proposed footprint of the development including any proposed access/haul roads and temporary construction or material storage areas or other associated development, as these can also have an impact, which could result in loss of roosts and/or foraging habitat.

A walkover survey is an essential part of the scoping study. This is a 'ground truthing' exercise, where the site is walked to search for the presence of features that may support bats such as tress, buildings, underground sites, vegetated cover, wetlands and linear features, including ridges and water courses. This will also allow an initial assessment to be made of the overall habitat quality and connectivity on the site and to identify likely areas of importance for bats (e.g. water bodies, riparian vegetation etc.). The walkover survey should be done by the specialist because information gathered during the walkover, together with the other data obtained from the scoping study, should be used by the specialist to inform the design of the pre-construction monitoring and the level of monitoring effort required. If possible, the use of a handheld or car-mounted bat detector during the site visit may also provide some initial information on species present on the site and on areas/habitats being used by bats.

Although not a requirement for the scoping study, data on bat activity could also be obtained and included in the scoping report. These data can be obtained by mounting a detector on an anemometer mast, or similar structure. Should this be done, data should be collected for 15-25% of one year (spread evenly throughout the year) and should include the spring/autumn migration period. These data are not a requirement but would be beneficial in providing good information (e.g. activity patterns, species present, potential migration route through site, bat activity relative to weather conditions) which would help inform the level of effort required for the one year pre-construction monitoring. However, if a developer decides that they would rather start with their one year of pre-construction monitoring as soon as possible, they can do this even if they do not have any data collected from an anemometer mast.

A scoping report should detail the potential impacts of the development and the data obtained should be used to inform the design of pre-construction monitoring methodology. However, although scoping desktop studies can provide some useful information, it is unlikely that all potential species and roosts will be known. Consequently, monitoring should be designed with this in mind, both to ensure coverage of the entire site and with the scope to investigate any rare or unusual records thoroughly as they come to light. If after the scoping report has been completed the presence of bats at the proposed site is considered to be unlikely, no subsequent pre-construction monitoring may be required.

DESIGN OF PRE-CONSTRUCTION MONITORING METHODOLOGY

"It is unrealistic to present an accurate and complete EIA for a specific wind energy development without taking into account the possible presence of bats throughout a timescale which reflects the full cycle of bat activity", Rodrigues *et al.* 2008, pg 14. In South Africa bats are active throughout the year and as such **pre-construction monitoring should take place for a period of one year** (12 consecutive months). Monitoring design and the level of effort required should be decided by the specialist concerned after a scoping study has been conducted. This document provides **guidance** on pre-construction monitoring techniques and the level of effort which may be required. In some instances (e.g. due to financial or logistical implications) deviations from the techniques and level of effort outlined in this document may be unavoidable. **Any deviation from the recommended monitoring guidelines should always be acknowledged clearly in any reports and accompanied with a clear rationale that is informed by scientific knowledge, evidence and expertise.**

Any site with the potential to significantly* impact bats should be monitored prior to development. If a developer has decided to mount a bat detector on an anemometer mast (or similar structure) - outlined in the above section - and these data were included in a scoping study that concluded that the presence of bats at this scoping stage is considered to be unlikely, or of no significant concern, no pre-construction monitoring may be required.

* '*An ecologically significant impact is defined as an impact (negative or positive) on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a given geographical area. The integrity of a site is the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified*.' Taken from: Insititute for Ecological and Environmental Management (IEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland (2007 revised 2011) Terrestrial, Freshwater and Coastal page 40.

It is advised that a period of **one year** pre-construction monitoring for bats on proposed wind farm sites should be undertaken after scoping indicates that bats are, or are likely to be, present on site during the year. In addition, habitats and features on a proposed site that should inform the decision to undertake monitoring include:

- Buildings or other features or structures that provide potential as bat roosts, including, but not limited to, bridges, mines, caves, sinkholes, rock crevices etc.;
- Known roosts, especially important maternity roosts;
- Vegetated habitat (including non-indigenous (alien) forest plantations and agricultural land);
- Linear features, such as tree lines, topographical ridges, water courses with associated riparian vegetation, potentially used by bats as commuting/foraging/migrating routes;
- Any water bodies, including man made structures e.g. farm dams, swimming pools; and
- Within or adjacent to a Protected Area (as described in NEMA National Environmental Management: Protected Areas Act 57 of 2003).

Sites with any of the features listed above, but not limited to these features, have the potential to impact bats and the potential impact is likely to increase the greater the number of features.

The techniques employed and level of effort for the pre-construction monitoring will vary depending on the location of the proposed site, the characteristics of the site, the bat species present, potential use of the site by bats, and the size and associated risks of the development, and should be informed by the results of the scoping study. An overview of the factors a specialist should consider when designing pre-construction monitoring is provided in Table 2. **This table is not intended to be used as an absolute measure of survey effort required, but rather as an indication of the relative survey effort that may be required.**

Consideration, where possible, should also be given to future changes in land use on the site. For example, a change from arable to cattle pasture in habitats around wind turbines (following construction) could provide higher quality foraging habitat for bats and lead to greater risk of mortality. This should be kept in mind when designing the monitoring to allow assessment of any future impacts on bats as a result of a change in site management. For example, where mitigation and habitat enhancement for other ecological receptors is planned on-site an assessment of whether these measures may attract bats into the area following implementation should be considered. Where possible, the potential effects of such operational site management should also be assessed.

Table 2: Overview of factors to consider when designing pre-construction monitoring methodology in relation to relative survey effort

Survey effort*	Habitat	No. of turbines	Type of roost
Lower	No feature that could be used by bats for roosting, commuting or migrating Small number of potential roosts, most likely less significant	One turbine	Night roost
	Isolated habitat that could be used by foraging bats Isolated site not connected by prominent linear features or well vegetated areas		
	Several potential roosts in buildings trees or other structures Habitat could be used by foraging bats		
Medium	Site is connected to the wider landscape by linear features such as topographical ridges and water courses Buildings, trees, water bodies or other structures with features of particular significance	Three or more turbines	Daytime roost (but not maternity)
	Habitat of high quality for foraging bats Site is connected to the wider landscape by strong linear features such as topographical ridges and water courses		
Higher	Site is close to known roost, or suspected/known migration route Confirmed presence on or adjacent to site, either roosting, commuting or migrating		Nursery roost Maternity Maternity roost/ Hibernaculum (winter roosts where hibernation occurs)

***For further information on survey effort see Section 6 and Table 3.**

4. PRE-CONSTRUCTION MONITORING REPORTS

These guidelines aim to provide guidance on assessing the standard of pre-construction monitoring reports for onshore wind farms. Additional information on EIA in South Africa is detailed in National Environmental Management: Biodiversity Act 10 of 2004, Chapter 5 of the National Environmental Management Act, 1998, Endangered Wildlife Trust Environmental Impact Assessment Toolkit and Western Cape 'Guidelines for Involving EIA Specialists'.

Before any application can be considered it is essential that sufficient information is received as part of the pre-construction monitoring report. Box 3 outlines what should be included within this report. The level of survey effort and survey methods needed should be assessed on a case-by-case basis using the guidance detailed within this document. It should always be considered that deviation from these guidelines of either an increase or a decrease in survey effort may be reasonable depending on the characteristics of the site, the species present, and the size and associated risks of the development. However, the minimum time period for pre-construction monitoring will be one year.

These are guidelines. Any deviation should always be acknowledged clearly in any reports and accompanied with a clear rationale that is informed by scientific knowledge, evidence, and expertise.

Box 3: Information needed in a wind farm bat pre-construction monitoring report

- **Expertise of specialist overseeing the work and expertise of other surveyors** (where relevant) . Where people other than the specialist are involved in the monitoring (e.g. walking manual transects, analysing recordings etc.) they should be listed and their relevant experience and knowledge indicated
- **Summary of scoping study** and how it has informed the pre-construction monitoring design methodology
- **Pre-construction monitoring methods used,** and acknowledgement and rationale should it have deviated from standard guidance. The equipment used should also be indicated.
- **Limitations of survey techniques and equipment** accompanied by an assessment of the impact of these constraints.
- **Monitoring information** that includes:
    - Monitoring area: how was the study area selected and how does it relate to the site area
    - Date, time, and duration of monitoring: if non-standard monitoring methods are used, provide justification – this would apply both for monitoring timings and monitoring methods.
    - Weather conditions during the surveys.
    - Distance of any bats from habitat features (as ambient light levels allow).
    - Map of developable area: and if known, potential locations, height, and sweep of proposed turbines.

- Details and criteria used to identify and distinguish between bat species and/or groups
- Where possible the height of any recorded bat activity (from observations, as ambient light levels allow or from detectors mounted on anemometers):
  The estimated height of the bat activity should be recorded wherever possible:
  - Low-flying therefore below blade; or
  - High flying at or above blade height

  This will allow for any changes in turbine height to be addressed. The exact heights of categories will depend on the size of the proposed turbines.
- Composite map detailing the location of habitat features, the transects walked, static detector locations and their proximity to proposed wind turbine locations(where known) or other site features.
- Map(s) detailing location of roosts and showing the result of the bat surveys detailing main foraging areas and commuting routes in the context of the developable area (or if known, turbine locations) . Details should be provided indicating differences in activity over the monitoring period, for example, monthly or seasonally.
- Appropriate tables: which may include results of each transect survey giving times at each listening point and walks between listening points along with the number of passes and estimated number of each bat species recorded at each listening station and between listening stations; summary tables detailing total number of passes of each species or species group recorded at and between each listening station.
- Estimates of bat activity index. Where possible bat activity levels should be calculated per unit time and described for different species or species groups where species or groups can be reliably separated from recordings. This would normally be done for both manual activity transects and static activity surveys separately.
- Constraints: what factors, if any, could have restricted the quasntity and quality of information collected.

- **Analysis and assessment of impacts** (based on monitoring results and up-to-date published research) that includes:
  - Identification of likely impacts and assessment of the impact.
  - Bat activity in relation to wind speed and where possible, other environmental parameters.
  - Seasonal variations in bat activity.
  - Where possible: consideration of the likely changes in land-use over the lifetime of the wind farm and consideration of other wind farm proposals that may have a cumulative impact on the proposal under consideration.
  - Recommendations for potential mitigation and /or compensation* should be included at this stage in order to assess the eventual impact of the proposal. Any mitigation measures proposed should be based on scientific evidence and discussed with the wind energy developer.

  *Details regarding mitigation and/or compensation measures are outside the scope of this document.

5. PRE-CONSTRUCTION MONITORING TECHNIQUES

Pre-construction monitoring at proposed wind farm sites should be site-specific and designed to provide the information required to complete a full impact assessment, as set out in Box 3. Monitoring will need to take seasonal, species, and geographical variation into account and will need to describe bat activity within the developable area and should cover the turbine locations within the site if these are known. Because provisional turbine layouts may change throughout the development process, especially in cases where developers wish to start pre-construction monitoring as soon as possible, the monitoring area should represent the maximum polygon that identifies the maximum size of all possible turbine arrangements.

This section of the document will outline the basic standards of best practice for each survey technique and highlight specific considerations relating to the monitoring of wind farms. This requires data to be collected using complimentary survey techniques designed to confirm and further inform any potential impacts initially identified in the scoping report. The main monitoring techniques required to collect this data fits into two broad categories: Activity Surveys and Roost Surveys. An overview of the different techniques that can be employed within these categories and other additional survey techniques (such as mist netting, harp trapping and radio tracking) can be found in Box 4. Each of these techniques will provide information on different aspects of the site and its use by bats.

Box 4: Overview of main pre-construction monitoring techniques

1) Roost surveys

Roost Surveys- Identifying potential roost sites

Surveys to assess and identify potential key areas for roosting such as (but not limited to) buildings, underground sites, caves, mines, trees, should be carried out. Any areas with high potential on or adjacent to (if access is granted) the site should be investigated further in order to identify potentially important roost sites. Although some of this information could have been collected during the scoping phase, roosts and roost occupancy may change seasonally and should be checked during each season.

Roost Surveys - Surveys at known roosts

Known roosts, identified in the scoping report or during initial surveys, should be surveyed to identify species roosting there and should include activity surveys to identify main commuting routes to and from the roost and the use of the site by bats throughout the year. Although some of this information could have been collected during the scoping phase, roosts and roost occupancy may change seasonally and should be checked during each season.

2) Activity surveys

- Manual surveys

Manual activity surveys such as walked or driven transects, are necessary to gain an understanding of the bat species using the site and the features on site that the bats are using. They can also be used to identify key features, commuting routes and overall activity within and surrounding the site. These surveys should always be complimented by static monitoring.

- Static monitoring at ground level

Manual bat activity surveys only provide a snapshot of activity on a site and therefore automated bat detector systems (remote acoustic monitoring) at ground level should be used to assess bat activity at proposed wind farm sites. Static detectors provide an invaluable volume of data on the bats present on the site at a set series of fixed locations and are essential in order to gauge the relative importance of features and locations, and potential migratory routes and how these may change throughout the year.

- Static monitoring at height

This may have already been undertaken as part of the scoping survey (mounting detector to anemometer mast) and may not need to be repeated at the pre-construction monitoring phase, unless turbine locations or site footprint have been changed, or scoping results indicate further at height information is needed to produce a robust impact assessment.

If further static monitoring at height is required static survey detectors should be installed at height with the aim of identifying the amount of bat activity occurring in habitat over the open ground, and in the rotor swept area. It is strongly recommended that the static detector microphones should be mounted at height within swept path area of rotor blades. To achieve this technical information regarding the type, height, and design of the wind turbines to be erected at each location is required.

3) Other Survey Methods

Other methods such as infrared cameras and radar have been suggested internationally. For logistical and financial reasons, it is impractical to use these at most wind farm sites. It is not recommended that these form part of a standardised methodology. However, such techniques may be appropriate for sites where particular potential impacts have been identified and more detailed, targeted monitoring is required.

The capture of bats (mist-netting/harp-trapping) may be considered where other standard techniques (activity surveys and roost surveys) cannot deliver a robust impact assessment and should only be conducted by appropriately trained people. In some instances species identities will need to be confirmed (species with overlapping echolocation call parameters, or recorded echolocation calls that cannot be assigned to species). Trapping will also help assist in identifying non-echolocating fruit bats on site as well as species that use calls of low intensity that are difficult to detect using acoustic monitoring techniques (e.g. *Nycteris thebaica*). Trapping may also be necessary in order to obtain echolocation calls from released bats which can be used as reference calls for the acoustic monitoring. It should be noted that these methods are not required for pre-construction monitoring and that if used they should be used IN ADDITION to the above-mentioned methods (activity surveys, roost surveys, and acoustic monitoring) and cannot be used in isolation. Furthermore, whenever these techniques are used it is important to remember that the sampling of bats will not be at the height of the turbine blades. Radio-tracking may provide additional information on what areas of a particular site the bat is using and how it commutes or migrates between various areas (e.g. roost and foraging sites). However, radio-telemetry is expensive and may not be appropriate in certain habitats (e.g. many landscape features that will obscure the signal, resulting in very little data being collected because the bat cannot be ‘located’).

WEATHER CONDITIONS

General guidance for carrying out manual bat surveys (i.e. walked transects) suggests that they only take place in optimum weather conditions in order to maximise the likelihood of recording bats if they use the site being surveyed. It is advised to avoid heavy rain, strong winds, and low temperatures, because bats are least likely to fly in these conditions and activity levels will be low. However, where static detectors are deployed for a number of days at a time, the selection of survey nights with ideal weather conditions is unlikely to be achieved for all survey nights. Data from windy or wet nights may also prove useful in determining how bat activity changes in these circumstances,

<u>Measuring environmental parameters</u>

Whenever possible, weather information should be recorded on site throughout the monitoring period. Data on wind speed, rainfall and temperature that is gathered over the entire year should be compared with the bat data (i.e. bat activity) of the site, particularly data collected from static detectors. This information could be used first to help and inform the impact of the wind farm on bats, and potentially at a later date to inform mitigation if it is required.

TIMING OF MONITORING

Manual surveys should commence 30 minutes before sunset to ensure that species of bat which emerge early in the evening, are included within the monitoring period. The duration of a manual activity survey (i.e. walked transects) will be site specific and will depend on the site size, composition of habitats on the site and number of surveyors. The aim is to cover the site area during one transect period, and this may require more than one surveyor. Manual surveys should focus on, but not be limited to, habitat features likely to be used by bats across the site (e.g. water bodies and associated vegetation) and be used to further investigate findings from the static monitoring

Static monitoring should commence half an hour before sunset and finish half an hour after sunrise to ensure that bat species which emerge early in the evening or return to roosts late are included within the monitoring period. Static monitoring should occur as described below and in Table 3 for the pre-construction monitoring period of **one year** (twelve consecutive months). The survey period when data collected should be 15-25% of one year (spread evenly throughout) for each location. Timers on static detectors, determining the start and end times of the survey, should be regularly adjusted throughout the year to take account the changing times of sunset and sunrise.

One year of pre-construction monitoring is advised.
When deploying static detectors for pre-construction monitoring at wind farm sites, the survey period is one consecutive 12 month period, or longer if proposals are delayed and data is no longer current.
Details on the proportionality of survey effort are summarised in Table 3.

MONITORING METHODS

<u>Roost surveys</u>

- *Identifying potential roost sites*

At sites offering good opportunities for bat roosts, the survey should include a daytime inspection of any structures that can be examined for evidence of roosting bats. Any other features that could not be inspected in detail, or require further survey and need to be observed at dusk, should be mapped. At least one survey should be carried out at these locations at dusk, with the aim of observing emergence at features assessed as providing high potential for roost sites. Sites with evidence of roosting should be subject to additional surveys.

- *Surveys at known roosts*

If roosts are known or located during survey, activity surveys should be undertaken that identify whether the bats utilise or cross the site, including key commuting routes made by the bats from these roosts, located either within or close to the wind farm site. The survey effort and methods required to gather this information will depend largely on how close the roosts are located to the site, the quality and quantity of commuting routes from the roost, potential foraging habitat in the area and whether species that are more reliant on specific commuting routes are present within the surrounding area. It must be noted that these may vary during the year as colonies may move regularly and some roosts may only be occupied seasonally.

Activity surveys

- *Manual surveys*

Broadband bat detectors (frequency division or full spectrum, not time expansion) should be used for all manual activity surveys, either connected to a recording device or with a built-in recording capability, to ensure that all bat calls are recorded and can be subsequently analysed for identification to species or species-group level.

The number and length of transects required to cover the main habitat features of the site will depend on the proposed size and complexity of the site. Sufficient transects should be set up to ensure that all identified features that may be used by bats, are sampled within three hours after dusk. More than one transect may therefore be required to cover all areas as well as all habitats of the proposed site in one survey session. Sampling points can be identified along the transect routes to divide the route into comparable sections. These points should be evenly distributed in distance and amongst the habitats across the site and should include habitats considered of low value to bats (e.g. arable fields). Bat activity should be recorded for a set amount of time at each sampling point (BCT recommend at least three minutes) and continually between points and should aim to represent and compare bat activity across the site. Where possible, the number of bat passes and species concerned should be recorded at each sampling point and between sampling points. A single bat pass is defined as a sequence of two or more echolocation calls, with passes separated by >1s (Fenton 1970). If it is thought that the bat passes are multiple recordings of the same individual this should be noted. The number of sample points will be dependent on the size of the site. In order to ensure robust data collection, surveys should be undertaken from opposite directions throughout the year to allow for the differing emergence times of bat species. To ensure that data are comparable, transect routes should be kept as close to the original routes as possible.

With regards to the number of manual surveys which should be undertaken during the one year pre-construction monitoring period (Table 3), we recommend two replicates per season (which is four site visits per year with two replicates for each site visit; replicates should be conducted from opposite directions). For most sites, provided appropriate and adequate static monitoring is occurring it should be sufficient to visit the site once per season (every three months). At some sites (e.g. near important maternity roosts) it may be necessary to visit more often, but this will be at the discretion of the specialist after he/she has visited and assessed the site. Some sites may only need one transect to cover what they need in a night, other larger sites may require more transects to achieve this. Once again this will be up to the specialist to decide what is appropriate at a particular site.

The use of bat detectors connected with a GPS unit - which unequivocally indicates the exact transect walked and where each sampling point was, and can thus be used by any person instructed to walk the transect - may obviate the need for the specialist to conduct each of the manual surveys. Similarly, at site where more than one transect will be needed to cover the area of the site, other people will be required to participate in the manual survey. Where other people are used in the monitoring protocol, this should be stated in the report together with their relevant experience and knowledge (Box 3).

- *Ground level static surveys*

Although static acoustic monitoring at exact turbine locations would be preferential in may cases this will be difficult because provisional layouts may change throughout the development process, especially in cases where developers wish to start pre-construction monitoring as soon as possible. Monitoring data collected by ground level static surveys should represent the maximum polygon of the development area. It is up to the specialist, after the scoping study and visiting and assessing to propose where and how the static monitoring should happen in order to obtain data that adequately represents the area under development and which is appropriate to assessing the likely impact of the development on local bat populations.

Static detectors should be deployed in sufficient numbers or or moved on rotation (ensuring even coverage of developable area) to enable collection of data on bat activity across the site, as informed by the scoping report and site 'walkover' surveys. There are a number of ways in which this can be done and the best design will depend on the site size, habitat features present, number of proposed turbine locations, and number of static detectors available. Where possible, static detectors should be used to monitor proposed turbine locations, plus additional locations identified as features that may be used by bats for comparison. Alternatively if this is not possible, detectors could be set up on a grid system, with detectors placed both within the developable area where turbines may be located and along features (identified as part of the scoping study) that are, or are likely to be, used by bats. These designs will allow bat activity levels to be compared between open areas and areas with features used by bats across the site. The exact locations for static detectors may need to be adjusted following the manual survey findings; it is important to monitor interim results from surveys and adapt further survey work according to the results to maximise the information collected on bat species presence and activity across the site.

The same model of static detector should be used for all static detector surveys on a single site if direct comparisons in activity between locations within the site are to be made. In addition all detectors must be appropriately calibrated to allow for variation between detector units and to allow a valid comparison of recorded bat activity across a suite of detectors (Larson & Hayes 2000). Microphones should be directed at an angle of 45 degrees towards the target area. This may be within the developable areas, or at proposed turbine locations if they are known, or along linear features. Specialists should be aware of the constraints of bat detectors (e.g. microphone sensitivity and area of coverage) and should take these into consideration when designing the pre-constructions methodology. Constraints/limitations should also be listed in the report (Box 3).

The level of effort required for static monitoring at ground level will be site specific and should be determined by the specialist (following the guidelines provided in Table 3) after completion of the scoping study.

- *Static surveys at height*

UK studies (Collins & Jones 2009) suggest that, with the exception of woodland, monitoring bats at height may not always increase the number of bat species recorded. However, there is a strong likelihood that the proportion of species presence at height will differ from ground level, which could have significant impacts in relation to assessing impacts in sites with a high proportion of high-risk species (e.g. species commuting, migrating and foraging within the rotor swept area).

Depending on vegetational height at the proposed site, some bat species, for example open air foraging bats such as free-tailed bats (family Molossidae), may only forage above the canopy and may not be recorded if monitoring is only completed at ground level. It is therefore recommended that on wind farm sites static monitoring is undertaken at height in addition to ground-level monitoring. Similarly some species forage at just above ground level and will be missed if only at-height monitoring is undertaken. Where the proposal is to either clear fell areas or site turbines in small clearings (key-holing), survey data may not be representative of the situation post-construction as the habitat available for bats will change following construction. In these cases it is also recommended that survey locations include vegetated areas and vegetation edges to provide information on the bat species assemblage and activity levels in these areas as a baseline for post-construction monitoring.

The level of effort required and the design layout for static monitoring at height will be site specific and should be determined by the specialist (following the guidelines provided in Table 3) after completion of the scoping study. Where possible, detectors should be sited within the rotor swept path height. Because the exact locations of turbines are not always known and may changed throughout the development process, data should be collected at enough locations in the maximum polygon of the developable area to enable a comparison of bat activity across the site.

- *Affixing static detectors at height*
  There are several available techniques that can be used to affix static detectors at height. Appropriate methods will depend largely on the type of equipment used. Certain detectors will have limitations in their range depending on the methods employed and these should always be considered when designing a survey. New equipment and techniques are being developed and the choice of methods should be reviewed in the light of new developments. Other possible options for installing detectors at height include using portable towers or masts specifically located for bat detector use, as are used extensively in North America (Kunz *et al*. 2007) or placing bat detectors on the nacelles of existing turbines where a site extension is proposed - a technique which has been trialled in Germany (Cooper-Bohannon *et al*. 2009).

6. MONITORING EFFORT

The impact of a single large wind turbine will differ from that of a wind farm (comprising multiple turbines), not only regarding the likely direct impact on bats, but also because of the area of habitat affected and the infrastructure required. The relatively lower risk of a single or small number of turbines needs to be balanced against the suitability of the site for bats. In large scale schemes, because of the area involved there may be more options for micro-siting and also for on- or off-site habitat enhancement schemes.

It is important that any assessment considers the scale of the likely impacts and takes a proportionate approach.

Deviations from these guidelines of either an increase or a decrease in survey effort may be reasonable depending on the characteristics of the site, the species present, and the size and associated risks of the development. The level of effort required for the **one year pre-construction monitoring** should be determined by the specialist after completion of the scoping study. Any deviations from the guidelines should always be acknowledged clearly in any reports and accompanied with a clear rationale that is informed by scientific knowledge, evidence, and expertise.

ROOST SURVEYS

Surveys of known roosts identified from the data search or during initial surveys should be undertaken, as well as searches of potential sites, such as trees, buildings or underground sites, for as yet undiscovered roosts. Additional surveys should also be carried out to identify main commuting routes to and from the roost and the use of the site by bats from the roost throughout the year.

ACTIVITY SURVEYS

Manual bat activity surveys only provide a small "snapshot of activity" on site but help inform how detailed information on bat activity should be collected at specific locations, and also allow for additional visual observations to be made of bat activity on the site. Static detectors can provide an invaluable volume of data on the bats species present on the site and are essential in order to gauge the relative importance of features and locations, as well as provide information to assess nocturnal and seasonal variations in patterns of bat activity. It therefore recommended that:

Manual activity surveys *and* static surveys at ground level should be carried out as a minimum at multiple turbine sites

The design of the surveys and the level of effort required during the one year pre-construction monitoring should be site specific and should be informed by the scoping study. Design and effort will vary depending on among other things, the location of the site, the size of the developable area (including number of proposed turbines), whether the location of proposed turbines are known, and the presence (and number) of habitats and features that may be used by bats. Consideration should be given to the spatial scale for the survey, which should closely reflect the size and number of wind turbines, potential use of the site by bats and how this may affect the timing of survey work. This is largely influenced by the complexity of the site, its potential to support bats and the historical data of the site and the surrounding area.

Recommendations of minimum standards of pre-construction monitoring effort are provided in Table 3. (This is additional to any initial baseline data collection obtained as part of the scoping study). Pre-construction monitoring effort should always be proportional to the likely impact of the development on local (where migration is suspected, regional populations may also be impacted upon) bat populations. Deviations from the suggested guidance may be necessary depending on the characteristics of the site, the species present, and the size and associated risks of the development. Some sites may require an increase (or a decrease) in effort. Any deviations should be acknowledged clearly in any reports and accompanied with a clear rationale that is informed by scientific knowledge, evidence and expertise.

Table 3: Minimum Survey Standards – Undertaken over a minimum of a 12 month period.

<table>
<tr><th></th><th>ROOST SURVEYS</th></tr>
<tr><td>Potential roosts</td><td>Daytime inspection <u>and</u> two dusk or dawn surveys</td></tr>
<tr><td>Known roosts</td><td>Roost surveys and conduct commuting route surveys.</td></tr>
<tr><th></th><th>ACTIVITY SURVEYS</th></tr>
<tr><td>Survey period</td><td>The pre-construction monitoring period is one year as a minimum. Surveys should provide robust representation of species assemblage as well as seasonal activity patterns.</td></tr>
<tr><td>Survey area*</td><td>Should represent adequate coverage of the developable area (where turbine locations are not known, surveys should cover the maximum polygon that identifies the maximum size of all possible arrangements)</td></tr>
<tr><td>Manual surveys**</td><td>One survey per season (4 surveys per year) and each survey should comprise two replicates (starting from opposite directions)</td></tr>
<tr><td>Static surveys at ground level***</td><td><table>
<tr><td>1-4 turbines per site</td></tr>
<tr><td>5 consecutive nights per month for 12 months; for each turbine</td></tr>
<tr><td>For sites with >4 turbines per site</td></tr>
<tr><td>5 consecutive nights per month for 12 month; 30-40% of total number of turbines (min. 3 locations)</td></tr>
<tr><td>For sites with >10 turbines per site (number of nights reduced to 3 nights)</td></tr>
<tr><td>3 consecutive nights data per month for 12 months; 20% of total number of turbines (min. 5 locations)</td></tr>
</table>
NB - Although monitoring at exact turbine locations would be preferable, this may be impossible or very difficult because provisional layouts may change throughout the development process, especially in cases where developers wish to start pre-construction monitoring as soon as possible. Monitoring data should represent the maximum polygon of the development area. It is up to the specialist, after visiting and assessing the site, to propose where and how the static monitoring should happen in order to obtain data that adequately represents the area under development and which is appropriate to assessing the likely impact of the development on local bat populations.</td></tr>
<tr><td>Static surveys at height</td><td>The survey period when data are collected should be 15-25% of one year (spread evenly throughout and including the spring and autumn migration periods) and sampling locations should be representative of the developable area.</td></tr>
<tr><td colspan="2">* should include ancillary developments (access roads etc) and account for any light spillage, removal of vegetation etc.</td></tr>
<tr><td colspan="2">** sampling should be carried out to ensure that the data collected represent bat activity across the site</td></tr>
<tr><td colspan="2">*** in all instances where the developable area is uncertain, sampling locations should be spread evenly across the site</td></tr>
</table>

7. INTERPRETING RESULTS

Survey information should always be collected, recorded, and analysed to provide information that can be applicable to the direct proposals for the site and assess the likely impacts throughout the year. One important component is the relative bat activity for the site.

ESTIMATIONS OF BAT ACTIVITY

The volume of data collected from static detectors provides the raw data to estimate relative bat activity, known as a 'bat activity index' for the site. This is calculated by dividing bat passes by time.

BAT ACTIVITY INDEX = BAT PASSES or PULSES/ UNIT TIME

Data collected should be analysed to detail the total number of bat passes or bat pulses (depending which bat detectors and analysis software are being used) for each species or species group (depending on level of identification possible from echolocation recordings) and relative bat activity for each survey location and also the whole site. This information should also be normalised to sunset so that activity levels can be compared across sites and analysed within site to provide:

- An indication of seasonal variation in species activity and composition across the site. Site-wide information on bat distributions may provide useful information on which species are using which parts of the site;

- Relative levels of bat activity at ground level and within the proposed turbine swept path area. This can be done by comparing data collected on bat activity at height with ground-level data.

- Variations in activity and species composition at different wind speeds and other environmental parameters where these are available. This can be used to inform any future mitigation

8. CUMULATIVE IMPACTS

'C*umulative impact, in relation to an activity, means the impact of an activity that in itself may not be significant, but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area'* (taken from Regulations in terms of Chapter 5 of the National Environmental Management Act, 1998 Chapter 1 Interpretation and Purpose of these Regulations).

Consideration should be given to other wind farm proposals that may have a cumulative impact on the proposal under consideration, and under NEMA (Part 3 Applications subject to scoping and environmental impact assessment, 32 (2) (k) (i) Cumulative impacts) there is a requirement to assess these combined impacts. If cumulative impacts are not taken into consideration where several wind farm proposals are located in close proximity to one another, the possibility exists of reducing the value of large tracts of land for bats and obliterating ecological corridors, which migrating bats or commuting bats may historically and seasonally use. Cumulative impacts and their associated bat mortality may detrimentally affect environmental services provided by bats (e.g. pest control, pollination, seed dispersal and forest regeneration), thus adversely impacting on local biodiversity and may permanently alter the ecosystem.

9. POST-CONSTRUCTION MONITORING

There is evidence to suggest that bat activity changes after turbine installation, possibly due to bats being attracted to turbines or to insects around turbines (which are themselves attracted to heat and, if applicable, lighting on turbines). At present there is no knowledge to inform how bats within South Africa react to installation of turbines. A precautionary approach is therefore recommended and the effort and trechniques employed should be assessed on a site by site basis. The aim of post-construction monitoring should be to assess changes in activity patterns, determine mortality at sites where impacts are predicted following installation and operation of the turbines and provide additional information on any mitigation schemes. If the change is significant enough to have impacted the ability of the population to survive, breed or reproduce (including to rear their young), or be affected significantly in their local distribution or abundance, this puts the population of bats at risk. Because of their life-history characteristics, which includes low fecundity (or low rates of producing and raising young), bat populations are slow to recover from disturbances and declines, including mortality. This in turn runs the risk of infringing the National Environmental Management: Biodiversity Act 10 of 2004 unless mitigation is implemented. Without information on how the bats' activity changes after installation and operation, effective mitigation cannot be proposed and instigated to reduce any substantive risk to bat populations.

The first two years of wind farm operation are the most important period in which to collect post-construction information as this is when any change in bat activity and mortalities are likely to occur. It is suggested that a minimum of one year post-construction monitoring be undertaken at wind farm sites where bats were recorded as being present on site during pre-construction monitoring. Where more severe impacts have been identified or predicted, an extended period of data collection may be needed to assess the effectiveness of any mitigation proposed. Post-construction acoustic monitoring should be carried out using static bat detectors installed at the nacelle (hub/casing) height on turbines identified most likely to be at risk from having bat activity and potentially causing mortality. It is recommended that during post-construction monitoring, carcass searches for bats are undertaken (e.g. at the same time as birds) during September and April (minimum) and other periods of increased bat activity as indicated by the pre-construction acoustic monitoring data. Details regarding guidelines for post-construction monitoring are not provided in this document.

10. BASELINE DATA COLLECTION AND STORAGE

In order to better inform future pre-construction monitoring methodology and mitigation measures, it is important that the current limited knowledge of the biology and ecology of many South African bat species as well as the interaction between bats and wind farms is addressed within the South African context. To this end, data collected during pre-construction (e.g. acoustic monitoring and roost surveys) and post-construction monitoring (e.g. carcass searches) at wind farms, should be deposited with the designated authority (currently EWT). This information is CRITICAL for our understanding of wind farms and their impacts on bats in South Africa and, in addition to informing future guidelines, will inform future avenues of research.

11. REFERENCES

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