South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities

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Sowler, S. and Stoffberg, S. 2011. South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments. Wildlife & Energy Programme of the Endangered Wildlife Trust

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GLOSSARY OF TERMS & ABBREVIATIONS

Acoustic monitoring: Bat sampling conducted through recording and analysing echolocation calls.

BA: Basic Assessment. This basic assessment report is a standard report that may be required by a competent authority in terms of the EIA Regulations, 2006 and is meant to streamline applications. The BA process should be undertaken for project activities that are included under Listing Notice 1 (GN: 983) and 3 (GN: 985).

Barotrauma: Physical damage to body tissue caused by a difference in pressure between a gas space inside, or in contact with the body, and the surrounding fluid.

Bat call: A single pulse of sound produced in the larynx of a bat and emitted out through their mouth or nose. Bat call and bat pulse can be interchanged for the purposes of this document.

Bat detector: Equipment capable of detecting and recording ultrasonic echolocation calls of bats.

Bat pass: A single crossing of a bat through a bat detector's cone of detection. This can be displayed in the data by a single echolocation call or pulse or by a series of bat echolocation call pulses, known as a call sequence.

Blade: The aerodynamic surface of a wind turbine that catches the wind.

Buffer zone: Non-disturbance areas that provide a protected zone for sensitive resources such as bat foraging habitat and bat roosts. In the case of wind energy development, no part of the turbine infrastructure, including the blade can be positioned within the buffer zone, i.e. these are No-Go development / activity zones.

BWEC: Bats and Wind Energy Cooperative - www.batsandwind.org.

Civil Twilight: This is defined to be the time period when the sun is no more than 6 degrees below the horizon at either sunrise or sunset. The horizon should be clearly defined and the brightest stars should be visible under good atmospheric conditions (i.e. no moonlight, or other lights). One still should be able to carry on ordinary outdoor activities. Evening civil twilight begins at sunset and ends when the geometric centre of the sun reaches 6° below the horizon (civil dusk). Morning civil twilight begins when the geometric centre of the sun is 6° below the horizon (civil dawn) and ends at sunrise.

Clutter: Obstacles present in an area that can affect the flight behaviour of bats, bat call structure and recording of bat echolocation calls.

Colony: The term colony is used to identify a genetically related or socially interactive population of bats within an area that may associate within a number of roost sites during the annual cycle.

Conservation Important Taxon: A bat taxon (e.g. genus, species or subspecies) that is protected internationally (under e.g. CITES or the Bonn Convention), nationally (under the latest NEM:BA ToPS Regulations), or provincially (under relevant provincial legislation), or Red Listed as threatened, Near Threatened or Data Deficient internationally (by the IUCN) or nationally (by Child *et al.* 2016), or provincially protected, or is endemic or near-endemic to South Africa or a part thereof. These taxon may be especially vulnerable to disturbance due to one or more aspects of its ecology (such as roosting in large numbers), or biology (such as its high mortality from disturbance in winter), or is especially important in terms of the eco-services it provides.

DEA: Department of Environmental Affairs

DEFF: Department of Environment, Forestry and Fisheries

Echolocation: Use of ultrasound and the returning echoes to orient and navigate in the environment.

EA: Environmental Authorization

EIA: Environmental Impact Assessment. The EIA process should be undertaken for project activities that are included under Listing Notice 2 (GN:984)

EMP: Environmental Management Plan

EWT: Endangered Wildlife Trust

Harem: The mating and association of several adult females with one male.

Harp trap: Harp traps are composed of two (sometimes up to four) frames strung vertically with monofilament line. Bats attempting to pass through the trap are captured either by colliding with the exterior of the lines or by entering the space between the frames. Once captured, bats flutter down into a catch bag where they are confined until being removed for identification.

Least Concern: IUCN Red Data status for a Non-threatened species

Maternity roost: A maternity roost is the structure within which pregnant females aggregate in summer to give birth to young. The bats may utilise the maternity roost up until autumn, when they move on to winter hibernacula.

Microphone sensitivity: The minimal amplitude required at a given frequency for a microphone to detect a sound.

Minimum requirement: An action that is considered compulsory in these guidelines, unless scientifically motivated as to why it wasn't performed.

Mist net: A finely woven large mesh erected to entangle and capture bats.

Monitoring station: A monitoring station is a geographical location of a mast where one or more detectors may be installed, with microphones at varying heights.

Nacelle: The body of a propeller-type wind turbine, containing the gearbox, generator, blade hub and other parts.

Population: A population is the number of individuals of a given species occupying a certain area of land over a certain period of time.

Pulse: A single emission of sound; i.e. a bat call. See the definition of a bat call.

Roost: This term has a dual application and is used to describe the structure (house, shed, bridge, tree, cave, etc.) within or on which a number of bats take shelter. Secondly, the bats within or on such a structure are also referred to as a roost of bats. 'Roost' does not infer a genetic or social association between the bats within a structure.

SABAA: South African Bat Assessment Association

SAWEA: South African Wind Energy Association

Scoping Report: A Scoping Report (including Plan of Study or Roadmap for the EIA) requires a description of the proposed activity and any feasible and reasonable alternatives, a description of the property and the environment that may be affected and the manner in which the biological, social, economic and cultural aspects of the environment may be impacted upon by the proposed activity; description of environmental issues and potential impacts, including cumulative impacts that have been identified, and details of the public participation process undertaken.

Standard: The level of quality or something used as a measure, norm, or model in comparative evaluations.

Static detector: A bat detector placed in a set position for the period of monitoring that is capable of detecting and recording ultrasonic echolocation calls of bats.

Sunrise: Sunrise is the instant at which the upper edge of the sun appears over the eastern horizon in the morning

Sunset: The time of sunset is defined in astronomy as the moment when the trailing edge of the sun's disk disappears below the horizon.

Watercourse: Water body or resource: Includes natural or man-made permanent, seasonal or ephemeral wetland systems including:

- springs, seeps and marshes.
- pans and lakes.
- ponds, reservoirs and dams.
- lakes and estuaries.
- drainage lines, streams and rivers.
- canals and channels.

- any other surface water bodies or resources not mentioned.

Wind energy facility: A group of wind turbines often owned and maintained by one company, also known as a wind power plant or wind farm.

Wind turbine: A device that converts kinetic energy from the wind, also called wind energy, into electrical energy in a process known as wind power.

WWF: World Wildlife Fund

EXECUTIVE SUMMARY

These best practice guidelines are based on information gathered and compiled from North America, Europe and South Africa, previous versions of these guidelines and input from South African scientists and specialists. The guidelines 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 energy facilities on bats and the important ecosystem services bats provide in the South African context. Guidance is provided on preparing, planning and implementing bat pre-construction monitoring with respect to wind energy facility developments, survey techniques and interpreting results. This document also includes some information on the need for the consideration of cumulative impacts, and operational phase monitoring. Where mitigation and management recommendations are derived from the monitoring, these must be carried forward into the Environmental Authorization and the auditable Environmental Management Plan.

It is important to note that this document provides *guidance* and that each assessment must consider the significance of the likely impacts and take a proportionate approach.

Any deviation from the recommended minimum requirements must be acknowledged and motivated clearly. Such deviation must be informed by scientific knowledge, evidence and expertise. Financial or capacity constraints are not acceptable reasons for deviating from the minimum requirements.

1. INTRODUCTION

1.1 Scope of the Guidelines

The environmental principles for sustainable development that are set out in Chapter 1 of the National Environmental Management Act (NEMA) Act 107 of 1998 state that: Sustainable development requires the consideration of all relevant factors including, but not limited to the following:

- That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimized and remedied;
- That a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions; and
- That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied.

On the 7th April 2017, the Minister of Environmental Affairs published the following amendments to the NEMA: EIA Regulations of 2014: GNR 326 EIA Regulations; GNR 327 Listing Notice 1; GNR 325 Listing Notice 2; GNR 324 Listing Notice 3.

A Basic Assessment (BA) process is required for activities listed under Listing Notices 1 and 3, with the relevant activity for Wind Energy Facilities (WEFs) being:

1. The development of facilities or infrastructure for the generation of electricity from a renewable resource where—
   i. the electricity output is more than 10 megawatts but less than 20 megawatts; or
   ii. the output is 10 megawatts or less but the total extent of the facility covers an area in excess of 1 hectare;

A Scoping and Environmental Impact Assessment (EIA) process is required for activities listed under Listing Notice 2, with the relevant activity for WEFs being:

1. The development of facilities or infrastructure for the generation of electricity from a renewable resource where the electricity output is 20 megawatts or more, excluding where such development of facilities or infrastructure is for photovoltaic installations and occurs —
   a. within an urban area; or
   b. on existing infrastructure.

The minimum requirements in these guidelines are aimed at multi-turbine WEFs that require a Scoping and EIA process to be followed in order to receive Environmental Authorization (EA). A proportionate approach should be adapted for smaller WEFs that only require a BA process. However, the relatively lower risk of a small number of turbines needs to be balanced against relevant bat conservation concerns and the sensitivity and complexity of bat important habitats.

The pre-construction bat monitoring must be conducted prior to the finalisation of a BA or EIA to inform the final layout. The information gained from the monitoring must inform the BA or Scoping and EIA assessments and provide adequate information to the competent authority for them to make an informed decision.

Furthermore, mitigation and management recommendations derived from the monitoring, must be carried forward into the EA and the Environmental Management Plan (EMP).

These guidelines seek to provide technical guidance for consultants charged with carrying out impact assessments for proposed wind energy facilities, to ensure that pre-construction monitoring surveys produce the required level of detail and answers for authorities evaluating applications for wind energy facility developments. It outlines basic requirements of best practice and highlights specific considerations relating to the pre-construction monitoring of proposed wind farm sites for bats.

The objectives of this document are:

- To provide a brief summary of bat related issues associated with wind power development,
- Provide guidance on suggested minimum requirements for pre-construction monitoring for bats at proposed wind energy facility sites, and
- Describe techniques for, and timing of, recommended pre-construction monitoring surveys.

1.2 Offshore Wind Energy Facilities

Offshore wind energy facilities are excluded from this guidance. Must proposed offshore developments occur within South Africa, prior to the development of detailed guidance, a proportionate approach must be taken which considers the significance of the likely impact on bat populations.

1.3 Impacts of Wind Energy on Bats

Internationally, the impacts of wind turbines on bats vary 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 size (Barclay *et al.* 2007) and wind speed (low-wind nights associated with increased fatality (Arnett 2005; Arnett *et al.* 2008; Horn *et al.* 2008). Through a synthesis of post-construction fatality surveys from 73 Wind Energy Facilities in Canada and the U.S.A from 2000-2012, Arnett and Baerwald (2013) calculated that 650,104 – 1,308,378 bats were killed during this period. Other studies documenting bat fatalities at wind energy facilities include Smallwood (2013), who found that an estimated 888,000 bat fatalities occurred in 2012 in the USA and similarly, Hayes (2013) estimated that, in 2012, over 600 000 bats may have died as a result of interactions with wind turbines in the USA. Bat fatalities are also documented in Europe (Rydell *et al*. 2012; Camina 2012; Georgiakakis *et al*. 2012; Lehnert *et al*. 2014; Eurobat 2015), with 6429 actual bat fatalities (not corrected for scavenger removal or searcher efficiency biases) having been reported to Eurobats for the period 2003-2014 (Eurobats 2015).

In South Africa, bat fatalities at operational facilities have only been published by Doty and Martin (2012), Aronson *et al.* (2013) and MacEwan (2016) to date. However, preliminary data from only ***some*** of the first operational WEFs in South Africa for only ***part*** of their operational lifespan shows a linear increase in bat carcasses as more turbines become operational and are monitored (**Figure 1**). This data is uncorrected for biases such as searcher efficiency and scavenger removal, therefore, the actual fatalities will be much higher.

Most documented direct impacts include fatality via:

- Direct collision (Rollins *et al*. 2012)
- Barotrauma (Baerwald *et al*. 2008)

Other impacts include:

- Roost disturbances and/or destruction if construction, operational or decommissioning activities occur close to bat roosts.
- Destruction of foraging habitat (due to wind energy facility construction and habitat change).
- Displacement of bats from their foraging habitat (bats avoid the wind energy facility area)
- Obstruction of movement paths to drinking, foraging, roosting and migration sites.

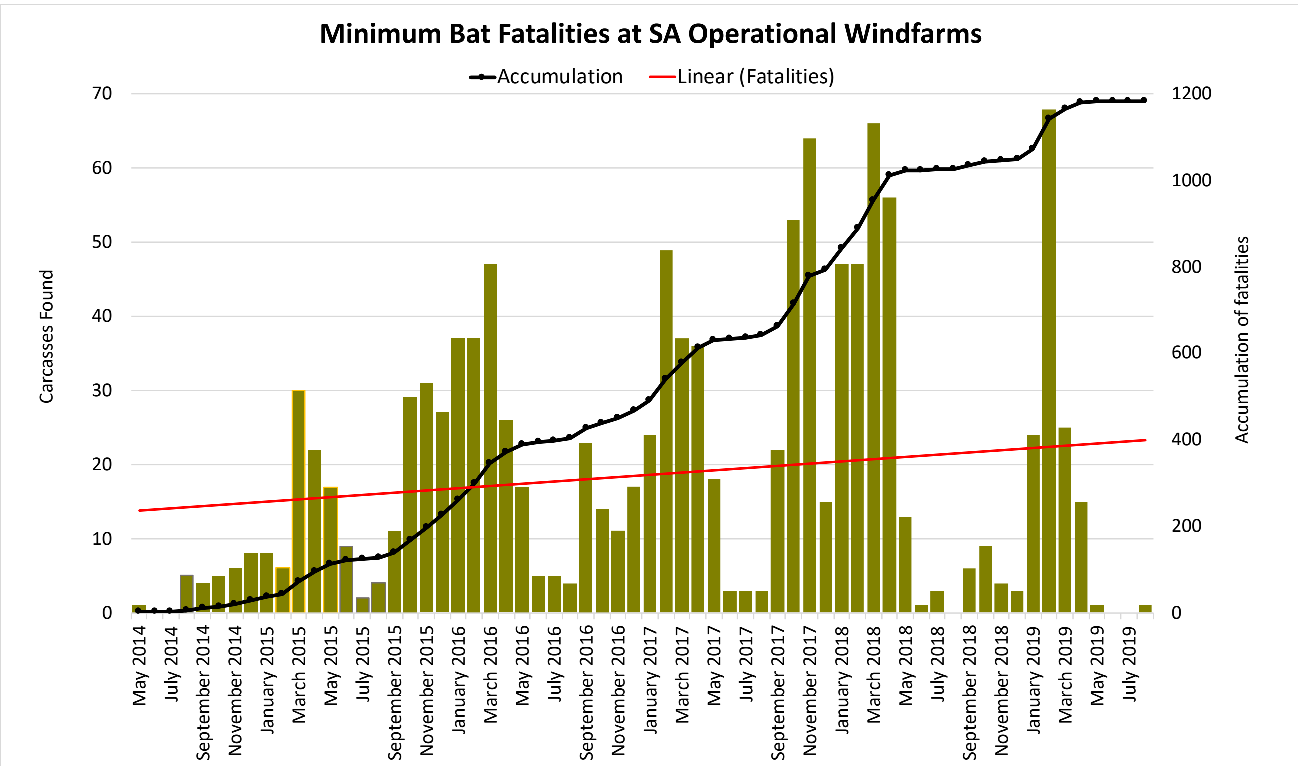

Figure 1 Uncorrected bat fatalities from only some of the operational wind farms in South Africa for only part of their operational life between May 2014 and August 2019.

Both migratory and non-migratory bats are vulnerable to impacts from wind turbines. Internationally, a large proportion of fatalities occur during migration and the majority of bat carcasses recovered have been from migratory species. In North America, 80% of bat fatalities at wind energy facilities involve migratory species (Arnett *et al.* 2008), with fewer fatalities recorded for resident species. Recent studies from Europe and, more recently, South Africa, however, show turbine related fatalities of resident species in the summer months (Dubourge-Savage *et al*. 2009, Doty and Martin 2012, Aronson *et al.* 2013, MacEwan 2016).

The full extent of migratory bat movements across South Africa is not yet fully understood. *Miniopterus natalensis* (Natal long-fingered bat) is known to migrate several hundred kilometres (e.g. 260 km, Van der Merwe 1975 and 560 km, Miller-Butterworth *et al.* 2003) between summer maternity caves and caves used for mating and hibernation during the winter months. *Myotis tricolor* (Temminck's myotis) may undertake seasonal migrations similar to that of *M. natalensis,* although details are not yet fully understood (Monadjem *et al*. 2010). 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 and du Plessis 1976). *Rhinolophus simulator* females also migrate to maternity roosts in spring (Wingate 1983). Seasonal appearances and disappearances of *Eidolon helvum* (Straw-coloured Fruit Bat) are likely to reflect responses of these bats to changing food supplies (Richter and Cumming 2008). Research by Richter and Cumming (2008) - which involved tracking four bats from the Kasanka National Park (Zambia) colony using satellite telemetry - showed that (i) individuals foraged up to 59 km from their roosts, (ii) one bat moved 370 km in one night, and (iii) one bat travelled a cumulative 2518 km in 149 days.

It is the potential barrier effect of wind energy facilities, barotrauma and direct collisions with blades that are seen to present the greatest threats to bats, especially migratory species. Until we have a better understanding of South African bat population levels and fluxes, bat ecology and migration, it is recommended that a precautionary approach is adopted.

Table 1 represents which families (or genera) have and will most likely be affected by wind turbines, through collision risk and barotrauma. Some of the risk ratings are evidence-based others are based on an assumed likelihood of risk based on the foraging and flight ecology of the bats concerned, e.g. open air foragers such as *Tadarida aegyptiaca* (Egyptian free-tailed bat) more likely to encounter turbines because of their higher flight heights, than clutter foraging species such as *Nycteris thebaica* (Egyptian slit-faced bat) which are known to forage close to vegetation. In addition, daily foraging and flight habits may vary significantly 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 fro turbine blades (direct collision/barotrauma)
Emballonuridae	Common – restricted distributions Species fly high enough to come into contact with turbine blades	High
Hipposideridae	Species with restricted distributions	Low
Miniopteridae	Common – widespread and restricted distributions Some species known to move large distances	High
Molossidae	Common – widespread Species fly high enough to come into contact with turbine blades.	High
Nycteridae	Common – widespread and restricted distributions	Low
Pteropodidae	Common – restricted distributions Some species known to move large distances	High
Rhinolophidae	Species with restricted distributions	Low
Vespertilionidae	Common – widespread and restricted distributions	
Cistugo	Restricted distributions – species endemic to Southern Africa o Africa	Low
Eptesicus	Wide, but sparse distribution	Medium
Glauconycteris	Species with restricted distributions	Medium – High
Hypsugo	Wide, but sparse distribution	Low
Kerivoula	Species with wide but sparse distributions	Low
Laephotis	Species with restricted distributions	Low
Myotis	Species with wide or restricted distributions; some species ma large distances	Medium – High
Neoromicia	Species with wide or restricted distributions	High
Nycticeinops	Common throughout restricted distribution	Medium
Pipistrellus	Species with wide or restricted distributions	Medium – High
Scotoecus	Sparse distributions	Medium – High
Scotophilus	Some with widespread or restricted distributions	Medium – High

1.4 Legislation and Policies related to Bats and Biodiversity

There are currently several pieces of guidance relating to both survey standards and assessing the impacts of wind energy facilities for bats, as well as international and national law, principles, and treaties that can and have provided guidance towards formulating South African monitoring guidelines, some of which are summarised in **Appendix 1**.

Key principles underpin the consideration of biodiversity in EIAs, 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:

- 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.

Furthermore, Section 28(1) of NEMA imposes a duty on every person who causes, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring.

1.5 Other Relevant Information and Guidance

Refer to the South African Bat Assessment Association (SABAA) website at www.sabaa.org.za for access to other SA bat guidelines and general SA bat information. Other useful international websites regarding bats and WEFs include, but are not limited to the Bats and Wind Energy Cooperative (BWEC) at www.batsandwind.org, the U.S. Fish and Wildlife Services website at http://www.fws.gov/ecological-services/energy-development/wind.html, the Bat Conservation Trust at https://www.bats.org.uk/ and Eurobats at https://www.eurobats.org/.

2. THE ECONOMIC AND ECOLOGICAL ROLE OF BATS IN SOUTH AFRICA

Bats (Order Chiroptera) comprise nearly one quarter 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 and Harder 2003). Because of this, bat populations are sensitive to changes in fatality rates and their populations only recover slowly from declines.

Bats provide important ecosystem services (Cleveland *et al*. 2006; Kunz *et al.* 2011; Boyles *et al*. 2011; 2013; Lopéz-Hoffman *et al*. 2014; Maas *et al*. 2015). The relative value of bats may be greater in developing countries than in more developed regions, because even though the economic value of crops produced in developing countries is considerably less, their marginal value as food can be enormously greater (Boyles *et al*. 2013). Bats are major pollinators of fruiting trees, dispersers of seeds and controllers of insect populations, including those of agricultural pests. They have contributed substantially to medical research, to our understanding of radar and sonar and their droppings are 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 mosquito-sized insects a night per bat (Taylor 2000). A small colony of bats can therefore, consume over 200,000 insects in one night. In Sacramento USA, it was reported that the presence of sufficient numbers of bats due to proximity to a bat roost reduced fruit crop damage to pears by corn ear moth, by 55% (Long *et al*. 1998). Exclusion of bats and birds from Indonesian cacao plants resulted in a 31% decrease in cacao production due to increased insect damage (Maas and Tscharntke 2013). The estimated value of bats to the United States agricultural industry is approximately $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 $3.7 billion/year (Boyles *et al.* 2011). In south western United States, the pest control value of bats to cotton was approximately $12 million per year between 1990 and 2008, amounting to between 6 and 28% of the total value of the crop (Lopéz-Hoffman *et al*. 2014). In the USA, wind operators have also been fined $2.5 million as compensation for the impact on local biodiversity (Cuff 2010). Maine and Boyles (2015) have shown that bats are worth over $1 billion to the global corn industry.

In Africa, as in other parts of the world, bats provide essential ‘ecosystem services’. Insectivorous bats provide essential services through maintaining a healthy ecological balance by means of natural insect control. For example, in sugar cane monocultures in Swaziland, two species of molossid bats selectively foraged over sugar cane fields rather than over natural vegetation (Noer *et al*. 2012). In the same area, based on next-generation DNA sequencing from faecal pellets, several local pest insect species (including the borer moth, *Eldana saccharina*) featured in the diet of these species (Bohmann *et al*. 2011). Based on next-generation DNA sequencing results, five out of six bat species tested in macadamia orchards in a Limpopo study contained DNA from the major pest of macadamia, green vegetable stinkbugs (*Nezara viridula*) (Taylor *et al*. 2013a). Seasonal activity of bats foraging in these same macadamia orchards was correlated with the annual cycle of two stinkbug pest species (Taylor *et al*. 2013b). Stinkbugs of the Family Pentatomidae result in damage of up to R50 million per year in South African macadamia and avocado orchards

(Schoeman 2013). Bats also play an important role in social health by combatting disease (e.g. malaria; Gonsalves *et al*. 2013). Frugivorous bats provide seed dispersal (thus aiding forest regeneration) and pollination services. In a recent study at Amani in Tanzania, fruit bats were shown to disperse 20% of the local submontane forest trees for hundreds of metres (Seltzer *et al.* 2013). Unlike in South America where bats seem important in dispersing pioneer species in regenerating forests, fruit bats in Africa appear to play an important role in propogation of larger forest trees including species economically important for timber production (Muscarella and Fleming, 2007).

An example of how the ecological and economic value of bats was recognised and supported occurred in the mid-1950s when 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 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).

The potential loss of these ecosystem services should be considered when assessing the environmental impact of wind energy facilities. The possible loss of bat colonies could therefore potentially result in increased costs in pesticides and reduced agricultural productivity. **Table 2** summarises the likely economic importance of various bat families in South Africa most likely to be affected by wind turbines.

Table 2 Likely level of ecological importance of various bat families in South Africa, based on our current knowledge of the biology of these families

Family	Wind Turbine Fatality Risk	Likely level of ecological importance	Potential Ecosystem Service Provided
Pteropodidae	Medium-High	High	Pollination, seed dispersal, forest regeneration.
Molossidae	High	High	Agricultural pest control (tendency for high abundance).
Emballonuridae	High	Medium	Agricultural pest control (Lepidoptera prey but low abundance).
Rhinolophidae	Low	Medium	Agricultural pest control (prey consists of Lepidoptera and Coleoptera), but occurrence is localised, dependant on specific roost types.
Hipposideridae	Low	Low to Medium	Agricultural pest control (prey consists mainly of Lepidoptera), but occurrence is localised, dependant on specific roost types and usually low numbers.
Nycteridae	Low	Medium to high	Preys on a variety of invertebrates and occurrence is widespread.
Miniopteridae	Medium-High	High	Agricultural pest control (high concentrations around roosts), ecological role (almost only energy provider for cave ecosystems).
Vespertilionidae	Medium-High	High	Pest control, ecological role (tendency for high abundance).

3. PREPARATION AND PLANNING OF PRE-CONSTRUCTION MONITORING

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 energy facility sites is to identify and assess the potential impacts that the proposed development will have on both local and regional bat populations. The objectives of long-term pre-construction bat monitoring should be to determine:

- The assemblage of potentially occurring and detected bats in species groups of higher, medium and lower risk of fatality from turbines.
- The presence of rare and Conservation Important bat species in the study area.
- The location of bat roosting habitat in the study region.
- Differences in the assemblage and activity of bats between ground level and rotor sweep height.
- Differences in the assemblage and activity of bats between monitoring localities and between different habitat types.
- Seasonal variation in the assemblage and activity of bats during the 12-month monitoring period.
- The incidence of bat migration in the study area.
- Variation in the assemblage and activity of bats between sunset and sunrise.
- Wind speed and other meteorological conditions associated with bat activity.
- The relative importance/sensitivity of different parts of the site for bats based on e.g., vegetation, significant landscape features, proximity to water, buildings and caves.
- The relative importance/sensitivity of the site based on e.g. its proximity to protected areas and regionally important cave roosts, and the overall level of bat activity relative to that at other IWS bat monitoring sites.
- Potential site-specific impacts of the proposed WEF on bats.
- Effective site- and habitat/turbine-specific bat mitigation measures.

Approval of the site selection and turbine localities must only be decided on completion of a long-term pre-construction monitoring programme.

A description of each phase of the monitoring is described below:

3.1 Design and Planning for the Scoping Phase

A key factor influencing the design of pre-construction monitoring methodology is information received from scoping studies: data searches, desktop studies (including literature reviews and site information from maps and aerial photographs), site walkovers and baseline data collection such as information from the early stages of the acoustic monitoring. The potential impacts of a wind energy facility development will be site-specific and will depend on the habitats and species present. The presence of rarer species, species of conservation concern and ecological importance, known roosts, or species that have been identified to be at risk of impacts, must 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.

To ensure that these aspects are sufficiently covered, a scoping study should *always* be undertaken for a proposed wind energy facility site as part of the EIA process. The scoping study should include 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 energy facility site.
- Desktop search for any designated Protected Areas within 100km of the site.
- The scoping study should include the entire area of interest supplied by the developer/ client. This is the full study boundary area in which all infrastructures could be placed.

A ‘walkover’ survey is an essential part of the scoping study. This is a ‘ground truthing’ exercise, where the site is traversed to search for the presence of features that may support bats such as trees, 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(s) 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 (and often not possible in the time frames available for scoping studies), data on bat activity, through passive monitoring, could also be obtained and included in the scoping report. 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.

A scoping report should list the potential impacts of the development and the data obtained should be used to inform the design of pre-construction monitoring methodology.

3.2 Design and Planning for the EIA Phase

"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).

In South Africa, bats are active throughout the year and as such, **pre-construction monitoring must take place for a minimum period of one year (12 consecutive months)**. The minimum requirements for all pre-construction monitoring studies are detailed in **Table 4**. However, guidance on how much extra effort to invest in a study above these minimums is provided in **Table 3**.

This guideline document provides **guidance** on pre-construction monitoring techniques and the level of effort which may be required. In some instances deviations from the techniques and level of effort outlined in this document may be unavoidable, but these must be scientifically or practically (not economically or logistically) justified. **Financial or capacity constraints are not acceptable reasons for deviating from the minimum requirements.** Any deviation from the recommended monitoring guidelines must always be acknowledged clearly in any reports and accompanied with a clear rationale that is scientifically or practically (not economically or logistically) justified.

Habitats and features on a proposed site that should particularly inform the monitoring programme 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 or wetlands, including manmade structures e.g. farm dams, swimming pools; and
- Within or adjacent to a Protected Area (as described in the National Environmental Management (NEMA): Protected Areas Act 57 of 2003).

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

The additional techniques employed and level of effort for the pre-construction monitoring (apart from the minimum requirements in **Table 4**) 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 3**. **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 should also be given to future changes in land use on the site. For example, a change from arable land to cattle pasture in habitats around wind turbines (following construction) could provide habitat of higher foraging quality for bats and lead to greater risk of fatality. This should be kept in mind when designing the monitoring to allow for 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. The potential effects of such operational site management should also be assessed.

It is important that climatic factors also be taken into consideration. Should the study take place during unusual weather conditions for that climatic area, this should be noted and potentially further verification work at a later time, once weather patterns have normalised should be undertaken. The specialist should advise on this.

3.3 Design and Planning for a BA

A BA should consider all the requirements of an EIA level survey but may not require as much survey effort as for a full EIA. Using information from **Table 3, Table 4** and **Table 5** develop a proportionate approach in order to adequately inform the BA. For example, in a medium to high risk area, where there is little roosting potential on site but good foraging habitat that is connected to a wider landscape, you may want to confirm bat activity levels through acoustic monitoring during the high activity and migrating periods – spring through to autumn. In such a case, erecting a static detector, with a microphone in rotor sweep height (preferably) or at the very least at 10 m above ground level between October and March, may be an appropriate solution. Whatever decision is made, it must be scientifically justifiable.

Table 3 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 or two turbines	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	Three or more turbines	Daytime roost (but not maternity)
	Habitat of high quality for foraging bats		
Higher	Site is close to known roost, or suspected/known migration route Confirmed presence on or adjacent to site, either roosting, commuting or migrating Buildings, trees, water bodies or other structures with features of particular significance (Sirami *et.al.* 2013)		Nursery roost Maternity Maternity roost/ Hibernaculum (winter roosts where hibernation occurs)

3.4 Amendment Reports or New EIAs

If an amendment to a wind energy project is required or a new EIA for the same project is required, the following must apply:

- In the case of a turbine dimension or specification change causing turbine blade tips to further encroach on bat sensitive areas/ buffers, the layout must be adjusted to move turbines (including the full rotor swept area) out of the bat sensitive areas/ buffers.
- Any turbine dimension or specification change (positive or negative) must be accompanied by an official statement from the original specialist who did the preconstruction monitoring as to whether the monitoring conducted was sufficient to assess such a change and whether the impact assessment and/ or the mitigation recommendations change. The need for another year of monitoring must be according to the discretion and motivation of the specialist. If new monitoring

is required, it must be done according to the latest version of the guidelines at the time of the amendment.

- Special attention must be given to changes whereby the lower rotor swept is likely to impact on another suite of bat species due to different flight patterns and foraging ecologies. The original monitoring must have covered various heights to determine which species were active closer to the ground and which were active nearer to the hub.
- The monitoring data used to make any of the above informed decisions must have been done according to the latest version of the guidelines at the time of the original monitoring and the results must still be valid according to Section 3.5 below.

3.5 When are New Editions of the Guidelines Applicable?

Guidelines are applicable after the comment period is complete and the new edition has been sent out by the chairperson of SABAA to SABAA, SAWEA, DEFF, EWT and Birdlife in an official email. All new proposals being issued or appointments being made after this date, must follow the latest edition of the guidelines. If a proposal process has been completed and a consultant has been appointed according to the previous version, the study can continue according to the previous edition. However, if all proposals are submitted and no appointments have been made at the release date of the new edition, the proposals must be revised according the latest requirements before appointment is made.

3.6 Validity Period of Bat Monitoring Studies

A bat monitoring study conducted in accordance with the latest guidance relevant at the time of commencement of the monitoring is valid for a period of 5 years from the last day of the fieldwork period.

Should an environmental application only be submitted 5 years or more after the completion of the fieldwork period:

- For an EIA, a minimum of an additional consecutive 4 months of on-site pre-construction bat monitoring must take place sometime between October and April. The new data collected must be compared to the old data from the same period and an amended impact assessment must be conducted.
- For a BA, a bat specialist, preferably the one who did the original assessment, must conduct a brief site visit and compile a letter stating whether the assessment of impacts on bats is still valid. If the study is still valid, the letter is sufficient. If it is not, the specialist must propose what additional work is required to amend the BA.

4. MONITORING MINIMUM REQUIRMENTS

As summarised in **Table 3,** 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, 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.

Recommendations **of minimum requirements of pre-construction monitoring effort** are provided in **Table 4**, with further methodological detail on each survey aspect provided in Section 5. Additional pre-construction monitoring effort should always be proportional to the likely impact of the development on local bat populations (e.g. where migration is suspected, regional populations may also be impacted upon).

Any deviations from the guidelines must be scientifically or practically (not economically or logistically) justified. **Financial or capacity constraints are not acceptable reasons for deviating from the minimum requirements.**

Table 4 Minimum requirements of pre-construction monitoring effort to be undertaken over a minimum of a 12 month period.

	ROOST SURVEYS
Potential roosts	Daytime inspection in summer and winter and if bats are suspected to be present, at least one dusk survey, during the season in which their presence was evident. If no evidence of bats is apparent on the first inspection, the same potential roost must be inspected again in the opposite season during the 12 month period.
Known roosts	Non-invasive roost surveys of known roosts on site or within a 10km radius must be surveyed once per the main 4 seasons to identify species roosting there. The survey methods depend on the type and size of roost and distance from site - commuting route surveys are recommended. Provincial permits must be acquired where needed.
	ACTIVITY SURVEYS
Survey period	The pre-construction monitoring period is one year (12 months) as a minimum. Surveys must provide robust representation of species assemblage, as well as seasonal and nightly activity patterns.
Survey area	The area must represent adequate coverage of the full developable area (where turbine locations are not known, surveys must cover the maximum polygon that identifies the maximum size of all possible arrangements. The area must include ancillary developments, like access roads, powerlines, etc. (if known) and account for any light pollution, spillages, removal of vegetation, etc.
Manual surveys	Sampling must be carried out to ensure that the data collected represent bat activity across the site. 8 nights of manual surveys through transects or point sampling in various biotopes, spread evenly across all four seasons. Surveys must begin at evening civil twilight when conducted in the evening and last for at least 1.5 hours. If point sampling is used by the specialist, the reasons for deviating from transects must be well justified and enough sampling nights must be conducted to cover all the various biotopes on site for all four seasons each.
Static surveys	In all instances where the developable area is uncertain, sampling locations should be spread evenly across the site. The survey period when data are collected should strive to be 100% (especially in autumn and spring to collect data during the migration and peak foraging and breeding times) but a minimum of 75% of one year of data for each site, **covering all four seasons** is acceptable. This is calculated as the average % recording time over all static monitoring stations deployed on the site over one year. Monitoring within the rotor sweep zone for each project application area is non-negotiable and a minimum of 1 monitoring station at height per 10 000 ha or part thereof is required. If the lowest rotor swept height is unknown or uncertain, then 50 m is the minimum height for the higher microphone. Additional monitoring stations must all have microphones mounted between 7-10 m. Static detectors must remain in a fixed location within each biotope and at each height throughout the 12 month monitoring period. It is up to the specialist to determine where across the site the static monitoring should take place 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 across the different site locations to assist developers in layout design. Guidance on how many and the distribution of monitoring stations and microphones is provided in **Appendix 2**. Nightly monitoring periods must begin at sunset and end at sunrise and must record the entire night. These times can be obtained relatively accurately from appropriate software programs such as Wildlife Acoustic's Songmeter Configuration Utility or Chris Corben's Anasun Application.
Data analysis and Reporting	Survey information should always be collected, recorded and analysed to meet the objectives set out in Section 3. All data collected must be analysed, rather than a subset of the data. As a minimum, • •Average and Median bat passes per hour per microphone per annum, per season and per month • 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 recorded between 7m and 10m 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 (temperature, barometric pressure and humidity) where these are available. This can be used to inform any future mitigation.

5. PRE-CONSTRUCTION MONITORING METHODS

Pre-construction monitoring at proposed wind energy facility sites must be site-specific and designed to provide the information required to complete a full impact assessment (for details on what is required in a monitoring report see Section 7). Monitoring will need to take seasonal, species, and geographical variation into account and will need to describe bat activity within the developable area and must cover the turbine locations within the site if these are known.

This section outlines the basic requirements of best practice for each survey technique and highlights specific considerations relating to the monitoring of bats at proposed wind energy facilities. This requires data to be collected using complementary 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: Roost Surveys and Activity Surveys. Each of these techniques to be described will provide information on different aspects of the site and its use by bats.

5.1 Roost Surveys

5.1.1 Roost Surveys- Identifying potential roost sites

At sites offering good opportunities for bat roosts and where safe to do so, the survey must include a daytime inspection in summer and winter of any structures that can be examined for evidence of roosting bats (e.g. buildings, underground sites, caves, mines, trees, culverts, bridges, etc.). Repeated surveys of potential roosts, even if unoccupied, may be necessary as some bat species are known to switch roosts.

Any other features that could not be inspected in detail, or require further survey and need to be observed at dusk, should be mapped. Any areas with high potential on or adjacent to (if access is granted) the site should be investigated further, 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.

5.1.2 Roost Surveys - Surveys at known roosts

Known roosts on site or within a 10km radius should be surveyed once per the main 4 seasons to identify species roosting there. 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.

If identified roosts are entered to identify species or estimate abundance, important precautions must be taken to ensure the safety of both the specialist and the bats themselves (if you are unsure of the detailed safety precautions to be followed, please contact either the Gauteng and Northern Regions Bat Interest Group (www.batsgauteng.co.za) or Bats KZN (www.batskzn.co.za). Permits must be acquired where necessary. 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.

5.2 Activity surveys

5.2.1 Manual surveys

Manual activity surveys, such as walked or driven transects, are necessary to gain a spatial understanding of the bat species using the site and the features on site that the bats are using. Transects compliment the static monitoring points in terms of spatial coverage. They can also be used to identify key features, commuting routes and overall activity within and surrounding the site. Another method of manual sampling to compliment static monitoring is point sampling in key biotopes. If point sampling is used by the specialist, the reasons for deviating from transects must be well justified and enough sampling nights must be conducted to cover all the various biotopes on site for all four seasons each. These manual surveys DO NOT replace continuous static monitoring according the minimum requirements.

Broadband bat detectors (frequency division or full spectrum, not time expansion) should be used for 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 or number of point sampling sites required to cover the main habitat features of the site will depend on the proposed size and complexity of the site. Sufficient transects or point sampling sites should be set up to ensure that all identified features that may be used by bats, as well as all biotopes present, are sampled within the first two to four hours after dusk. More than one transect may therefore be required to cover all areas and habitats of the proposed site in one survey session. If certain features or biotopes are identified by the specialist as not being significant to bats, and therefore were included in transects or point sampling sites, they should justify this decision.

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 both pristine and transformed habitats (Sirami *et.al.* 2013). 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. The number of bat passes (or similar in accordance with current best practice and technology) and species concerned should be recorded at each sampling point and between sampling points. The number of sample points will be dependent on the size of the site. 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.

Nights when weather conditions are favourable should be selected for transect/ point sampling nights where possible, as weather conditions largely affect bat activity.

Eight nights of manual surveys/ transects, spread evenly across all four seasons is considered reasonable. 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 to 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 sites 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 (Section 7).

5.2.2 Static monitoring

Manual bat activity surveys only provide a snapshot of activity across a site and therefore, automated bat detector systems (remote acoustic monitoring) must be used to assess bat activity at proposed wind energy facility sites. These 'static detectors' provide an invaluable volume of data on the bats present on the site at a set series of fixed locations (representative of area to be covered and all biotopes present in a study site) and altitudes and are essential to gauge the relative importance of features and locations, and potential migratory routes and how these may change throughout the year and throughout the night in different seasons or months.

Although static acoustic monitoring at exact turbine locations would be preferential in most cases, this will be difficult because provisional layouts may change throughout the development process and the cost of having a bat detector per proposed turbine in unfeasible. Therefore, the distribution of static detectors must aim to cover the variety of biotopes found on site and must aim to monitor activity occurring near ground level and in the rotor swept area – preferably both the lower and upper rotor swept zone. Static detectors must remain in a fixed location within each biotope and at each height throughout the 12 month monitoring period. This will allow a full 12 months of monitoring to compare seasonal variation within each biotope type and at each height.

A guide on how many detectors should be used for static monitoring is provided in **Appendix 2**.

In addition, all detectors must be appropriately calibrated to account for variation between detector units and to allow a valid comparison of recorded bat activity across a suite of detectors (Larson & Hayes 2000). Specialists must be aware of specific microphone capabilities and limitations and must take this into account when setting the location and angle of the microphone. 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 (Section 7).

Microphone(s) sensitivity must be monitored in the field during every site visit using an appropriate calibrator. The aim is to ensure correct bat detector and microphone performance. This will enable more accurate comparisons between results from different sites. If sensitivity has been lost, the gain and sensitivity settings on the bat detector can be adjusted to compensate. Microphones should be replaced if the loss in sensitivity is significant - this will depend on the specific capability for each manufacturer.

5.2.3 The importance of static surveys at rotor sweep height

There is a strong likelihood that the proportion and composition of species presence at height will differ from ground level, which could have significant impacts in relation to assessing impacts at sites with a high proportion of high-risk species (e.g. species commuting, migrating and foraging within the rotor swept area). Kunz *et al.* (2007) have shown that the correlation between bat activity estimates from pre-construction acoustic monitoring and post-construction bat fatality estimates is stronger as the bat detector is deployed at greater heights.

Monitoring within the rotor sweep zone for each project application area is a non-negotiable of these guidelines and at least one monitoring station at height per 10 000 ha or part thereof is required. However, more microphones may be required at height if the site has heterogenous landscape.

Depending on vegetation height at the proposed site, some bat species (e.g. open air foraging bats such as free-tailed bats - Molossidae) may only forage above the canopy and may not be recorded if monitoring is only conducted between 7m and 10m. This will account for species that forage both at ground level and those that forage up to a certain height. Static monitoring must be undertaken within rotor sweep height, in addition to monitoring between 7m and 10m to account for species that forage at different heights. Monitoring at additional heights on a meteorological mast can be added to cover the full rotor swept zone, but the distance between microphones on a single mast must be enough to distinguish independent calls at each microphone.

There are several available techniques that can be used to fix static detectors at height. Appropriate methods will depend largely on the type of equipment available. Lattice meteorological masts are useful for installing detectors at height because they are easy to climb for installation and maintenance purposes.

In South Africa, developers are erecting meteorological masts on most sites that can be used to erect bat monitoring equipment. Ideally, such masts are climbable lattice structures; however, some developers use pole structures that provide more of a challenge in terms of erecting equipment and maintaining microphones. Such challenges could be overcome through pulley systems or guy wire climbing systems. Other methods do exist and, if proven to be effective, can be used. Early engagement between specialists and developers can assist in overcoming some of these challenges.

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. Another possible option for installing detectors at height, includes using portable towers or masts specifically located for bat detector use, as are used extensively in North America (Kunz *et al*. 2007).

5.3 Control Sites

There is much debate around the true value of control sites. Whilst data collected at a control site could add value to a bat monitoring assessment, there are too many uncertainties around the true value of this extra monitoring effort to justify control sites as a minimum requirement. It is an option that can be recommended for a particular site, if the specialist feels it is appropriate. The concerns regarding making the use of a control site for bat monitoring a minimum requirement are as follows:

- Finding a control site that is truly comparable to the study site, with a similar composition of biotopes will be very difficult, especially for very large sites.
- Most of the wind energy facility sites are extremely large. Hence, to cover double or one and a half of the bat monitoring equipment and survey effort required, will make these studies unfeasibly expensive and time consuming.
- Whilst there are various potential impacts on bats due to wind energy, such as roost disturbance, displacement from or loss of foraging habitat, fragmentation of migration routes, etc., the most severe impact identified to date, is large-scale bat fatalities. A control site may inform on whether bat activity has decreased on site for natural reasons or as a result of the wind energy facility, however, it does not add value in terms of mitigating for fatalities. This can only be done through a combination of activity monitoring on site before and after construction and carcass searches in the operational phase.

It is suggested, that where the entire study area is monitored pre-construction, yet only a certain area of the site is developed, the remaining area that is monitored both pre- and post-construction be used as the control. However, if a bat specialist does see value in a control site for a particular wind energy facility site, this can be included in their study proposal with the correct motivation.

5.4 Other Survey Methods

5.4.1 Cameras and Radar

Other methods for monitoring bats, such as infrared or thermal cameras and radar, have been suggested. For logistical and financial reasons, it may be impractical to use these at most wind energy facility sites, however, such methods can be used in addition to acoustic monitoring where the budget and suitability of the site allows.

5.4.2 Capture of bats

The capture of bats (mist-netting/harp-trapping) may be considered where call identification requires clarification and/ or other standard techniques (roost surveys and activity surveys) cannot deliver a robust impact assessment. **Capture and handling of bats should only be conducted by appropriately trained and experienced people.** For species with overlapping echolocation call parameters, particularly in certain species rich and diverse regions, live capture and release for identification purposes may be necessary. 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*). Please see the Section 5.5 for more information on fruit bats. Live capture and release may also be necessary 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 a minimum requirement for pre-construction monitoring (except for sites where fruit bats are likely), but can be used *in addition* to the above-mentioned methods (roost surveys, activity 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. Individuals using these methods must have training and/or experience in the safe, ethical and effective capture of bats **and possess the appropriate provincial permits to catch and handle bats in the area.**

5.4.3 Radio tracking

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 and for many species (e.g. many landscape features that will obscure the signal, resulting in very little data being collected because the bat cannot be 'located' and many bats are too small to put sensors on to). This is not a minimum requirement of the guideline, but can be used in addition to the recommended techniques.

5.5 Fruit Bats

Fruit bats (Family: Pteropodidae) in South Africa are susceptible to fatality by wind turbines (MacEwan 2016). In areas where the Scoping study indicates the likely presence of fruit bats, intensive roost surveys should be undertaken to determine the presence of both cave-dwelling and tree roosting species. For *Epomophorus* species, nocturnal surveys involving listening for calling males should be undertaken, especially in the months of May and June (although calling can be heard throughout the year). These fruit bats can also be located by finding feeding spit-out under fruiting or feeding perch trees and can often be seen flying at night. Because *Rousettus aegyptiacus* echolocates, it may be picked up by acoustic recording equipment. *R. aegyptiacus* is a cave dweller; hence, roost surveys are also important for this species. In areas where fruit bats are likely to occur, capture techniques, such as mist-netting should be used to confirm their presence and to identify the species in the area.

5.6 Weather Conditions

General guidance for carrying out manual bat surveys (i.e. walked and driven transects and mist-netting where appropriate) suggests that surveys should only take place in optimum weather conditions, to maximise the likelihood of recording bats. 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 with weather conditions.

5.6.1 Measuring environmental parameters

During static monitoring, weather information should be recorded on site throughout the monitoring period. Data on wind speed, rainfall and temperature that are gathered over the entire year should be compared with the bat data (i.e. bat activity) of the site. This information is useful for data interpretation, impact assessment and mitigation recommendation purposes. Basic weather conditions should also be recorded on nights when transects or if live-capturing is conducted.

6. INTERPRETING RESULTS

Survey information should always be collected, recorded and analysed to meet the objectives set out in Section 3. One important component in meeting these objectives is the relative bat activity for the site.

Static detectors provide the raw data to estimate relative bat activity. There are a number of ways in which this can be determined but consideration should be made to the end results which is to achieve a robust impact assessment.

BAT ACTIVITY INDEX = BAT PASSES (or similar)/ UNIT TIME

A single bat pass is defined as a sequence of ≥1 echolocation calls where the duration of each pulse is ≥2 ms. Single call fragments do not apply, only completed single pulses. Where there is a gap between pulses of >500ms in one file, this then represents a new bat pass. If it is thought that the bat passes are multiple recordings of the same individual, this should be noted.

Furthermore, it is recommended that surveys also calculate a relative abundance index, to address the potential skewing of the data by a single bat making several passes at the recording site as opposed to multiple bats flying by. It is possible to estimate relative abundance by adjusting the activity by the survey times (unit effort) (Miller 2001), i.e. the number of minutes per night (time interval) having recorded passes.

Different detectors and different microphones produce different quantities of data and various conversion software may produce a different number of bat activity units; hence, detector type, microphone type and conversion software used on site must remain consistent throughout the monitoring period and must be described in the monitoring reports. Bat activity data should be corrected for gaps in recording due to technical and/or other problems that may have been experienced during the monitoring period. An explanation of these corrections should be detailed in reports. Data must be normalised from sunset to sunrise so that activity levels can be compared across microphones and sites and analysed within site to provide:

- Average and Median bat passes per hour per microphone per annum, per season and per month.
- 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 recorded between 7m and 10m 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 (temperature, barometric pressure and humidity) where these are available. This can be used to inform any future mitigation.

7. PRE-CONSTRUCTION MONITORING REPORTS

The following Section provides guidance on assessing the standard of pre-construction monitoring reports for onshore wind energy facilities. In addition, all specialist reports written for an EA process must meet the requirements laid out in Appendix 6 of the 2014 EIA regulations.

As a minimum, each pre-construction monitoring report should be include, but not be limited to the following:

- **Expertise of specialist overseeing the work and expertise of other surveyors.** The lead specialist/ the person who signs off on the report should be registered as a Zoological or Ecological Scientist with the South African Council for Natural Scientific Professions (SACNASP), according to the Natural Scientific Professions Act of 2003 and should have at least 5 years of bat scientific experience. Where people other than the specialists are involved in the monitoring (e.g. walking manual transects, analysing recordings etc.), they should be listed and their relevant experience and knowledge described.
- **Introduction to the project development and the background environmental conditions,** including but not limited to a description and map of the monitoring area, the proposed infrastructure development and the background habitat relevant to bats – vegetation, climate, geology, hydrology, land use, etc.

- **Pre-construction monitoring methods used,** including the dates, times and duration of monitoring and equipment used. Acknowledgement and rationale should it have deviated from guidance provided in this document.
- **Technical or other limitations** of the survey and how this could have restricted the quantity and quality of information collected.
- **Results and discussions** should provide answers that meet the objectives in Section 3 of these guidelines. The results should provide information on, but not be limited to:
    - Bat species composition and activity levels near the ground and within rotor sweep height.
    - A description of the biology and conservation importance of the species on site.
    - Bat distribution across the site in relation to various habitats or biotopes.
    - 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.
    - Bat activity in rotor weep height compared to climatic variables such temperature, wind speed, humidity and barometric pressure.
    - A description and map of bat sensitive features, including roosting and foraging potential and confirmed areas and appropriate buffers on sensitive features.
    - Results should be presented scientifically in text, graphs and tables but must not be too complex that the public, developers and authorities cannot understand what is presented.
- **Identification and assessment of impacts** (based on monitoring results and up-to-date published research) that links back to:
    - The identified species, their conservation status and likely impacts and assessment of the impact.
    - Bat activity in relation to habitat, height, wind speed and other environmental parameters.
    - Daily and seasonal variations in bat activity.
    - Consideration of the likely changes in land-use over the lifetime of the wind energy facility and consideration of other wind energy facility proposals that may have a cumulative impact on the proposal under consideration (where data are available to facilitate cumulative assessment within a reasonable timescale, it should be included in the assessment, but this should be already determined at proposal phase, so that the specialist can budget for the analysis of these data).
    - Cumulative impacts should also be assessed – see Section 8 below.
    - A description of fatal flaws, rendering the project as “No-Go” should be provided if the scientific evidence supports this.

- **Recommendations for potential mitigation** (see Section 9 below). Assuming there are no fatal flaws, mitigation and management measures to reduce or prevent impacts on bats, based on scientific evidence, should be included in the report.

8. CUMULATIVE IMPACTS

'*Cumulative 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).

Preliminary data from some of the first operational facilities in South Africa shows a linear increase in bat fatalities as more turbines are monitored (**Figure 1**).

Consideration should be given to other wind energy facility 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. In considering cumulative impacts, specialists should also take into consideration impacts on bats from other activities, types of developments or agricultural practises in the immediate vicinity of the proposed wind energy facility. Information on other renewable energy developments in the area can be obtained from various sources, including but not limited to https://egis.environment.gov.za/.

9. MITIGATION MEASURES

Because of the principles, legislation and constitutional rights discussed in **Appendix 1,** the duty of care that each developer has to the environment and that bat fatalities are a reality at all operational WEFs in South Africa (Doty and Martin 2012, Aronson *et al*. 2013, MacEwan 2016 and Kate MacEwan pers comm. 15 March 2020), it is important that where pre-construction monitoring surveys show medium to high levels of bat activity relative to the terrestrial ecoregion that the site is situated in (**Table 5**) and/or where conservation important bat species and/or habitats are present, mitigation is recommended. Recommending mitigation measures upfront in the planning stages is advantageous because it can feed into the financial models and technical planning of a project. It is more difficult to apply adaptive mitigation after commercial operation has commenced. In terms of the South Africa Environmental legislation, mitigation and management measures are only enforceable if they are written into the EA and the auditable EMP and thus, **important bat mitigation measures should be written into the EA and the wording should leave no doubt that these measures should be applied.** Experience in SA to date, is that some developers (not all), are very reluctant to mitigate during the operational phase, even if their site is exceeding the bat fatality thresholds for that site (method for determining bat fatality thresholds for specific sites can be found in MacEwan *et al.* 2020 or subsequent editions). Some guidance on recommending mitigation measures is provided below, however, the specialist should keep up to date with the latest and most effective mitigation measures being researched in South Africa and worldwide.

9.1 Buffer Zones

The primary mitigation measure during the pre-construction monitoring phase should be to place turbines in less sensitive locations to bats. This can be achieved by the use of appropriate buffer zones. These should be considered no-go areas for wind turbine development, i.e. no part of the wind turbine, including the blade tips must encroach into these buffers zones. SABAA has recommended a set of nationally applicable buffer zones for bats at proposed wind energy development as described below:

For wind turbine developments, including all parts of the blades and towers, SABAA recommends, as an absolute minimum, a buffer of 200m around all potentially bat important features, e.g. delineated watercourses, i.e. from the edge of the riparian zone or from the edge of the outer wetland zone (DWAF definition), woodland vegetation (any trees or bush clumps considered important on site, including alien vegetation), outbuildings (all structures considered as potentially important for bats – water towers, farm buildings, bridges, artificial roosts, etc.), rocky outcrops, topographical ridges and Protected Areas (as described in NEMA: Protected Areas Act 57 of 2003). The exception to the above distance is for confirmed or suspected roosts (permanent or seasonal roosts), where the following buffers should apply:

- A buffer of 500 m for a colony of 1 – 50 Least Concern bats and/or Low Fatality Risk bats.
- A buffer of 1 km for a colony of 50 – 500 Least Concern bats and/or Low Fatality Risk bats.
- A buffer of 2.5 km for a colony of 500-2000 Least Concern bats and/or Low Fatality Risk bats.
- A buffer of 1 km for a colony of 1 - 50 Medium, Medium-High and High Fatality Risk and/or Conservation Important bats
- A buffer of 2.5 km for a colony of 50 - 500 Medium, Medium-High and High Fatality Risk and/or Conservation Important bats
- A buffer of 10 km for a colony of 500 - 2000 Medium, Medium-High and High Fatality Risk and/or Conservation Important bats
- A buffer of 20 km for a colony of >2000 Bats of any status and/or risk level

Important Notes:

- These are minimum values and they do not exempt the developer from implementing additional mitigation measures outside of the buffer zones where bat activity levels dictate.
- Where radial buffers are not appropriate, the specialist must map appropriate polygons within those buffers distances that are suitable for foraging and safe movement.
- The buffer distances must also ensure protection of the roost from disturbance
- Increased linear buffers may be required where migration or movement corridors are known.

- For other associated wind energy facility developments, such as buildings, sub-stations, roads and powerlines, SABAA recommends:
    - For roads: The 200m minimum buffer applies to bat roosts, and disturbances to foraging areas by roads should be considered in the EIA.
    - For power lines: No powerline infrastructure should be constructed within 2km of any large known confirmed roosts and 500m from smaller confirmed roosts. However, power lines can cross bat important foraging areas area, as long as all the other water use license mitigation measures are in place in the case of wetlands and rivers.
    - For buildings and sub-station infrastructure: the 200m minimum buffer applies.

9.2 Recommending Operational Fatality Minimization Measures

Very little published data on relative bat activity levels in South Africa exists. However, acoustic bat activity data gathered from 36 completed 12-month pre-construction and operational surveys conducted by Inkululelko Wildlife Services (Pty) in South Africa was collated and analysed for publication (MacEwan *et al.* 2020). The data was obtained from 156 microphones in the 0-11 m above ground level height range and 55 microphones in the 50-110 m above ground level height range. These data were used to develop an initial table of bat fatality risk for some of the terrestrial ecoregions in South Africa. Terrestrial ecoregions were delineated according to Dinerstein *et al.* (2017).

Biodiversity is not spread evenly across the Earth but follows complex patterns determined by climate, geology and the evolutionary history of the planet. These patterns are called "ecoregions" - https://www.worldwildlife.org/biomes. The World Wildlife Fund (WWF) defines an ecoregion as a "large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions".

The data presented in **Table 5** can be used in two ways:

- **Between ecoregions.** It is assumed that levels of recorded bat activity are correlated with turbine fatality risk, whereby sites with high activity levels will have greater fatality risk. I.e. Ecoregions with very high bat activity should be avoided for WEF development.
- **Within ecoregions.** Due to varying bat population levels in different ecoregions, the level of loss and risk must be assessed differently for different ecoregions. For example, 2.31 bat passes per hour near ground level is indicative of high bat activity and high bat fatality risk in the Fynbos Shrubland Ecoregion but is considered to be low activity and low bat fatality risk in the Renosterveld Shrubland. Game management principles for maintaining sustainable and viable populations teach us that certain ecosystems or areas can only withstand certain death rates in a population in order for that population to remain stable or to grow. This will vary per taxon group and per region.

Table 5 Estimated turbine related bat fatality risk levels based on Median bat activity levels for different terrestrial ecoregions and in two different height ranges

Ecoregion	Height category	Low Risk	Medium Risk	High Risk
Fynbos Shrubland	Near ground	< 0.56	0.57-2.31	> 2.31
	Rotor sweep	< 0.06	0.07 - 0.23	> 0.23
Albany Thickets	Near ground	< 0.51	0.52 - 2.20	> 2.20
	Rotor sweep	< 0.08	0.09 - 0.69	> 0.69
Succulent Karoo xeric Shrublands	Near ground	> 0.08	0.09 - 0.21	> 0.21
	Rotor sweep	> 0.02	0.03 - 0.09	> 0.09
Renosterveld Shrubland	Near ground	< 2.36	2.37 - 10.99	> 10.99
	Rotor sweep	< 1.20	1.21 - 5.00	> 5.00
Namaqualand-Richtersveld steppe	Near ground	< 0.05	0.06 - 0.30	> 0.30
	Rotor sweep	< 0.02	0.03 - 0.18	> 0.18
Nama Karoo Shrublands	Near ground	< 0.18	0.19 - 1.01	> 1.01
	Rotor sweep	< 0.03	0.04 - 0.42	> 0.42
Maputuland Coastal Forests and Woodlands	Near ground	< 6.88	6.89 - 20.87	> 20.87
	Rotor sweep	< 27.45	27.46 - 139.68	> 139.68
Limpopo Lowveld	Near ground	< 0.60	0.61 - 3.62	> 3.62
Kwazulu Natal-Cape Coastal Forests	Near ground	< 8.31	8.32 - 40.39	> 40.39
	Rotor sweep	< 3.46	3.47 - 13.85	> 13.85
Highveld Grasslands	Near ground	< 0.03	0.04 - 1.00	> 1.00
	Rotor sweep	< 0.14	0.15 - 0.70	> 0.70
Drakensberg Grasslands	Near ground	< 0.09	0.10 - 0.36	> 0.36
	Rotor sweep	> 0.02	0.03 - 0.20	> 0.20
Drakensberg Escarpment Savanna	Near ground	< 0.22	0.23 - 2.43	> 2.43
	Rotor sweep	< 0.39	0.40 - 1.09	> 1.09

* **Near Ground** = 0 – 11 m above ground level

** **Rotor sweep** = 50 – 110 m above ground level

Operational mitigation measures should be recommended in pre-construction monitoring reports and applied from the commencement of turbine rotation where medium to high risk levels occur, i.e. where annual average hourly bat passes at any monitoring station exceed the ranges in the medium and high risk levels in the appropriate terrestrial ecoregion (**Table 5**). Environmental and weather parameters must be used to determine turbine specific, seasonal specific and hourly specific mitigation measures. A proportional approach must be applied.

Whilst all bats are considered important from an ecosystem services perspective and all bats should be protected, special attention should be given to assessing impacts on conservation important taxon and operational mitigation may be required. Residual impacts occurring during the operational phase must be addressed to protect especially these species (but all species at risk) during the operation of wind energy facilities.

10. OPERATIONAL MONITORING

Operational monitoring according to Aronson *et al*. (2020) or subsequent editions is required for all projects. A proportional approach can be adopted if bat activity is extremely low or the size and numbers of turbines is very small. However, there is evidence to suggest that bat activity changes after turbine installation, possibly due to bats being curious, or being attracted to turbines or to insects around turbines. At present it is not known how southern African bats react to installation of turbines. A precautionary approach is therefore recommended and the effort and techniques employed should be assessed on a site by site basis. The aim of operational monitoring should be to assess changes in activity patterns, determine fatality at sites where impacts are predicted following installation and the 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, and fatality may occur. 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.

Where operational monitoring shows an exceedance of bat fatality thresholds (MacEwan *et al*. 2020), adaptive mitigation and management must be recommended and implemented.

11. BASELINE DATA COLLECTION AND STORAGE

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 energy facilities is addressed within the South African context. To this end, data collected during pre-construction (e.g. acoustic monitoring and roost surveys) and operational monitoring (e.g. acoustic monitoring and carcass searches) at wind energy facilities, must be deposited with a designated coordinator at the end of the relevant data collection campaigns. This information is critical for our understanding of wind energy facilities and their impacts on bats in South Africa and, in addition to informing future guidelines, will inform future avenues of research.

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13. APPENDIX 1: Relevant Legislation

13.1 Regional and International Legislation, Principles and Treaties

There are various Conventions, Unions and Treaties in place for the protection of biodiversity, under which bats would also be protected – to name just a few:

13.1.1 African Convention on the Conservation of Nature and Natural Resources

- The Convention was adopted by the Assembly of the African Union on the 11th July 2003 in Maputo, and is the result of a thorough revision of the original convention, adopted in Algiers in 1968. The new Convention deals with an array of sustainable development matters. In particular for bats, it deals in detail with regard to the conservation of species and genetic diversity, conservation of protected species and discusses sustainable development in the context of the conservation and management of natural resources.

13.1.2 Convention on Biological Diversity (CBD)

- South Africa has ratified the Convention on Biological Diversity, which means that it has an international obligation to work towards conservation of its biodiversity. In terms of this Convention, conservation entails:
    - The protection of species and ecosystems that warrant national protection;
    - Sustainable use of indigenous biological resources; and
    - The fair and equitable sharing of its benefits.

13.1.3 The Bonn Convention (on conservation of migratory species of wild animals)

- South Africa is a party to the Convention on Migratory Species, which aims to conserve terrestrial, marine and avian migratory species throughout their ranges (this includes *Miniopterus natalensis*).

13.1.4 CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)

- CITES is a global agreement between nation states to ensure a sustainable international trade in wild species which does not threaten their overall survival and populations. The global trade in fauna and flora is worth billions of dollars and a huge number of species are traded both legally and illegally, both within and across international borders, hence the requirement for an international agreement and regulations. Unlike Agenda 21, the CITES Convention is legally binding and nations are required to develop local legislation to ensure CITES is implemented based on species classified as threatened or endangered in the respective country. Species are classified according to three appendices according to the level of protection required, with Appendix I species being the most critically threatened and trade only allowed in exceptional circumstances. CITES globally covers over 35 000 species, whether used as live specimens or for parts by-products of the species (CITES, 2016). In South Africa, the DAFF is responsible for undertaking and coordinating policy ad intervention in respect of upholding CITES regulations (DEA, 2016). A list of CITES-classified animals is available and a permit is required to transport or export these animals and plants. Contravention of this carries large penalties and even prosecution. In South Africa, each provincial environmental department lists species which are threatened, of which bats do form part of their lists. The export of these animals is regulation under CITES regulations as well as the Threatened or Protected Species Regulations (TOPS). Even export and storage for research and conservation purposes require TOPS permits, if the specimen is taken out of it's in situ location. Unfortunately, while CITES covers a number of bat species, currently only one species is protected by TOPS in South Africa.

13.1.5 Agenda 21 and Rio Declaration

- Agenda 21 is a plan of action which arose out of the United Nationals Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil in 1992. It is essentially a comprehensive but non-binding, voluntary plan which seeks to be implemented at global, regional and local levels. The main aim of Agenda 21 is to ensure effective management and conservation of natural resources and balancing this with socio-economic facets to ensure that development pathways continue, without hindering the integrity of the natural environment on which humanity depends, for future generations (United Nations, 2015). National plans and strategies have largely been based on Agenda 21 or included it in some way and much of South African legislation is no different. The National Environmental Management Act (107 of 1998) (NEM) is the overarching legal framework for environmental management in SA and the Strategic Environmental Assessments and Environmental Impact Assessment processes within NEM seek to identify environmental threats caused by economically-based developments and mitigate or seek alternatives where necessary. Under the NEM, there are various laws which protect biodiversity and particularly threatened or economically-important or economically important species and landscapes. Given bats' value to ecosystem services via goods and services such as pollination and pest control, they are included in legislation at various levels, particularly at a provincial level and are given greater focus in respect of renewable energy developments.

13.1.6 The IUCN (World Conservation Union)

- The Union's mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.The IUCN have assigned various conservation categories to faunal species, from those requiring little conservation effort to those in desperate need of conservation:
  - Least Concern (LC)
  - Near Threatened (NT)
  - Vulnerable (V)
  - Endangered (EN)
  - Critically Endangered (CR)

13.1.7 Global Principles - Equator Principles

- The globally recognised Equator Principles are applied when countries, such as South Africa, seek external funding for large projects. These 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 must also propose mitigation and management measures relevant and appropriate to the nature and significance of the proposed project.

13.2 National Legislation, Policies and Guidelines

13.2.1 South African Constitution

- 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.

13.2.2 National Environmental Management Act

- The National Environmental Management Act (NEMA) Act 107 of 1998 and the NEMA: Environmental Impact Assessment Regulations (No. R682 of December 2014) 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.

13.2.3 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 and Feris 2010) are within the framework of the National Environmental Management Act, to provide for:
    - the management and conservation of biological diversity within the Republic and of the components of such biological diversity;
    - the use of indigenous biological resources in a sustainable manner; and
    - the fair and equitable sharing among stakeholders of benefits arising from bio-prospecting involving indigenous biological resources;
    - to give effect to ratified international agreements relating to biodiversity which are binding on the Republic;
    - to provide for co-operative governance in biodiversity management and conservation; and
    - to provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act.

13.2.4 National Biodiversity Strategy and Action Plan (NBSAP)

- The development of the NBSAP is part of South Africa's obligations as a signatory to the CBD, and was compiled by the Department of Environmental Affairs and Tourism (DEAT 2005). The NBSAP is based on the recognition that South Africa is extremely rich in terms of biodiversity, but is also a developing country where the majority of the population resides in poverty. It provides an overarching framework for the conservation and sustainable use of South Africa's biodiversity, and equitable sharing of benefits from use of genetic resources. As far we know South Africa is the first country to include a comprehensive spatial assessment of biodiversity (the NSBA) as part of its NBSAP. Through the NBSAP it is recognized that biodiversity cannot be conserved through protected area networks only. All stakeholders, from private landowners and communities to business and industry must get involved in biodiversity management.

13.2.5 National Spatial Biodiversity Assessment (NSBA) Priority Areas & Threatened Ecosystems

- The NSBA, which is part of the NBSAP, was led by the SANBI (Driver *et al*. 2011). Its main focus was on mainstreaming biodiversity priorities and making links between biodiversity and socio–economic development in South Africa. The NSBA represents South Africa's first national assessment of spatial priorities for conservation action, integrating terrestrial, river, estuarine and marine ecosystems, using available spatial data, biodiversity planning software and a series of expert and stakeholder workshops. The NSBA involved systematic biodiversity planning based on three principles:
  - The need to conserve a representative sample of biodiversity pattern, such as species and habitats (the principle of representation).
  - The need to conserve the ecological and evolutionary processes that allow biodiversity to persist over time (the principle of persistence).
  - The need to set quantitative biodiversity targets that tell us how much of each biodiversity feature should be conserved to maintain functioning landscapes and seascapes.
- During the NSBA, nine geographic Priority Areas were identified for conservation in South Africa (Driver *et al*. 2004). Priority Areas were allocated where broad-scale habitat remained unprotected, or was inadequately conserved.
- A national list of Threatened Terrestrial Ecosystems was gazetted on 9 December 2011 in the NEM:BA. The identified Threatened Ecosystems occupy 9.5% of South Africa and were selected according to six criteria including:
  - Irreversible habitat loss;
  - Ecosystem degradation;
  - Rate of habitat loss;
  - Limited habitat extent and imminent threat;
  - Threatened plant species associations; and
  - Threatened animal species associations.
  - National Red Data Species Listings
- Lists of National Red Data Species have been produced for all five vertebrate classes. The National Red Data conservation status of mammals, including bat species in South Africa can be found in Friedmann & Daly (2004), soon to be updated by SANBI. The most currently published version will apply.

13.3 Provincial Legislation, Policies, Planning and Protected Species Listings

- Each province in South Africa has its own environmental and biodiversity legislation, policies, conservation planning tools and protected species listings. These are to be adhered to for each project, depending on the province in which the project falls within.

14. APPENDIX 2: Determining Number of Monitoring Stations

Monitoring within the rotor swept zone at all wind energy facility development sites in South Africa is a non-negotiable requirement of these guidelines[1]. A minimum of one (more should be used if the landscape is highly heterogenous) recording microphone within the rotor sweep zone (or if unknown at >/=50 m above ground level) per 10 000 ha or part thereof is required i.e. for all sites that are 10 000 ha or less, at least one microphone within the rotor sweep zone (or if unknown at >/=50m above ground level) is required. Thereafter, one microphone within the rotor sweep zone (or if unknown at >/=50m above ground level) must be added for every additional 10 000 ha or part thereof. For example, if a site is 4 000 ha, it will require one recording microphone within the rotor sweep zone (or if unknown at >/=50 m above ground level), if a site is 13 000 ha, it will require two recording microphones within the rotor sweep zone (or if unknown at >/= 50m above ground level), if a site is 25 000 ha, it will require three recording microphones within the rotor sweep zone (or if unknown at >/=50 m above ground level), if a site is 40 000 ha, it will have four recording microphones within the rotor sweep zone (or if unknown at >/=50m above ground level) above ground level, etc.

Every monitoring station[2] that has a microphone within the rotor sweep zone (or if unknown at >/=50 m above ground level), must have at least one other microphone near ground level (between 7-10 m above ground level) on the same mast. This will allow for both paired recordings at different heights and direct comparisons with recordings on smaller masts in other biotopes.

In addition to the paired recording on tall masts , monitoring on shorter masts, with microphones closer to the ground at heights of 7-10 m above the ground is recommended to cover different biotopes on site for all development infrastructure[3], not covered by the positions where at height masts are situated, are required as follows:

Vegetation types should be sourced from Mucina & Rutherford (2006). Land-use types should be considered when significant portions of a site have been transformed by e.g. crop cultivation, livestock over-grazing and alien plant invasion. Vegetation and land-use will often be correlated with topography, and low-lying areas (ravines and floodplains) will often be associated with water. Empty buildings and human settlements can be assessed using roost surveys, mist-netting and acoustic spot surveys.

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[1] To determine the number of static detectors in rotor swept height to use for a project, the developer must supply the specialist with a set “turbine development area”. The developer must ensure and understand that the bat monitoring and bat impact assessment in relation to turbine development only applies to that area, hence if the turbine layout is not certain, the largest possible area must be provided for the monitoring and assessment.

[2] A monitoring station is a geographical location of a mast where one or more detectors may be installed, with microphones at varying heights.

[3] In addition to the turbine development area, there will be a greater area where roads, sub-station, office and powerline infrastructure will be developed. The entire area must be covered by detectors placed every 5000 ha, with microphones recording at >7m.

For WEF sites >5 000 ha, in addition to the minimum number of monitoring stations at height, one microphone at >7 m should be assigned for every 5 000 ha comprising the site or for all unique combinations of vegetation, land-use and topography, i.e. significant biotope. The "at height" monitoring stations can represent one of these 5000 ha or biotope monitoring stations

Example:

As shown in the **Table 6** below**,** five monitoring stations would be assigned for all unique combinations of vegetation, land-use and topography at a hypothetical 31,500 ha WEF site in the Karoo.

Table 6 Minimum number of bat monitoring stations assigned for all unique combinations of vegetation, land-use and topography at a hypothetical WEF site in the Karoo

Vegetation types & Land-use types	Low (ravines, channels, floodplains)	Elevation/Topography Medium (plains, gently undulating terrain)	High (ridges, hills, mountains)	Number of monitoring stations
Tanqua Wash				
Riviere	1	1		2
Tanqua Karoo		1	1	2
Cultivated fields	1			1
Numbers of monitoring stations	2	2	1	**5**

In addition to the minimum five monitoring stations for all unique combinations of vegetation, land-use and topography, two additional monitoring stations should be assigned for the 31 500 ha WEF the site based on the following calculations:

- 5 monitoring stations (for vegetation, land-use and topography) x 5 000 ha per detector = 25 000 ha
- 31 500 ha – 25 000 ha = 6 500 ha
- 6 500 ha / 5 000 ha per detector = 1.3 monitoring stations (2 monitoring stations due to exceeding 1)
- Total minimum number of monitoring stations = 5 monitoring stations + 2 monitoring stations = 7 monitoring stations required in total.
- To determine how many paired at height stations vs how many 7 -10 m stations:
- 31 500 ha / 10 000 ha = 3.15 (i.e. 4 due to exceeding 3) paired monitoring stations at height.

This example demonstrates that when determining the total minimum number of bat monitoring stations for a WEF site, both site size and habitat diversity must be considered. Thus, each detector at a WEF site should record a fraction of the activity of bats flying within a radius around each detector.