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

Chapter 7:

Impact on Bats

Photos by NSS

Miniopterus natalensis (Natal long-fingered bat)

Neoromicia capensis (Cape serotine bat)

Tadarida aegyptiaca (Egyptian free-tailed bat)

Compiled by:
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CHAPTER 7 IMPACT ON BATS

The bat study for the Final EIA Report was conducted by Natural Scientific Services (NSS). It includes the findings of the first quarter of the twelve month preconstruction bat monitoring programme that is being conducted by Natural Scientific Services (NSS). Kate MacEwan is the bat specialist for the project and Megan Baumgartner is the project manager for NSS.

7.1 INTRODUCTION

An initial bat assessment was conducted for the site by Stephanie Dippenaar in late 2011 and this study was included in the Draft EIA Report and was part of the desktop review for this updated chapter on bat impacts prepared by NSS. WKN Windcurrent has commissioned NSS to conduct a long-term (12 month) monitoring survey which is being completed to satisfy the requirements of the South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg, 2012). The monitoring at the Banna Ba Pifhu site commenced in mid April 2012 and is scheduled to run until mid April 2013. The bat monitoring was conducted over two seasons, these being autumn and winter (from April to August 2012). The data (based on the first quarter of the twelve month monitoring) are included in the Final EIA report and therefore incorporate on-site data measured compared with preliminary data collected at the start of the project. This chapter serves as the **Bat Impact Assessment** (based on the first quarter of the twelve month monitoring). A final and more detailed monitoring report will be submitted by NSS by mid-May 2013. This chapter is therefore not the final bat monitoring report and NSS reserves the right to make changes to the findings, impact assessment and sensitivity mapping at the completion of the twelve months of monitoring. The final monitoring results and any updates in the findings and sensitivity mapping will be included in the project draft Environmental Management Programme (EMPr) as part of the detailed design phase.

7.1.1 *Approach to the study*

South Africa, through an initiative facilitated by the Endangered Wildlife Trust (EWT) has adopted best practice guidelines similar to existing international ones - South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg, 2012). These guidelines seek to provide technical guidance for consultants charged with carrying out impact assessments for proposed wind farms, in order to ensure that pre-construction monitoring surveys produce the required level of detail and answers for authorities determining applications for wind farm developments. It outlines basic standards of good practice and highlights specific considerations relating to the pre-construction monitoring of proposed wind farm sites for bats. The guidelines recommend that in order to assess the impacts correctly, the following information is required:

- Assemblage of species using the site;
- Relative frequency of use by different species throughout the year;
- Location and time of activity, which must include turbine locations where known;
- Locations of roosts within and close to the site;

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

To date, only three experimental wind farms have been constructed in South Africa - Klipheuwel and Darling (**Figure 7-1**), on the west coast of the Western Cape Province and one turbine at Coege IDZ in the Eastern Cape. Very preliminary research at these facilities is finding turbine related bat mortalities. So, bat impacts due to WEFs are a real concern for this "cleaner" energy source in South Africa.

Figure 7-1: Darling Wind Energy Facility, Western Cape

7.1.2 Terms of reference

The Terms of Reference for the bat specialist study are:

- Desktop review of all available information
- Fieldwork is being conducted in the form of:
  - Roost Surveys- Identifying potential roost sites
  - Activity Surveys - Static monitoring at ground level and height
  - Activity Surveys - Manual surveys & Mist-netting
- Data Analysis to determine the following:
  - Bat Activity Index
  - Relative Abundance Index
  - Wind Speed Threshold
- An impact Assessment
- Mitigation and Recommendations

7.1.3 Assumptions and Limitations

As can be expected with a long-term scientific study over a large study area, with equipment being actively and passively used out doors for long periods, and performing methodologies new to South Africa, some limitations were experienced. These are discussed in Sections 7.1.3.1 to 7.1.3.4 below.

7.1.3.1 Equipment Failures and Disruptions

7.1.3.1.1 Data Gaps

There are gaps in data recordings for HB2, HB3 and HB4. The reasons for the gaps are most likely to be the result of the SD (memory) cards filling up before the scheduled station check. This cause of data gaps has been noted and the stations will be checked more regularly.

7.1.3.2 Preliminary Monitoring Data

This assessment report was completed only two seasons into the year of monitoring and no mist netting and roost surveys have been conducted for the site as yet. Spring and summer still need to be recorded and analysed for a true representation of the bat activity patterns in all seasons on site. Calculations of the impacts on the bats therefore have been conservative until a better understanding can be established.

It is important to note: Despite these limitations, the monitoring period is well within the required times specified within the guidelines. Cumulatively, 65% of the possible monitoring time (April – August 2012) has had static monitoring running at the Banna Ba Pifhu site, as shown in **Figure 7-2** below. The current report presents 34% of the 12 month monitoring period, hence the need to complete the monitoring for a true representation of the preconstruction monitoring.

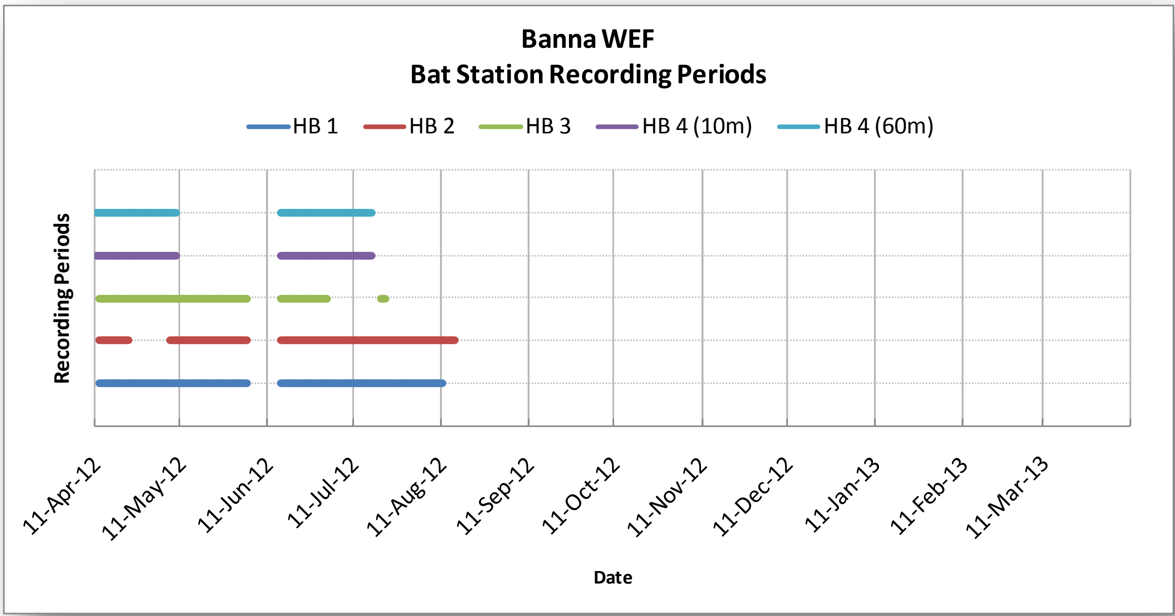


Figure 7-2: Recording periods used for this preliminary report

7.1.3.3 <u>Data Interpretation</u>

7.1.3.3.1 Assumptions

The following assumptions were made when analysing and interpreting the data:

- As bat passes could represent numerous passes of the same bat, NSS also calculated a relative abundance of bats to get a more realistic idea of the actual bat numbers. However, these numbers are relative and will not be fully accurate. With the relative abundance calculation, the goal was to determine a lower limit activity rating for the bats on site. The assumption NSS used was that no more than one bat per species group per minute was present.

- The reason for including a wind threshold calculation for each monitoring station was based on the assumption that bats do not fly at high wind speeds and the lower the wind speed, the higher chance of bat activity.

- Assumptions in the turbine risk assessment:

  - For the Banna Ba Pifhu site, the location of the wind turbines was linked to the monitoring stations, specifically, the distance of the turbine to delineated riparian zones. The assumption is that riparian zones or water bodies are important for foraging behavior at the Banna Ba Pifhu site.

  - Only one other wind energy project site was used in comparing this site. The assumption is that the other site, situated within the same parameters in the Southern Cape is considered the norm. The Banna Ba Pifhu site was therefore given a high rating, as it is has a higher activity index than the compared site. This may change once the 12 month monitoring is completed.

  - A high score has been given in the limitations score due to the lack of data available to interpret the seasonal variation.

- Due to the limited amount of South African literature on the impacts of wind farms on bats, it is assumed that findings in international literature can be applied to the site where appropriate.

- For foraging, the assumption was made that the whole site is a prime foraging ground based on the google imagery (**Figure 7-24**). Intensive fieldwork later in the monitoring year will assist in confirming this.

7.1.3.3.2 Limitations

Since only a third of the monitoring has been completed at the time of compiling this report, a number of items in the data interpretation couldn't be performed. These include:

- Roost survey scoring couldn't be done in the turbine risk assessment. A high default score was given. This may change in the final May 2013 report.

- Evidence of seasonal migration couldn't be analysed as inadequate data are available to determine the difference in bat activity from season to season. A default high score was given in the turbine risk assessment. This may change in the final 2013 report.

7.1.3.4 <u>Other</u>

- One of the objectives of the EWT 3rd draft guidelines is to estimate the flying height of bats. It must be emphasised that this is very much an estimation, due to the following reasons:

  - The sensitivity of the microphones varies in different weather conditions; therefore, it is difficult to say how far the bat was from the microphone.

  - The microphones are omni-directional, hence, there is no way to tell if the bats recorded were flying vertically or horizontally from the microphone.

  - The calls of different bats travel different distances, hence, lessoning the degree of accuracy for which to tell bat flying heights.

- On windy nights, some bat passes may not be detected by the bat detectors due to wind noise on the microphone, therefore, there may be under-estimate of bat activity on windy nights.

- Impact assessment: All impact assessment scores were given a low confidence rating as the monitoring results only represent two seasons.

- Recent consultation with other bat specialists during a Bat Mitigation Workshop held on the 1st October 2012 may affect the recommended mitigation measures in the final report.

7.1.4 Information Sources

7.1.4.1 Literature Review

To understand the potential impacts to bats it is important to understand the ecology and behaviour of bats and why they are at risk from wind farm developments.

7.1.4.1.1 Ecology of Bat Echolocation and Flight

For further details on the proposed wind energy project components, refer to Chapter 2 of the EIA (Project Description). Only those aspects that could affect bats are described below.

Bats use echolocation for orientation in space and many, especially those that hunt for flying insects, use echolocation to detect, identify, and localize prey (Schnitzler & Kalko, 2001). Moreover, insectivorous bats, which make up the majority of southern African bat species (Monadjem *et a*l., 2010), have adapted various flight strategies to facilitate effective nocturnal foraging.

Perceptually, bats are constrained by their sensory capabilities (e.g., echolocation, vision, olfaction, passive listening) to detect, classify, and locate prey in the vicinity of clutter-producing background targets such as twigs, foliage, or the ground (Schnitzler & Kalko, 2001). Two different echolocation systems – high and low duty-cycle echolocation – evolved independently in the Chiroptera (Eick *et al*., 2005). Low duty-cycle echolocation bats emit narrowband or broadband sound pulses separated by inter-pulse intervals that are much longer than the duration of the emitted pulses. High duty-cycle bats emit long, narrowband pulses that are separated by much shorter inter-pulse intervals.

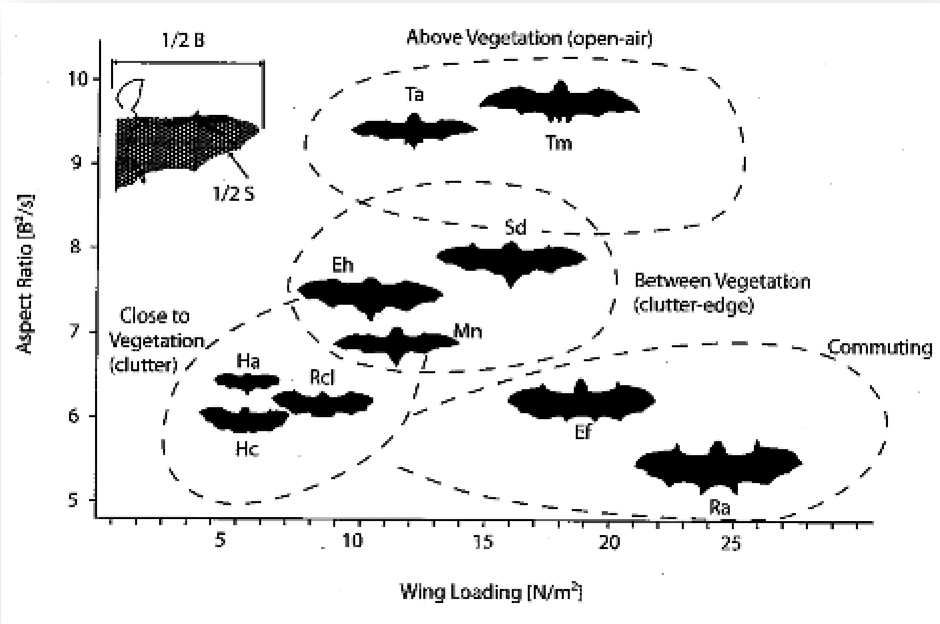
Broadband, low duty-cycle, frequency-modulated (LD-FM) echolocation pulses typically sweep downward through as much as an octave for a short duration of time (Schnitzler & Kalko 2001). LD-FM signals are less suited for the detection of distant and/or weak echoes, because the neuronal filters are activated for only a short time (Schnitzler & Kalko, 2001). Narrowband, low duty-cycle pulses composed of constant frequency (LD-CF) or shallow frequency-modulated (LD-QCF) components are not suitable for localisation of a hunted target, but are well suited to detection, because they activate the neuronal filters of the corresponding narrow frequency band during the entire echo (Schnitzler & Kalko, 2001).

In contrast to low duty-cycle bats, Doppler-shift compensation combined with a specialised auditory system enables constant frequency high duty-cycle (HD-CF) echolocating bats to localise and classify fluttering insects in dense (cluttered) habitats (Schnitzler & Kalko, 2001).

Mechanically, bats are constrained by their flight abilities (Norberg & Rayner, 1987). For instance, bats that forage in or near clutter require manoeuvrability to catch insects while avoiding collisions with the background clutter. Conversely, bats that forage high above the tree canopy are highly adapted for speed and agility. As such, bats can be classified into three foraging groups: clutter,

clutter-edge and open-air bats (Monadjem *et al*., 2010). Neuweller (2000) illustrates the adaptations of wing shape and the resulting flight style to different foraging habitats in **Figure 7-3**.

Foraging insectivorous bats must detect, classify, and localize an insect and discriminate between echoes of prey and echoes of unwanted targets such as twigs, foliage, or the ground, referred to as clutter echoes, or simply "clutter." Schnitzler and Kalko (2001) have categorized microchiropteran bats into guild structures according to habitat type, foraging mode, and diet. In the South African context and relevant to the current study, regarding mortality predictions for wind farm developments, the long-term monitoring project will be focusing on aerial foraging insectivorous bats that fly in cluttered and uncluttered space, with particular focus on bats hunting or migrating in open, uncluttered space, high above the ground. These types of bats are the ones most likely to face negative impacts as a result of wind turbine developments.



Legend:

Ta = *Tadarida aegyptiaca*
Tm = *Taphozous mauritianus*
Eh = *Eptesicus hottentotus*
Sd = *Scotophilus dinganii*
Mn = *Miniopterus natalensis*
Ha = *Hypsugo anchietae*
Rcl = *Rhinolophus clivosus*
Hc = *Hipposideros caffra*
Ef = *Epomops franqueti*
Ra = *Rousettus aegyptiaca*

Figure 7-3: Adaptations of Wing Shape and Foraging Habitats (adapted from Neuweller, 2000)

7.1.4.1.2 Bat Flight Heights

There is not enough detailed information available on bat flight heights internationally, and certainly not in South Africa, to make predictions on mortalities based on this literature. What we do know, is some facts on bat foraging ecology (as discussed in Section 7.1.3 above) and the results of specific studies conducted in the USA, Canada and Europe and unpublished results from two existing experimental wind farms in South Africa. Some examples of such research include:

- Jensen & Miller (1999) recorded *Eptesicus serotinus* foraging at average heights of 6.8m and 10.7m respectively at two different sites in Europe.

- Some groups of bats have been reported to migrate at altitudes greatly exceeding 100 meters (Altringham 1996).

- Allen (1939) reported that bats observed migrating during daylight hours over Washington D.C. flew at heights between 46 and 140 m above the ground.

- Van De Sijpe (2008) reported that trawling pond bats (*Myotis dasycneme*) fly at a median height of 43 cm and Daubenton's bats (*M. daubentonii*) at a median height of 24 cm.

- Williams, *et al*. (1973) recorded the Free Tailed Bat, *Tadarida brasiliensis*, flying in groups at heights of over 3000 m above ground level. Moreover, McCracken (1996) not only corroborated the findings of Williams *et al.* (1973) but also recorded foraging behaviour and feeding buzzes of *Tadarida brasiliensis* at heights between 200 m and 800 m.

As Mitchell-Jones and Mitchell-Jones (Date unknown) summarise from literature, there is very little actual assessment information available regarding bat flight heights, but there are some concerns:

- Commuting bats may fly higher than when foraging.
- Bats that are flying high may not be echolocating.
- Heights when given in literature were mostly observed - rarely measured
- As an average:
  - Most small bats flying in cluttered habitats flew within 0-10 m of the ground.
  - Anecdotal records for large bats ranged from 10-120 m above ground level.

The question of whether many smaller, or fewer bigger turbines, cause less impacts on bats was posed to NSS. NSS's desktop review has revealed that there is evidence to suggest that larger turbines cause higher mortalities in bats, however, site specific location of turbines in terms of sensitive habitats cannot be overlooked. The following literature is of relevance:

- In terms of turbine design, Rydell *et al* (2010) discusses how increased rotor diameter increases bat fatalities. The mortality increased with turbine tower height and rotor diameter but was independent of the distance from the ground to the lowest rotor point.

- According to NWCC (2010), early turbines were mounted on towers 18-25 m in height and had rotors 15-18 m in diameter that turned 60–80 revolutions per minute (rpm). Today's land-based wind turbines are mounted on towers approximately 80 m and higher in height with rotors 45-117 m in diameter, resulting in blade tips that can reach over 130 m above ground level. Rotor swept areas now exceed 1 acre and are expected to reach nearly 1.5 acres within the next several years. Even though the speed of rotor revolution has significantly decreased to 11–28 rpm, blade tip speeds have remained about the same; under normal operating conditions, blade tip speeds range from 222 – 292 km/h. Wider and longer blades produce greater vortices and turbulence in their wake as they rotate, posing a potential problem for bats in terms of barotrauma.

- Turbines with 65 m high towers caused more fatalities of migratory bats than turbines of 50 m even when bat activity was lower at the high towers than at the low towers (Baerwald & Barclay 2009).

Preliminary unpublished research from turbines in South Africa are showing bat mortalities, hence we know that certain species such as *Tadarida aegyptiaca* and *Neoromicia capensis* are flying within rotor sweep height.

7.1.4.1.3 Bats and Weather

There is no doubt that weather patterns can influence bat activity. The following literature is available on the subject:

- Bats restrict their flight activity during periods of rain, low temperatures, and strong winds (Eckert 1982; Erickson and West, 2003).
- Studies at proposed and operating wind facilities have also documented lower bat activity during high (usually > 6.0 m s–1) wind speeds (Reynolds, 2006, Horn *et al.*, 2008).
- Fenton *et al.* (1977) found that rain tended to suppress bat activity, although the timing of the rain was important. Since insects remained active in the rain, they suspected that the responses of the bats to rain reflected problems of thermoregulation associated with wet fur, and the effect of multiple echoes and attenuation of high-frequency sound on echolocation.
- Voigt *et al*. (2011) found that flight metabolism increased twofold when bats were wet, or when they were additionally exposed to rain. Therefore, they concluded that bats may not avoid rain only because of sensory constraints imposed by raindrops on echolocation, but also because of energetic constraints.
- Most species have distinct preferred foraging areas, which they abandon only when seasonal insect scarcities or major changes in prey populations force them to move to a different foraging habitat (Neuweiler, 1989).
- Paige (1995) showed that the seasonal cave dwelling Eastern Pipistrelle, *Pipistrellus subflavus*, tracks barometric pressure metabolically and it uses pressure as a cue for predicting the relative abundance of aerial insect prey outside the roost. Barometric pressure tracking affords bats an opportunity to conserve limited energy and make appropriate foraging decisions. Barometric pressure tracking is viewed as an alternative evolutionary strategy to torpor and may be a widespread phenomenon among insect-feeding bats that roost deep within caves.
- Whether moonlight/moon illumination levels can have an effect on bat activity patterns is uncertain, it appears to be species and habitat dependent – studies vary (e.g. Hecker and Brigham, 1999; Elangovan and Marimuthu, 2001).

It is hoped that the current bat monitoring for the Banna Ba Pifhu site will hopefully reveal how the bats behave under different weather conditions. This will assist in developing site specific mitigation measures. Baerwald *et al*. (2011) state that in addition to monitoring bat activity in relation to wind speed, temperature and humidity and to maximize the reduction of bat fatalities, operators of wind energy facilities could incorporate migratory bats' response to environmental variables, such as barometric pressure and fraction of moon illuminated, into their existing mitigation strategies.

7.1.4.1.4 Bat Foraging Distances

Foraging distances are not very well documented; however, the following information was found:

From South Africa:

- Movements of 9 km have been recorded by one individual male *Nycteris thebaica* (Monadjem, 2005)
- Jacobs and Barclay (2009) have shown that *Scotophilus* sp. bats can cover between 1 – 3 km during foraging.

Internationally:

- Leisler's bats *Nyctalus leisleri* commuted directly to foraging sites up to 13.4 km away at speeds often exceeding 40 km/h (Shiel *et al.,* 2006; Shiel *et al.,*1999).
- *Myotis grisescens* (Gray Bat) tend to forage over extensive ranges, averaging 12.5 km but ranging from 2.5 km to 35.4 km (LaVal *et al*., 1977).
- In a study tracking 21 female *Miniopterus schreibersii* (Schreiber's long-fingered bat) bats for 4 nights, for about 6 hours, each bat flew far from the roost (4.1 to 29.2 km) to forage on several small feeding areas (Vincent *et al*., 2011).
- Radio-telemetry revealed intense foraging activity in urban areas as well as in broad-leaved woodlands, as far as 30 km from the roost (Lugon *et al*. 2004).
- In a lowland agricultural area where the habitat suitable for foraging was extensive, the mean distance between the roost and the foraging areas as recorded by monitoring marked pregnant bats was 1.8 km and the maximum recorded distance was 5.1 km. These distances were reduced to 1.3 km and 3.7 km respectively during lactation (Racey and Swift, 1985).

7.1.4.1.5 Bat Migration in SA

Although much research is needed into the movement patterns of South African bat species, there is evidence of long-distance migration and seasonal movement of bats in South Africa. *Miniopterus natalensis* (Natal Long-fingered Bat) is known to migrate up to 260 km between their summer maternity caves and caves used for mating and hibernation during the winter months. (Van der Merwe, 1975) *Myotis tricolor* (Temminck's Myotis) may undertake seasonal migrations similar to that of *M. natalensis* although details are not known (Monadjem *et al*, 2009). One frugivorous bat species, *Rousettus aegyptiacus* (Egyptian rousette) is a gregarious cave-dweller also thought to move distances of 50 to 500 km (Monadjem *et al*., 2010; Herselman & Norton, 1985).

7.1.4.1.6 Bats and Wind Energy

Wind energy is emerging as a significant component of energy markets in a number of regions, with the USA, Spain and China being the biggest players (SAWEA, 2010). However, it has been estimated that between 33000 and 111000 bats may be killed annually by wind turbines in the Mid-Atlantic Highlands of the USA by 2020 (Kunz *et al*., 2007). The cumulative impacts of such mortality on affected species of bats could have long-term population effects (Kunz *et al*., 2007). Furthermore, in Europe, isotope analysis has revealed that wind farms don't only affect local bat populations but may also cause fatalities of bats from geographically distant populations – up to and possibly beyond 1000 km away (Voigt *et al.*, 2012).

Although considerable progress has been made in recent years towards better understanding the problem, bat fatalities at wind turbines is still a major concern. During a study by Arnett *et al*. (2009), 10 turbines monitored over a period of 3 months showed 124 bat fatalities in South-central Pennsylvania (USA). Cumulatively, turbines may have a catastrophic long term effect on bat populations if such a collision rate persists. It is, however, important to note, that the number of fatalities will vary greatly depending on the habitat and area where the wind farm is located, and the number can also be significantly decreased by effective mitigation measures.

Most documented impacts include:

- Direct collision;
- Barotrauma (mortality due to damage to bats' lungs caused by sudden change in air pressure close to the turning turbine blade (Baerwald *et al*., 2008);
- Loss of foraging habitat (either due to wind farm construction or because bats avoid the wind farm area);
- Barrier effect on commuting and migration routes; and
- Emission of ultrasound by wind turbines (probably limited).

It is the potential barrier effect of WEFs, direct collisions with blades and barotrauma that are seen to present the greatest threats to bats, especially migratory species. The very latest research from Iowa, USA strongly suggests from forensic pathology examinations that traumatic injury (collision) is the major cause of bat mortality at wind farms and, at best, barotrauma is a minor etiology. (Rollins *et al.,* 2012). The results from Horn *et al*. (2008) indicate that bats 1) approached both rotating and non-rotating blades, 2) followed or were trapped in blade-tip vortices, 3) investigated the various parts of the turbine with repeated fly-bys, and 4) were struck directly by rotating blades.

Although considerable progress has been made in recent years towards better understanding bat fatalities at wind turbines, the impact caused largely remains unquantified and unclear. It has been estimated that between 33000 and 111000 bats may be killed annually by wind turbines in the Mid-Atlantic Highlands USA by 2020 (Kunz *et al*., 2007). The cumulative impacts of such mortality on affected species of bats could be devastating, especially considering other current impacts on bats, such as White Nose Syndrome (WNS) in Europe and the USA (Boyles *et al*., 2011) and worldwide habitat threats (Mickleburgh *et al*., 2002). If mortality of bats associated with WNS and wind turbines continues unabated, we can expect noticeable economic losses to North American agriculture in the next 4 to 5 years (Boyles *et al*., 2011). In a single study by Arnett *et al*. (2009), 10 turbines monitored over a period of three months showed 124 bat fatalities in South-central Pennsylvania, USA. Also, unpublished data from experimental turbines in South Africa have provided evidence of mortality of bats.

If bats can echolocate, why can they not avoid the turbines and ultimately death caused by them? Cryan and Barclay (2009) reviewed hypothesized causes of bat fatalities at turbines, with all falling into two general categories—proximate and ultimate. Proximate causes explain the direct means by which bats die at turbines and include collision with towers and rotating blades, and barotrauma.

Ultimate causes explain why bats come close to turbines and include three general types: random collisions, coincidental collisions, and collisions that result from attraction of bats to turbines (Horn *et al*., 2008). The random collision hypothesis posits that interactions between bats and turbines are random events and that fatalities are representative of the bats present at a site. Coincidental hypotheses posit that certain aspects of bat distribution or behaviour put them at risk of collision and include aggregation during migration and seasonal increases in flight activity associated with feeding or mating.

Kunz *et al*. (2007) identified eleven hypotheses regarding how, when, where and why bats are being killed at WEFs. These are further discussed in Strickland (2011) and are summarised below:

a) <u>Linear Corridor Hypothesis;</u>

Modifications of landscapes during installation of wind energy facilities, including the construction of roads and power-line corridors, and removal of trees to create clearings (usually 0.5–2.0 ha) around each turbine site may create favourable conditions for the aerial insects upon which most insectivorous bats feed (Grindal & Brigham, 1998).

b) <u>Roost Attraction Hypothesis;</u>

Tree roosting bats may mistake the turbines for large trees and be attracted to them for roosting purposes.

c) <u>Landscape Attraction Hypothesis;</u>

Modifications of landscapes needed to install wind energy facilities, such as the construction of wide-access power corridors and the removal of trees to create clearings around each turbine site, create conditions favourable for insects upon which bats feed (Grindal & Brigham, 1998). Thus, bats that are attracted to and feed on insects in these altered landscapes may be at an increased risk of being killed by wind turbines.

d) <u>Low Wind Velocity Hypothesis;</u>

Fatalities of aerial feeding and migrating bats are highest on nights during periods of low wind velocity (Arnett, 2005; Baerwald *et al*., 2008). Horn *et al*. (2008) showed that blade rotational speed was a significant negative predictor of collisions with turbine blades, suggesting that bats may be at higher risk of fatality on nights with low wind speeds

e) <u>Insect Attraction Hypothesis;</u>

Flying insects are attracted to the heat produced by nacelles of wind turbines (Ahlén, 2003). As bats respond to high densities of flying insects near wind turbines (Ahlén *et al*., 2007), the risk of being struck by turbine blades may increase.

f) <u>Visual Attraction Hypothesis;</u>

Bats and their insect prey are attracted to lights placed on wind turbines as required by the United States Federal Aviation Administration (FAA), or to the reflection from white turbines under moonlit conditions, thus increasing the chances of collision and fatality as bats feed on insects (Arnett *et al*., 2005).

g) <u>Acoustic Attraction Hypothesis;</u>

It is possible that bats are attracted to the swishing sounds produced by the rotating blades. However, there is no literature to support this. Alternatively, bats may become acoustically disoriented upon encountering these structures during migration or feeding.

h) <u>Echolocation Failure Hypothesis;</u>

Migrating and foraging bats may fail to detect wind turbines by echolocation, or miscalculate rotor velocity (Ahlén, 2003). If bats are unable to detect the moving turbine blades, they may be struck and killed directly

i) <u>Electromagnetic-Field Distortion Hypothesis;</u>

Bats rely on a magnetic compass to return to their home roost (Holland *et al*., 2006). If wind turbines produce complex electromagnetic fields in the vicinity of the nacelle, the flight behaviour of bats may be altered by these fields and thus increase the risk of being killed by rotating turbine blades.

j) <u>Decompression Hypothesis; and</u>

Bats flying in the vicinity of turbines may also become trapped in blade-tip vortices and experience rapid decompression due to changes in atmospheric pressure as the turbine blades rotate downward.

k) <u>Thermal Inversion Hypothesis.</u>

The altitude at which bats migrate and or feed may be influenced by thermal inversions, forcing them to the altitude of rotor swept areas (Arnett *et al*., 2005). The most likely impact of thermal inversions is to create dense fog in cool valleys, possibly concentrating both bats and insects on ridges, and thus encouraging bats to feed over the ridges on those nights, if for no other reason than to avoid the cool air and fog. Most turbines proposed for South Africa are situated on ridges; hence, this hypothesis could apply here.

South Africa is following the world trend and has made firm progress in establishing potential sites for wind farm development. Whilst most biologists would support the development of clean, renewable energy sources, such as WEFs in South Africa, the impacts that wind turbines may have on South African bats is largely unknown, due to a lack of research in the country and poor level of knowledge of bat abundance, locations of roost sites and foraging and migratory behaviour. Therefore, in order to integrate this cleaner energy alternative to South Africa, much research is needed – both pre-construction and post-construction. Given the limited knowledge of the ecology and biology of many bat species, and the absence of studies investigating the impact of wind farms on South African bat species, it is strongly recommended that a precautionary approach is adopted until more information has been amassed.

7.1.4.1.7 Conservation Significance of Bats in SA

Bats are among the most overlooked, yet economically important, non-domesticated animals, and their conservation is important for the integrity of ecosystems and in the best interest of both national and international economies (Boyles *et al*., 2011). Furthermore, bats are long-lived, highly mobile animals that fill numerous ecological and trophic roles, making them excellent indicators of habitat disturbance (Fenton & Ratcliffe, 2010). The Chiroptera is also the second-most species-rich order of mammals (second to Rodentia) with upwards 1200 species worldwide (Simmons, 2005) hence they are extremely valuable in terms of biodiversity.

Whilst the exact numbers of bat species change as research continues, Monadjem *et al*. (2010) reports that there are approximately 117 species of bats in the Southern African sub-region, of which 5 species have a global Red List status of Vulnerable and 12 are classified as Near Threatened (IUCN Red List Category 2011). More than 50 bat species occur in South Africa (Taylor, 2000; Friedman and Daly, 2004; Monadjem, *et al*. 2010). Of these known 50 species:

- 21 are listed as Least Concern (LC)
- 18 are listed as Near Threatened (NT)
- 6 are listed as Vulnerable (V)
- 2 are listed as Critically Endangered (CR)
- 3 are listed as Data Deficient (DD)

In other words, 58% of the South African species are at risk according to the National Red Data List (Friedman & Daly, 2004).

The reproduction rates of bats are much lower than those of most other small mammals, because usually only one or two pups are born per female annually and in some species females may only reproduce every two years (Taylor, 2000, Monadjem *et al.*, 2010). Bats are also relatively long-lived small mammals (many species living more than 20 years). These life-history traits result in very slow recovery rates of bat populations if they experience a major reduction in numbers.

7.1.4.1.8 Micro-Habitats

A number of habitats are preferred by bat species, either for foraging or roosting purposes. Some of the habitats that are looked for during a bat survey include the following:

Foraging Habitats:

- Delineated Riparian / Wetland zones: These areas serve as a foraging site for many bat species as these sites are considered to be biodiversity hotspots as invertebrates prefer this type of habitat for breeding. A number of riparian zones have been delineated on-site, refer to Chapter 5. **Figure 7-24** indicates the regional distribution of riparian and wetland areas, these all must be considered as potential foraging grounds for the bats recorded on site.

- Permanent water bodies: Insects also utilize these features as breeding grounds. The presence of insects attracts bats to these sites for foraging. Permanent water bodies found onsite are shown in (**Figure 7-23**).

- Arable or cultivated land: These areas may represent feeding areas for bats due to insects being attracted to irrigated lands. There isn't any extensive cropping onsite, most of the cultivated land is for grazing purposes.

- Thicket / Forests: Clutter or clutter-edge feeder bats may be attracted to the thicket areas onsite. These areas have been shown in Chapter 5.

Roosting Habitats:

- Buildings: Some bats (notably VESPERTILIONIDAE and MOLISSIDAE) like to roost in the eaves or on rough walls of buildings.

- Trees: Some bats (notably PTEROPODIDAE, EMBALLONURIDAE, NYCTERIDAE and VESPERTILIONIDAE) like to roost in certain trees such as palm trees or trees with rough bark.

- Caves / mines / tunnels: Large dimly lit subterranean caverns can support large colonies of bats (notably MINIOPTERIDAE, MOLISSIDAE, RHINOLOPHIDAE, HIPPOSIDERIDAE and PTEROPODIDAE).

- Overhangs / crevices / rocky outcrops: habitat types such as ridges and gorges will often support large numbers of bats (notably NYCTERIDAE, EMBALLONURIDAE, MOLISSIDAE, RHINOLOPHIDAE and VESPERTILIONIDAE) in small clusters.

7.1.4.2 Legislation Pertaining to Bats

7.1.4.2.1 International

There are various Conventions, Unions and Treaties in place for the protection of biodiversity. These include:

- Convention on Biological Diversity
- The Bonn Convention (on conservation of migratory species of wild animals)
- CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)
- Agenda 21 and Rio Declaration
- 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 (VU)
  - Endangered (EN)
  - Critically Endangered (CR)
- Being at an international level, these categories often don't meet the national conservation needs of certain species, therefore national lists are implemented.

7.1.4.2.2 National

Unlike in the UK and the USA, bats are not directly protected in South Africa. However, there are various Acts and Regulations relevant to the protection of fauna, including bats:

- National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA)
- NEMA: Biodiversity Act, 2004 (Act 10 of 2004)
- NEMA: Biodiversity Act, 2004: Threatened and Protected Species (TOPS) Regulations
  - A person may not carry out a restricted activity involving a specimen of TOPS without a permit.
  - However, the NEMA TOPS Regulations fail to recognise most bat species of conservation concern - only one bat species, the Large-eared Free-tailed Bat (*Otomops martiensseni*), is listed on the TOPS list.
- NEMA: Protected Areas Act, 2003 (Act 57 of 2003)
- National Policies, Guidelines and Inventories:
  - National Spatial Biodiversity Assessment (NSBA)
  - South Africa's National Biodiversity Strategy and Action Plan (NBSAP)
  - Red Data Species Listings according to IUCN categories at a National level, e.g. Birds; Mammals (Friedman and Daly, 2004); Frogs; Butterflies, etc.

7.1.4.2.3 Provincial

- General Provincial Biodiversity Guidelines
- Permits for capturing and releasing of bats, transporting bats, and conducting scientific research on bats are required by the Provincial Authorities.

7.1.4.2.4 Buffer Zones

Although well intended for conservation purposes, the issue of placing a standardised buffer on conservation important habitats, plant localities or animal roosts is a controversial one. The controversy is sparked by the following challenges:

- Often these buffer distances are based on very little scientific research, but rather on educated guesses.

- If a buffer is placed on a particular habitat, the success of that buffer working is dependent on the requirement of all species and ecosystems utilizing that habitat. Different species and ecosystems usually have different needs.

- If enough pressure exists for a particular development, buffers will be relaxed to accommodate that development.

- For non-linear conservation important areas, a radial buffer is presumed; however, often habitats will be far more suitable on one side of the area than the other. Therefore, a radial buffer may not be appropriate – it may be more appropriate to select specific patches of suitable habitat around the sensitive ecological entity that will ensure its survival.

- Not all South African provinces have developed any policy or guidelines addressing buffers. There are no South African guidelines for the consideration of bats in relation to wind farm developments. Therefore, one can extrapolate from other provinces and other country's guidelines, for instance:
  - Gauteng Department of Agriculture and Rural Development (GDARD, 2009) recommends a 500 m buffer on natural caves systems and a 200m buffer on Class 1 ridge systems and, 200 m buffer on conservation important vegetation areas, and 50 m on riparian edge; all of these are important bat habitats.
  - Guidelines such as the Eurobats Guidance and the Natural England Technical Note (Mitchell-Jones and Carlin, 2009) give some indication of buffer zones which may be applicable, in the absence of limits in South Africa:
    - The Eurobats Guidance (Rodrigues *et al*., 2008) propose a minimum distance of 200 m to forest edges where forest clearing and tree felling is necessary to establish a wind farm.
    - The Natural England Interim Guidance suggests a 50 m buffer from wind turbine blade tip to the nearest feature (tree top or house).

In conclusion on buffers and bats, appropriate site-specific buffers need to be selected by a qualified specialist for habitats important for bat conservation (whether it is for foraging or roosting) that will meet the requirements of the particular species or populations occurring in the area. Recommended buffer zones for bats in South Africa are being developed as part of the Bat Mitigation Workshop that was held on the 1st October 2012.

7.1.4.3 Methodology

7.1.4.3.1 Literature Review

A review of literature, legislation and the Likelihood of Occurrence (LoO) of specific species was conducted. The LoO was done according to the species distribution maps provided in Friedman and Daly (2004) and Monadjem *et al.* (2010). The LoO was categorised as follows:

- High LoO – the species has been historically confirmed on or near the site
- Moderate LoO – the species is within the higher probability modelled distribution of potential occurrence (Monadjem *et al.*, 2010).
- Low LoO – the species is within the lower probability modelled distribution of potential occurrence (Monadjem *et al.*, 2010).
- Species definitely not occurring within the study area were not listed.

7.1.4.3.2 Fieldwork

Based on NSS's experience and on the Best Practice Guidelines (3rd draft) (Sowler & Stoffberg, 2012), the following fieldwork has been and will continue to be practised at the Banna Ba Pifhu site.

The bat monitoring at Banna Ba Pifhu site has and will cover more than the minimum required 15 – 25% of the total active bat season, with monitoring happening for most of the 12 months, with the following main monitoring periods:

- Mid April 2012 to end June 2012 (Autumn) – **complete**
- End June 2012 to mid August 2012 (Winter) - **complete**
- Mid August to Mid November 2012 (Spring)- **initiated**
- Mid December 2012 to mid April 2013 (Summer and Autumn)

The following monitoring techniques, in line with the requirements of the Best Practice Guidelines, were and will be employed during the monitoring:

7.1.4.3.2.1 Activity Surveys - Static monitoring at ground level and height

Four static monitoring sites were set up in mid April 2012, as per the Bat Monitoring Station localities HB1 – HB4 indicated in **Figure 7-6**. A summary of the stations is found in **Table 7-1**.

HB1, HB2 and HB4 use Wildlife Acoustics SM2 Songmeter Bat Detectors, and HB3 uses the Titley Electronics Anabat SD2 Bat Detector. The Wildlife Acoustics system was selected because of its effective recording, lower costs and weatherproof casings. The Anabat detector was already installed on site and was included into the long-term monitoring programme.

Two (2) different set up scenarios were deployed – monitoring at 10 m above ground on temporary masts at stations HB1 – HB3 and monitoring at 10 m and 60 m above ground at HB4. The detector is equipped with a stereo recording option, with a two-channel sample rate card. The two channels allowed for monitoring to take place at two different heights on the Met Masts. The left channel ultrasonic microphone was erected at 60 m and the right channel at 10 m. The detectors are powered by a 12V 7 Amp/hour battery and solar panel. Photographs of the set-up are shown in **Figure 7-4.**

Figure 7-4: Met Masts with the 192kHz SM2BAT Detector and Microphone at 10 m and 60 m respectively

At sites HB1 – HB3, the mono 384 kHz SM2BAT option, including a one-channel 384 kHz 16-bit sample rate card was used. This detector only has a left channel for a single ultrasonic microphone, but can record bats at higher frequencies. The left channel ultrasonic microphone connected to these detectors was erected at 10 m on temporary aluminium masts. The 384 kHz detector was powered by a combination of a 12 Volt 7Amp/hour battery and solar panel. Photographs of the set-up are shown in **Figure 7-5.** Strips of bristle brush or Perspex spikes were inserted on the microphone connector to reduce the risk of birds perching and damaging the microphones.

Figure 7-5: Temporary Mast with the 384kHz SM2BAT installed

Table 7-1: Summary of Monitoring Stations

STATION	HABITAT	HABITAT SENSITIVITY	DIST. RIPARIAN	DIST. WATERBODY	DAYS MONITORED	HEIGHT	EQUIP.
HB1	Riparian	High	0 m	138 m	111	10 m	SM2BAT
HB2	Thicket	High	52 m	123 m	101	10 m	SM2BAT
HB3	Riparian	High	25 m	118 m	73	10 m	Anabat
HB4 -10 m	Cultivated	Low	300 m	512 m	62	10 m	SM2BAT
HB4 -60 m	Cultivated	Low	300 m	512 m	62	60 m	SM2BAT

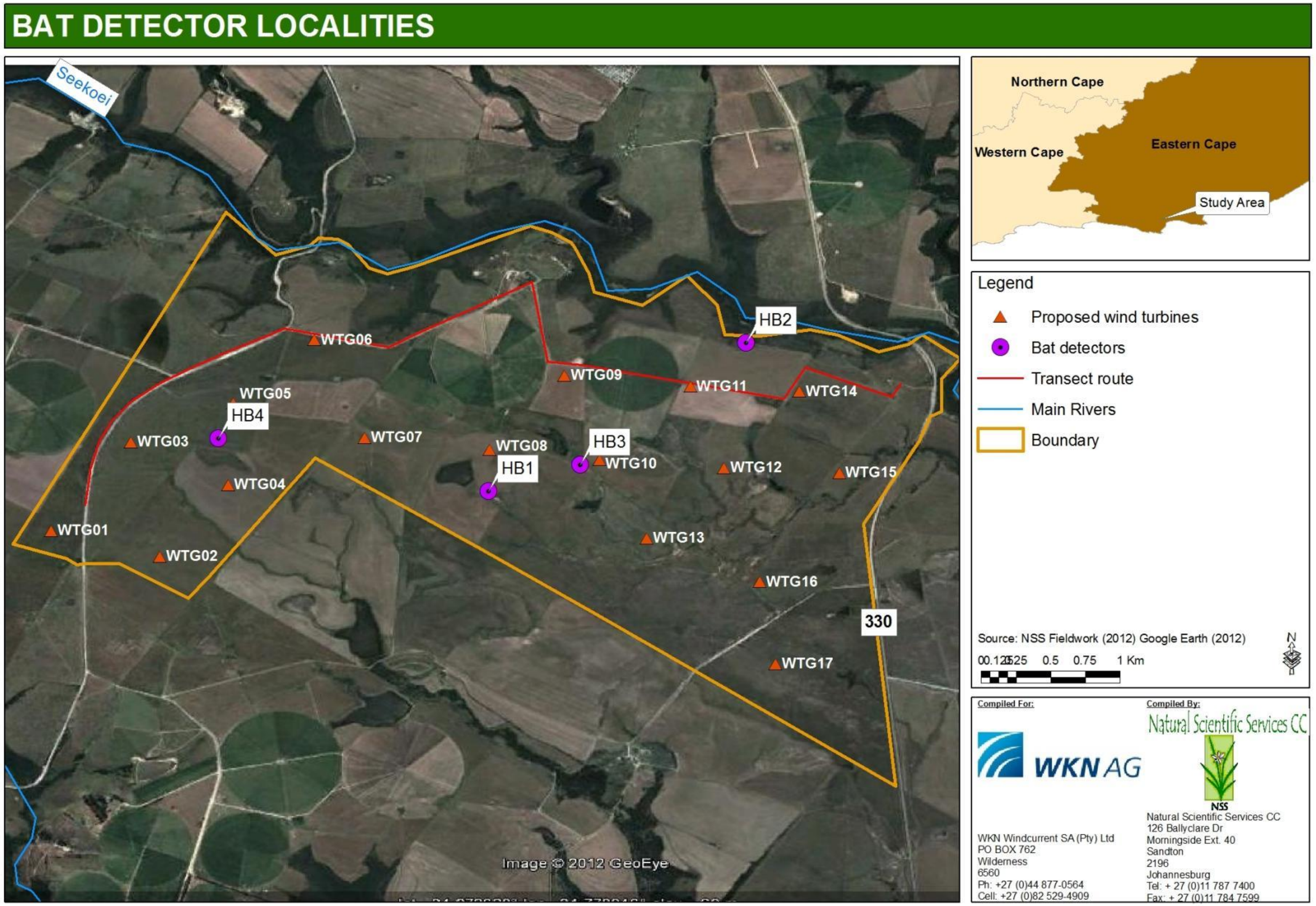


Figure 7-6: Location of Monitoring Stations at the Banna Ba Pifhu site

7.1.4.3.2.2 Roost Surveys- Identifying potential roost sites

By day, the main potential bat habitats on site, such as trees, ridges, gorges and rocky outcrops, farm buildings and culverts were and will be investigated by torch light for the presence of bats. Desktop research and discussions with local residents and farmers on potential known roost sites such as nearby caves is underway. Should any be discovered, these sites will be investigated in the field.

At a regional level, NSS has identified, through desktop research a number of known cave/ mine roosts within a 200 km radius of Banna Ba Pifhu site. NSS will attempt to visit some of these roost sites on subsequent visits.

7.1.4.3.2.3 Activity Surveys - Manual surveys & Mist-netting

Mist netting is planned to take place during the spring and summer field visits.

Two driven transect surveys were performed in autumn and winter using a Wildlife Acoustics EchoMeter 3 (EM3) handheld ultrasonic bat detector. The vehicle was driven at 10-20 km/h along a set route (**Figure 7-6**), whilst the front passenger held the detector at a constant height outside of the window. The route started at sunset and was driven for approximately 1 hour. The direction of the route was alternated over two nights per season where possible.

The transect bat calls are recorded in compressed .WAC files to later be converted. The EM3 also records the transect route and the point of each triggered event, allowing for easy mapping of these routes and findings.

7.1.4.3.3 Data Analysis / Interpretation

7.1.4.3.3.1 Bat Activity Index

Acoustic monitoring produces massive amounts of data, i.e. hundreds of gigabytes of ultrasonic call data. These call data were recorded by the SM2BAT as .WAC files onto four 32 GB SD cards for each detector and directly as Zero Crossing (.ZC) files from the Anabat. At the end of the monitoring period, NSS transferred the data onto a terabyte hard drive for analysis and storage.

The .WAC files were converted, using Wildlife Acoustics' Kaleidascope programme to both .WAV files and .ZC files for analysis in the following two ultrasound analysis software programmes:

- BatSound Pro by Petterssons. This software allows for the detailed analysis of .WAV sound files. Examples of bat calls of bats found in the study area using Bat Sound Pro are displayed in **Appendix A.**

- AnalookW Version 3.8s by Titley Electronics used for analysing large quantities of .ZC files.

A bat call consists of a series of ultrasonic sound pulses, with each species calling at a different sound frequency. Pulses within a bat call can also vary in their sound frequency and characteristics, although this variation is within a certain range associated with a certain bat species. Certain call parameters are used to identify a bat species from its echolocation call. These included pulse length, pulse bandwidth, pulse interval and pulse dominant frequency, of which peak frequency is the most commonly used. When a bat is approaching a prey insect, it will increase the rate of its echolocation pulses dramatically, and each pulse becomes shorter until it is difficult to distinguish the pulses using standard instrumentation. This method of increasing its echolocation resolution while homing in on its prey is referred to as a "feeding buzz".

Bat activity levels can either be measured by the number of bat pulses analysed using the AnalookW Scan function or bat Aactivity can also be calculated in the following way:

Activity Index = Bat passes / unit time

** Bat Pass = 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.

The best method for South African studies is still being debated amongst the various specialists. The objective is to develop a standardised protocol. At NSS, the "bat passes" approach will be employed in the following manner:

The aim of the monitoring is to determine bat presence or absence, activity patterns and the risk levels to bats. In order to do this, static detectors are deployed that produce huge quantities of data that takes many hours of data analysis time. The aim, is not to do a detailed study on the call structure of individual species, therefore, grouping bats according to their call structure and risk levels seems more appropriate, and can save a tremendous amount of time and reduces the risk of making identification errors. The EWT 3rd draft guidelines contain a risk level table for the various bat families and genera (**Table 7-2**).

Table 7-2: The likelihood of the risk of fatalities affecting bats, based on broad ecological features, excluding migratory behaviour (Sowler & Stoffberg, 2012).

FAMILY / GENUS	RELATIVE STATUS	LIKELY RISK OF IMPACT FROM WIND TURBINE BLADES*
PTEROPODIDAE	Common – restricted distributions Some species known to move large distances	**Medium – High**
MOLOSSIDAE	Common – widespread Species fly high enough to come into contact with turbine blades.	**High**
EMBALLONURIDAE	Common – restricted distributions Species fly high enough to come into contact with turbine blades	**High**
RHINOLOPHIDAE	Species with restricted distributions	**Low**
HIPPOSIDERIDAE	Species with restricted distributions	**Low**
NYCTERIDAE	Common – widespread and restricted distributions	**Low**
MINIOPTERIDAE	Common – widespread and restricted distributions Some species known to move large distances	**Medium – High**
VESPERTILIONIDAE	Common – widespread and restricted distributions	
Pipistrellus	Species with wide or restricted distributions	**Medium**
Hypsugo	Wide, but sparse distribution	**Low**
Nycticeinops	Common throughout restricted distribution	**Medium**
Neoromicia	Species with wide or restricted distributions	**Medium – High**
Kerivoula	Species with wide but sparse distributions	**Low**
Scotoecus	Sparse distributions	**Medium – High**
Cistugo	Restricted distributions – species endemic to Southern Africa or South Africa	**Low**
Laephotis	Species with restricted distributions	**Low**
Glauconycteris	Species with restricted distributions	**Medium – High**
Myotis	Species with wide or restricted distributions; some species may move large distances	**Medium – High**
Scotophilus	Some with widespread or restricted distributions	**Medium – High**
Eptesicus	Wide, but sparse distribution	**Medium**

**Direct collision and/or barotraumas*

NSS proposes the following groups to be used for the data analysis:

a. **Species Group A:** Bats that echolocate with calls having frequencies ranging from 10 to 32 kHz with a narrow bandwidth and intermediate to long duration. These bats are mostly all at a **high** risk of fatality due to wind turbines. Examples of species within this group include:

i. The Molossidae Family - *Chaerephon pumilus* (Little free-tailed bat) and *Tadarida aegyptiaca* (Egyptian free-tailed bat); and

ii. The Emballonuridae Family - *Taphozous mauritianus* (Mauritian tomb bat).

b. **Species Group B:** Bats that echolocate with calls having frequencies ranging from 29 to 42 kHz with a narrow to intermediate bandwidth and intermediate duration. These bats are mostly all at a **medium to high** risk of fatality due to wind turbines. Examples of species within this group include:

   i. *Neoromicia capensis* (Cape serotine);

   ii. *Scotophilus dinganii* (Yellow-bellied house bat); and

   iii. *Eptesicus hottentotus* (Long-tailed serotine).

c. **Species Group C**: Bats of the families Miniopteridae and Vespertilionidae that echolocate with calls having frequencies ranging from 40 to 75 kHz with a narrow to broad bandwidth and short duration. These bats are mostly all at a **medium to high** risk of fatality due to wind turbines AND several of these bats are of **conservation importance (CI)**. Where species of CI are suspected, these calls must be analysed more carefully and mist-netting must be done so their presence or absence can be confirmed. Examples of species within this group include:

   i. *Cistugo leseuri* (Leseur's wing-gland bat)
   ii. *Miniopterus natalensis* (Natal long-fingered bat)

   iii. *Myotis tricolor* (Temminck's myotis)

   iv. *Pipstrellus hesperidus* (Dusky pipistrelle)

d. **Species Group D**: Bats of the Rhinolophidae and Hipposideridae families with echolocation frequencies between 34 to 210 kHz. These bats are mostly all at a **low** risk of fatality due to wind turbines AND several of these bats are of **conservation importance (CI)**. Where species of CI are suspected, these calls must be analysed more carefully and mist-netting must be done so their presence or absence can be confirmed. Examples of species within this group include:

   i. *Cleotis percirvali* (Percival's short-eared trident bat)

   ii. *Hipposideros caffer* (Sundevall's leaf-nosed bat)

   iii. *Rhinolophus capensis* (Cape horseshoe bat)

   iv. *Rhinolophus clivosus* (Geoffroy's horseshoe bat)

   v. *Rhinolophus swinnyi* (Swinny's horseshoe bat)

e. **Species Group E**: Bats, excluding those of the Rhinolophidae and Hipposideridae families that echolocate with calls having peak frequencies ranging from 85 to 160 kHz. These bats are mostly all at a **low** risk of fatality due to wind turbines. Examples of species within this group include:

i. *Kerivoula lanosa* (Lesser woolly bat)

ii. *Nycteris thebaica* (Egyptian slit-faced bat)

7.1.4.3.3.2 Relative Abundance Index

A relative abundance index was also calculated using the ten minute interval data. Where the bat activity index above can be considered to be an "overestimation" of bat activity, as many bat calls can belong to one bat in a ten minute interval, this relative abundance calculation underestimates by assuming that no more than 10 bat passes can occur during a ten minute interval, the equivalent of a bat pass per minute. This result is meant to indicate the lower range of bat activity on site per night.

7.1.4.3.3.3 Wind Speed Threshold

There are a number of formulae available to determine the statistical significance of a scientific argument. Based on a visual analysis of the results, the knowledge of the proposed project and international literature, it was important to determine the relationship between bat activity and wind speed. Therefore, NSS decided to use a simple left-tailed hypothesis test to determine the wind speed threshold of each species group recorded at the different stations. The wind speed threshold represents the maximum wind speed value that the bats on site fly in, assuming that the lower the wind speed the higher the bat activity. To determine the significance rating the following statistical method was used:

Step 1: Determine the Experiment

The experiment for this project is to determine the wind speed range that the majority of the bat calls were recorded at, with the assumption that the lower the wind speed the more bat activity there will be.

At the Banna Ba Pifhu site, bat passes were recorded up to a wind speed of 16.66/sec and the highest wind speed recorded at the site during the monitoring period at night was 21.58/sec.

Step 2: Null Hypothesis (H0)

Both Baerwald *et al.* (2008) and Arnett *et al.* (2010) have shown significant decreases in bat mortality at WEFs when cut-in wind speeds of turbines are increased to between 5.0 m/s to 6.5 m/s.

The speed of 5 m/s was the starting point for our testing where H0 >=5. The range of wind speeds tested varied from station to station until the correct significant value was achieved.

Step 3: Determine Confidence Level

A confidence level of 95% (p-value = 0.05) was used to determine the wind speed threshold for each monitoring station. The 95% confidence level means that for every twenty 10-minute samples, only one sample would fall outside of the wind speed range.

<u>Step 4: Determine Data</u>
The bat data were analysed according to date, time, species group and number of bat passes; this was done for every 10 minutes for each monitoring station. Wind speed data were supplied by WKN Windcurrent at 10 min intervals at 25 m, 50 m and 75 m. The 25 m height wind speeds were paired with the 10 m height bat data and the 50 m wind speed were paired with the 60 m height bat data. The 75 m wind speed data were not utilized as the data set was incomplete.

Each station was analysed separately to ensure different habitat types could be included as a variable when determining the appropriate mitigation.

<u>Step 5: Calculate the Mean Value</u>
All the wind speed recordings were added together for both sets of data and divided by the sample size to give the mean/average (μ).

<u>Step 6: Calculate the Sample Standard Deviation</u>
The Sample Standard Deviation (s) was calculated in Excel using the STDEVP formula, which expands to:

$$\sqrt{\frac{\sum(x-\bar{x})^2}{n}}$$

<u>Step 7: Convert the Mean to a Standard Normal Value (Z-score)</u>

- Subtract the value from H0 (?) from your observed mean μ.
- Divide the result by the sample standard deviation s.

<u>Step 8: Convert the Z-score to a P-value to Determine the Confidence Level (Significance).</u>
This value comes from a table of the normal distribution. For the purpose of this project a formula obtained from a website was used to calculate the left-tailed p-value (http://easycalculation.com/statistics/p-value-for-z-score.php). The formula on the website expands to:

$$P(Z \le z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{\frac{-u^2}{2}} du$$

A p-value of 0.05 or smaller has a confidence level of 95% and up.

7.1.4.3.4 Impact and Risk Assessment

The potential for impacts on bats by the proposed wind energy facility is evaluated in terms of impacts related to the three main behavioural activities exhibited by bats:

- Roosting impacts:
  - roosting habitat destruction or disturbance
  - attraction of bats to towers for roosting and due to curiosity and therefore fatalities due to collision or barotrauma.

- Foraging impacts:
  - displacement from foraging habitat due to wind turbine operation; and
  - bat fatalities due to collision or barotrauma during foraging activity.

- Migration impacts:
  - bat fatalities due to collision or barotrauma during long distance seasonal migrations

The general impacts were assessed according to the criteria laid out in Chapter 4 of this EIA.

To calculate the risk to bats specifically for each turbine, a risk assessment was conducted for each turbine on site using the data recorded during the monitoring period. But firstly, the wind turbine had to be linked to the appropriate data, or in this case monitoring station. For the Banna Ba Pifhu site two heights were utilised, 10 m (canopy height) and 60 m (nacelle height). For each turbine, the distance of the riparian zone was utilised to pair the turbine with a 10 m monitoring station to assess the risk of the bats flying at canopy height. The riparian zone delineation used for the distance calculations is shown be found in Chapter 5 of this EIA. Each variable was then given a score from 1 – 5 and the average of the scores determined the risk rating in order to identify the wind turbines with the highest risk to bats on site, according to the canopy (10 m) readings. A second risk rating was determined using the HB4 (60 m) score from the microphone representing nacelle height (60 m). The mitigation measures were then awarded accordingly. **Table 7-3** below indicates the variables and their associated risk scores. The risk assessment scores are shown in **Table 7-4**

Table 7-3: Intensity / Risk Assessment Rating Variables and Scoring

NO	VARIABLE	COMMENTS	SCORE 0	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
1	Footprint Habitat	This is the habitat the proposed turbine will be placed.	-	**Low sensitivity** -Cultivated Land	-	**Medium Sensitivity** -Transformed Land	-	**High Sensitivity** - Renosterveld -Riparian -Thicket
2	Distance from Riparian Zone (m)	Measured in Google earth using delineation in Chapter 5. Based on relative buffer zones.	>500	350-500	200-350	100-200	50-100	0-50
3	Distance from permanent water body (m)	Measured in Google earth using delineation in Chapter 5 as well as remote sensing. Based on relative buffer zones.	>500	350-500	200-350	100-200	50-100	0-50
4	Site comparison	A score for the overall passes per date was given in comparison to similar sites analysed by NSS. For the Banna Ba Pifhu site a true site comparison could not be conducted as the monitoring is not complete. This score is likely to change in the final assessment.	-	**Very Low:** >50% less	**Low:** 10-50% less	**Average:** The same or within 10% of comparison on either side	**High:** 10-50% more	**Very High:** >50% more
5	Monitoring Stations risk	This is calculated from the average of the variables below.	-	Negligible	Low	Medium	High	Very High
5.1	Activity Index (Bat Passes per date)	The values and ranges are site specific and can differ from project to project.	-	0 – 25	26 – 50	51 – 75	76 – 100	>100
5.2	Relative abundance	The values and ranges are site specific and can differ from project to project.	-	0 -15	16 – 30	31 – 45	46 – 60	>60
5.3	Threshold Wind	This is rated according to the highest wind speeds that the majority of bats have been	<4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	>8 m/s

NO	VARIABLE	COMMENTS	SCORE 0	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
		recorded to fly in. The values and ranges are site specific and can differ from project to project.						
5.4	Species of Concern	This is scored according the recorded presence of highest conservation important species.	-	LC	NT	VU	EN	CR
5.5	Species at Risk	This gives a score according to the species group composition for each monitoring station. The species group with the highest composition at height (60m) will be considered at each 10m monitoring station, in the case of the Banna Ba Pifhu site, the composition of the Species Group A bats were scored.		0-25%	25-50%	50-60%	60-80%	80-100%
5.5	Roosting	The roosting score will be calculated by results of the roost surveys to be done in Spring and Summer. Species group, conservation importance and distance will be taken into account. For this stage of the project a high score has been given as a default until more information is available to make an informed decision. The values and ranges are site specific and can differ from project to project.	-	-	-	-	Default	-
5.6	Evidence of seasonal migration	The difference in species group bat passes and relative abundance per season is strong evidence of seasonal migration taking place	-	-	-	-	Default	-

NO	VARIABLE	COMMENTS	SCORE 0	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
		on site. The higher the difference the higher the score given. As only 2 seasons have been assessed, this variable has been given a default high score The values and ranges are site specific and can differ from project to project.						
5.7	Limitations	Each station will be given a score based on the limitations and problem experienced during monitoring. The higher the limitation the higher the score. A default high score has been given as only a third of the monitoring has been done for the project which limits the outcomes used to recommend mitigation measures. The values and ranges are site specific and can differ from project to project.	-	-	-	-	Default	-

Table 7-4: Risk Assessment scores

SCORE	RATING	RISK RATING
5	Very High	Impacts to the bat population from this turbine will be devastating.
4	High	Impacts to the bat population will definitely occur at this turbine and high fatality rates are expected.
3	Medium	Impacts to the bat population will definitely occur at this turbine and medium fatality rates are expected.
2	Low	Impacts to the bat population may occur at this turbine and few fatalities are expected.
1	Negligible	Impacts to the bat population will be negligible at this turbine.

7.1.5 Declaration of Independence

Declaration of Independence

BOX 7.1: DECLARATION OF INDEPENDENCE FOR BATS IMPACT ASSESSMENT

I Kate MacEwan declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Banna Ba Pifhu Wind Energy Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Kate MacEwan

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

7.2.1 Construction Phase

Clearing of land: Vegetation will need to be cleared in the footprint areas designated for the wind turbines. If the wind turbine is situated in an area associated with high insect presence or with the potential to house bats, this activity will have an effect on the bat population on site.

Artificial Lighting: Lighting at night may attract insects and therefore, bats. Some bats may also be deterred by artificial lighting.

7.2.2 Operational Phase

Operation of turbines: Sweeping turbine blades during operation have a risk of killing / disturbing bats through a number of documented ways (refer to **Section 7.1.4.1**). The longer the blade length of the turbine the larger the disturbance to the bats on site.

Artificial Lighting: Artificial lighting at the nacelle may attract insects and bats. This could increase the potential of bat fatalities for bats that are not affected by light. Some bat species will avoid the light completely. This will mostly affect species that forage at height.

Power lines: Bats may be electrocuted by utilising the power lines required for the WEF to connect to the power grid.

These are further discussed in the impact assessment in **Section** 7.4 and **Section** 7.5

7.3 DESCRIPTION OF AFFECTED ENVIRONMENT

7.3.1 Vegetation

7.3.1.1 Regional Vegetation

Regional and local habitats are important in interpreting the bat monitoring results.
There are two regional vegetation types in the Banna Ba Pifhu study area – predominantly the Humansdorp Shale Renosterveld, with Gamtoos Thicket found along the Seekooi Rivier on the Northern boundary of the project site (Mucina and Rutherford, 2006) (see Chapter 5).

7.3.1.1.1 Humansdorp Shale Renosterveld (FRs19)

Biome

Fynbos Biome

Vegetation & Landscape

Moderately undulating plains and hills supporting vegetation composed of low, medium dense graminoid, dense cupressoid-leaved shrubland, dominated by renosterbos. There are both grassland and shrubland forms of the renosterveld present, probably depending on grazing and fire regimes, In wetter areas (>550mm) it grades into FFt 2 Loerie Conglomerate Fynbos. Thicket patches are common on termitaria (heuweltjies are absent) and in fire-safe enclaves, especially in the east. It is dominated by *Aspalathus nivea* in the post-fire, early seral stages.

Geology & Soils

Clays and loams derived from the Ceres Subgroup of the Bokkeveld Group shales. Plinthic catenas prominent. Land types mainly Ca and Bb.

Conservation Status

Endangered.

7.3.1.1.2 Gamtoos Thicket (AT4)

Biome

Albany Thicket Biome

Vegetation & Landscape

On the low mountain slopes in steeply sloping areas and on low ridges. Tall, dense thicket, where both the trees and shrubs, and the succulent component are well represented. Few distinct strata can be differentiated within much of the vegetation, as the lower and upper canopy species are intertwined, often together with a wide variety of liana species linking the understorey species with the canopy. Occurs mostly as a fragmented community with large, dense stands restricted to south- and southwest- facing slopes that are protected against fires. The structure of the dense stands of Gamtoos Thicket is similar to that of the Sundays Thicket, but it differs in the dominant species.

Geology & Soils

Mostly restricted to rocky, sandy-loamy soils derived from shale and sandstone of the Bokkeveld Group (Ceres and Tarka Subgroups) and Table Mountain Group (Nardouw Subgroup) as well as the Jurassic Enon conglomerates. Also found are fairly shallow clayey soils derived from the Gamtoos Group limestone, phyllite and arenite of the Kaan and Klein River Formations (Namibian Erathem). Fc land type covers half of the area, followed by Ae and Ib.

Conservation Status

Least Threatened

7.3.2 Climate

7.3.2.1 Regional Climate

The regional climate for the two vegetation units is summarised in Mucina and Rutherford (2006) as follows: Mean annual precipitation (MAP) of 500 – 850 mm (mean: 630 mm), peaking slightly in March, but otherwise even. Mean daily maximum and minimum temperatures of 25.1ºC and 7.5ºC for February and July, respectively. Frost occurs about 3 days per year.

7.3.2.2 Local Climate

WKN Windcurrent is monitoring weather conditions on the site. NSS has obtained the temperature, wind speed, wind direction and humidity data from WKN Windcurrent for use in the interpretation of the nightly and seasonal patterns in bat activity and to assist in predicting impacts and developing mitigation measures.

7.3.3 Preliminary Bat Monitoring Findings

7.3.3.1 Likelihood of Occurrence (LoO)

Purely based on distribution (Friedman and Daly, 2004; and Monadjem *et al*., 2010), 14 species of bats have the potential to occur at the Banna Ba Pifhu site (see Table 7-5). However they vary in their likelihood of occurrence: – 4 highly likely, 8 moderately likely and 2 with a low likelihood but possible.

Table 7-5: Potential Bats for Banna Ba Pifhu Site

FAMILY	SPECIES	COMMON NAME	LoO	STATUS (national)
PTEROPODIDAE	*Epomophorus wahlbergi*	Wahlberg's epauletted fruit bat	Medium	LC
PTEROPODIDAE	*Rousettus aegyptiacus*	Egyptian Rousette	Medium	LC
RHINOLOPHIDAE	*Rhinolophus capensis*	Cape horseshoe bat	High	NT
HIPPOSIDERIDAE	*Cloeotis percivali*	Short-eared trident bat	Low	CR
EMBALLONURIDAE	*Taphozous mauritianus*	Mauritian tomb bat	Medium	LC
MOLOSSIDAE	*Tadarida aegyptiaca*	Egyptian free-tailed bat	High	LC
MINIOPTERIDAE	*Miniopterus fraterculus*	Lesser long-fingered bat	Medium	NT
MINIOPTERIDAE	*Miniopterus natalensis*	Natal long-fingered bat	Medium	NT
VESPERTILIONIDAE	*Neoromicia capensis*	Cape serotine bat	High	LC
VESPERTILIONIDAE	*Cistugo lesueuri*	Lesueur's hairy bat	Low	NT
VESPERTILIONIDAE	*Myotis tricolor*	Temminck's hairy bat	Medium	NT
VESPERTILIONIDAE	*Eptesicus hottentotus*	Long-tailed serotine bat	Medium	LC
VESPERTILIONIDAE	*Kerivoula lanosa*	Lesser woolly bat	Medium	NT
VESPERTILIONIDAE	*Scotophilus dinganii*	Yellow-bellied house bat	Low	LC
NYCTERIDAE	*Nycteris thebaica*	Egyptian slit-faced bat	High	LC

7.3.3.2 Confirmed Bat Species

From the data analysed to date based on the first quarter of the twelve month monitoring, NSS has preliminarily confirmed the presence of four bat species utilizing the Banna Ba Pifhu site. A summary description of these species and their preferred habitat is provided in **Table 7-6.** Further monitoring and spring and summer field observations may confirm the presence of other bat species utilising the site or nearby habitats.

Table 7-6: Confirmed bat species at the Banna Ba Pifhu site (monitoring only)

FAMILY	SPECIES	COMMON NAME:	SG*	STATUS (int)	STATUS (SA)	HABITAT	METHOD OF CONFIRMATION
MINIOPTERIDAE	*Miniopterus natalensis*	Natal long-fingered bat	C	NT	NT	Temperate or subtropical species; savannas and grasslands; cave-dependent.	**Confirmed – calls only**
MOLOSSIDAE	*Tadarida aegyptiaca*	Egyptian free-tailed bat	A	LC	LC	Forages over desert, semi-arid scrub, savanna, grassland and agricultural land. Avoids forests.	**Confirmed – calls only**
VESPERTILIONIDAE	*Neoromicia capensis*	Cape serotine	B	LC	LC	Arid semi-desert to montane grassland, forests and savanna. Less abundant in low-lying hot savannas.	**Confirmed – calls only**
VESPERTILIONIDAE	*Eptesicus hottentotus*	Long-tailed serotine	B	LC	LC	Rocky outcrops, miombo woodland in gorges and granitic hills.	**Confirmed – calls only**

Notes: SG = Species Group

7.3.3.3 Bat Activity Index

Monitoring at the Banna Ba Pifhu site from April to August 2012 shows an overall average bat activity index of 52 bat passes per date. The different bat passes per date for each monitoring station are shown in **Figure 7-7**. The location with the highest index is HB1 with 98 bat passes per date. This is most likely due to the location of the station in a riparian zone and close to a large water body as seen in **Figure 7-6**. When comparing the Banna Ba Pifhu site with a similar site in the Southern Cape, The Banna Ba Pifhu site has comparable activity indexes for the amount of time monitored. A true site comparison can only be performed once the long-term monitoring has been undertaken.

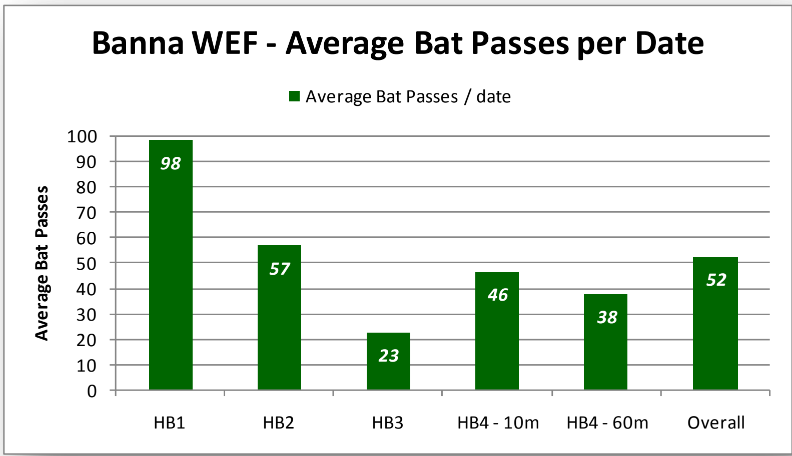


Figure 7-7: Preliminary Bat Activity Index for the Banna Ba Pifhu site

7.3.3.4 Relative Abundance

Where the bat activity index above (**Figure 7-7**) is considered to reflect a higher range of bat activity (even with the limitations), the relative abundance is considered to represent a lower range of bat activity at the site. **Figure 7-8** below indicates the relative abundance on site. The relative abundance indicates that location HB1 has the highest abundance of bats. The activity at 60 m at HB4 has a higher relative abundance than at 10 m at HB4, indicating the established population / abundance of high flying (high risk) bats on site.

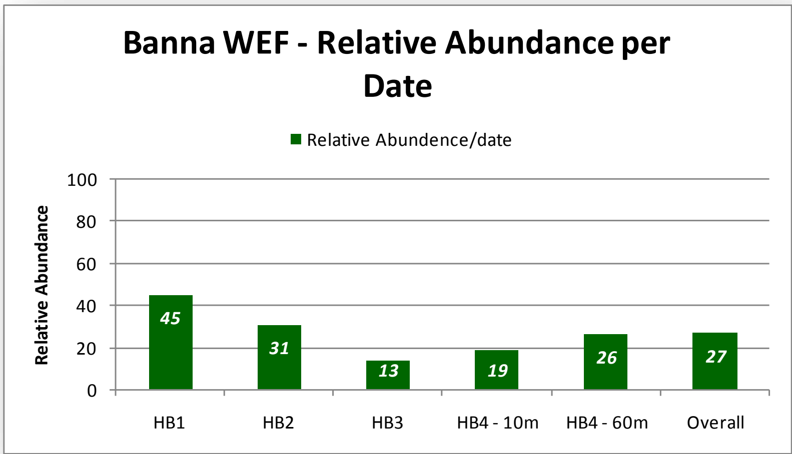


Figure 7-8: Preliminary Relative Abundance for the Banna Ba Pifhu site

7.3.3.5 Species Composition

The preliminary species group composition for the whole Banna Ba Pifhu site can be seen in **Figure 7-9**. At the 66.78% of all the bat passes recorded were from the Species Group A bats or more specifically *Tadarida aegyptiaca* (Egyptian free-tailed bat), a species at high risk of mortality from sweeping turbine blades. One conservation important species, *Miniopterus natalensis* (Natal long-fingered bat) was recorded on site throughout the monitoring period in smaller numbers and more activity for this species was seen in autumn than winter (**Appendix D**). This bat species is also significant because it is known to migrate, and migrating bats are at risk from wind turbines. The Species Group B bats consist of *Neoromicia capensis* and *Eptesicus hottentotus* bats, both were recorded on site.

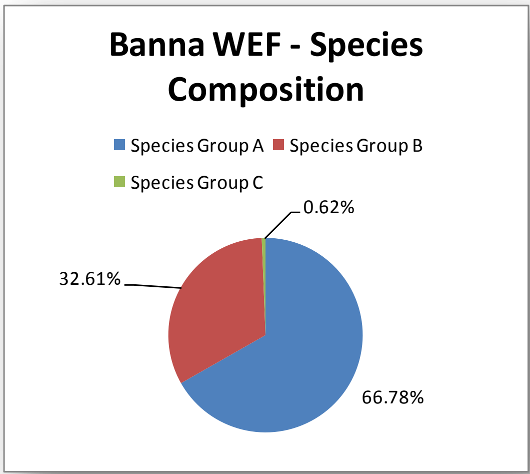


Figure 7-9: Species Distribution at the Banna Ba Pifhu site

The preliminary species composition for each monitoring station is shown in **Figure 7-10**. Every monitoring station recorded Species Group C bats even at the height of 60 m. The species mainly flying at height is the *Tadarida aegyptiaca* (Egyptian free-tailed bat) which has a **high** risk of fatality from the wind energy project.

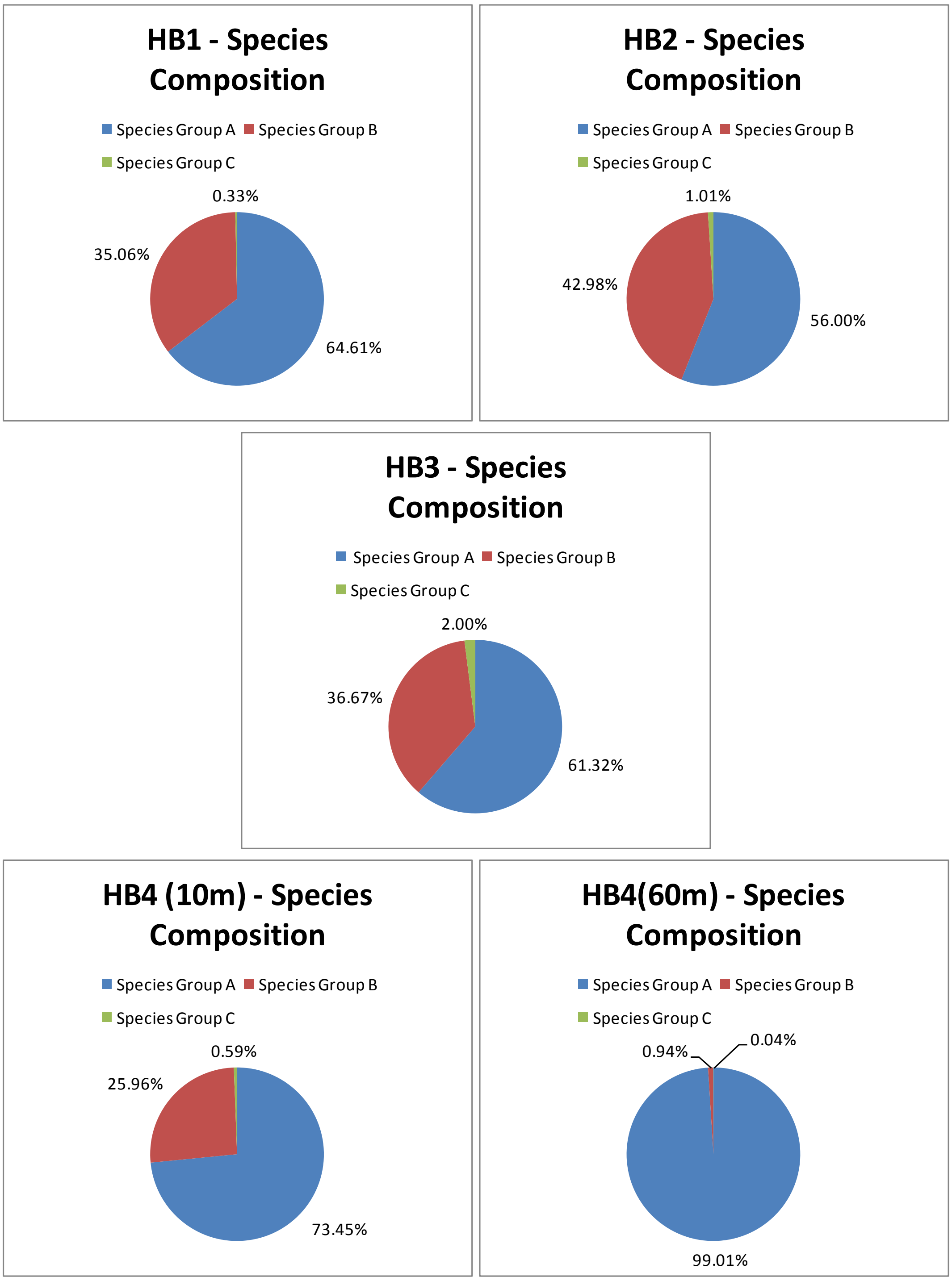


Figure 7-10: Species Composition of each monitoring station at the Banna Ba Pifhu site

7.3.3.6 Key Activity Times

According to the preliminary data, 91% of all bat passes recorded at the Banna Ba Pifhu site occurred between 17:30 and 19:30 in the evening. **Figure 7-11** below presents these findings for the whole Banna Ba Pifhu site and similar preliminary representations for each monitoring station can be found in **Appendix B**. It must be noted that these activity times are only for autumn and winter and it is highly possible that more activity may be experienced during different times of the night in spring and summer due to expected higher nightly temperatures. It is also likely that this activity is by bats located on or near the proposed site because the recorded activity started immediately after sunset.

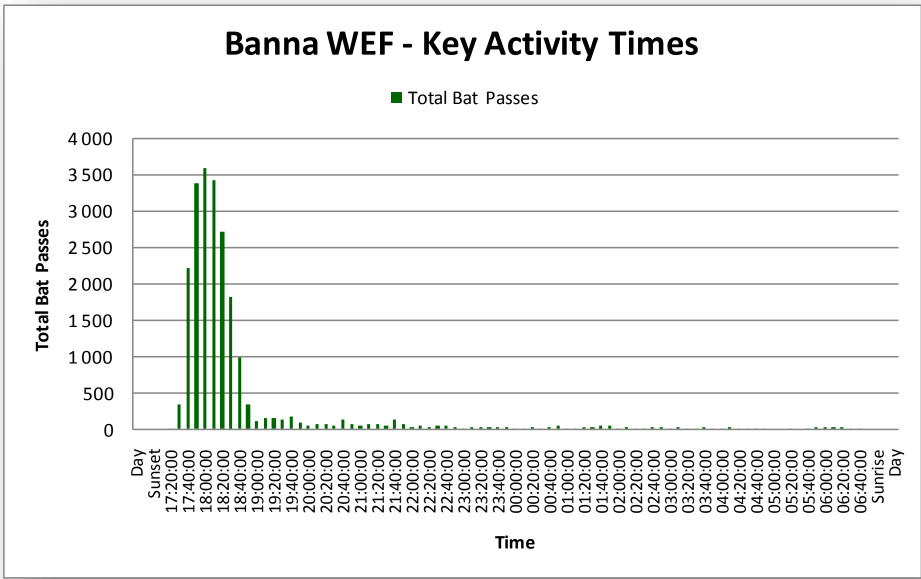


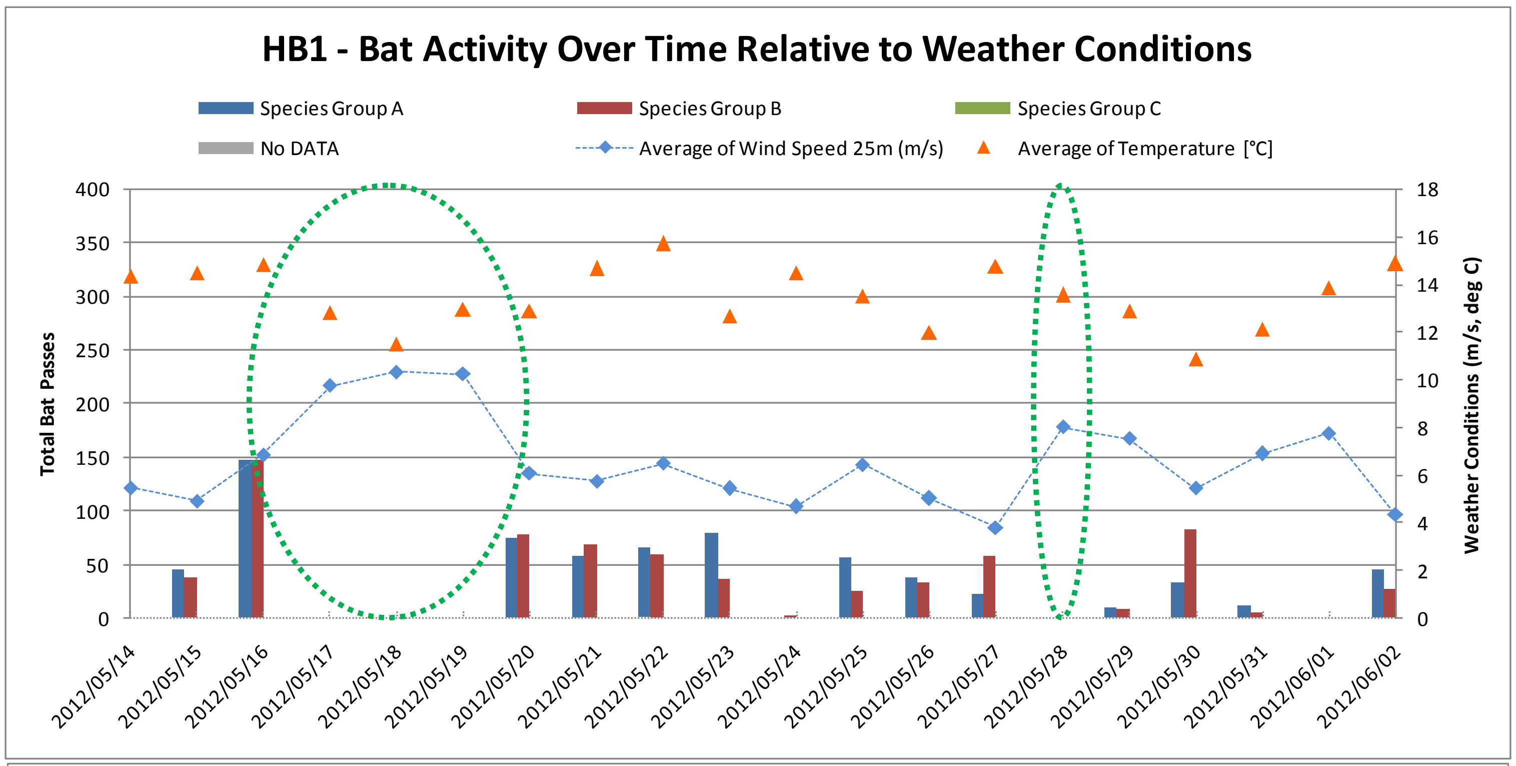
Figure 7-11: Key activity times at the Banna Ba Pifhu site

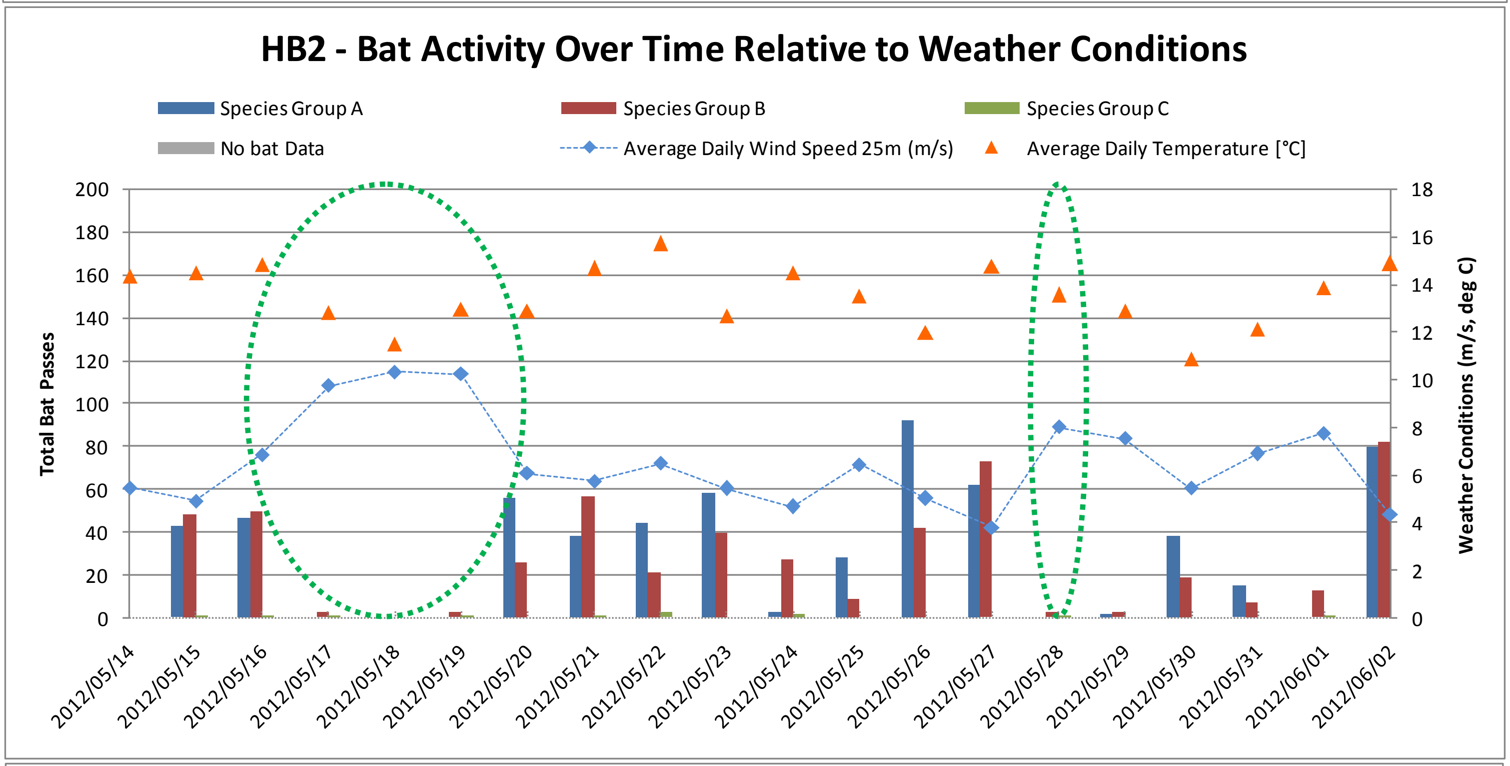
7.3.3.7 Bat Passes, Weather and Season

It has been concluded from previous bat monitoring projects that there is definitely a correlation between bat activity, weather and season. The correlations include the following:

- High wind speed events have little bat activity (the threshold of what is considered a high wind speed event is site dependent);
- Low temperatures have little bat activity; and
- Season variation in bat activity due to temperature and rainfall.

As only two seasons have been monitored, the seasonal variation cannot be depicted at this stage. **Appendix D** indicates that there is a difference in bat activity from autumn to winter for Species Group C bats. For this report, three of the stations (HB1, HB2 & HB3) were compared over a period of three weeks (14 May – 03 June 2012) to represent the correlations between average wind speeds and temperatures. These are shown in **Figure 7-12** below. The green circles indicate good examples of peaks in average wind speeds correlating with little to no bat activity at all three stations on the same dates. However, dips in temperature do not show the same correlations. Further investigations into the site specific weather correlations will be done once all four seasons have been monitored.





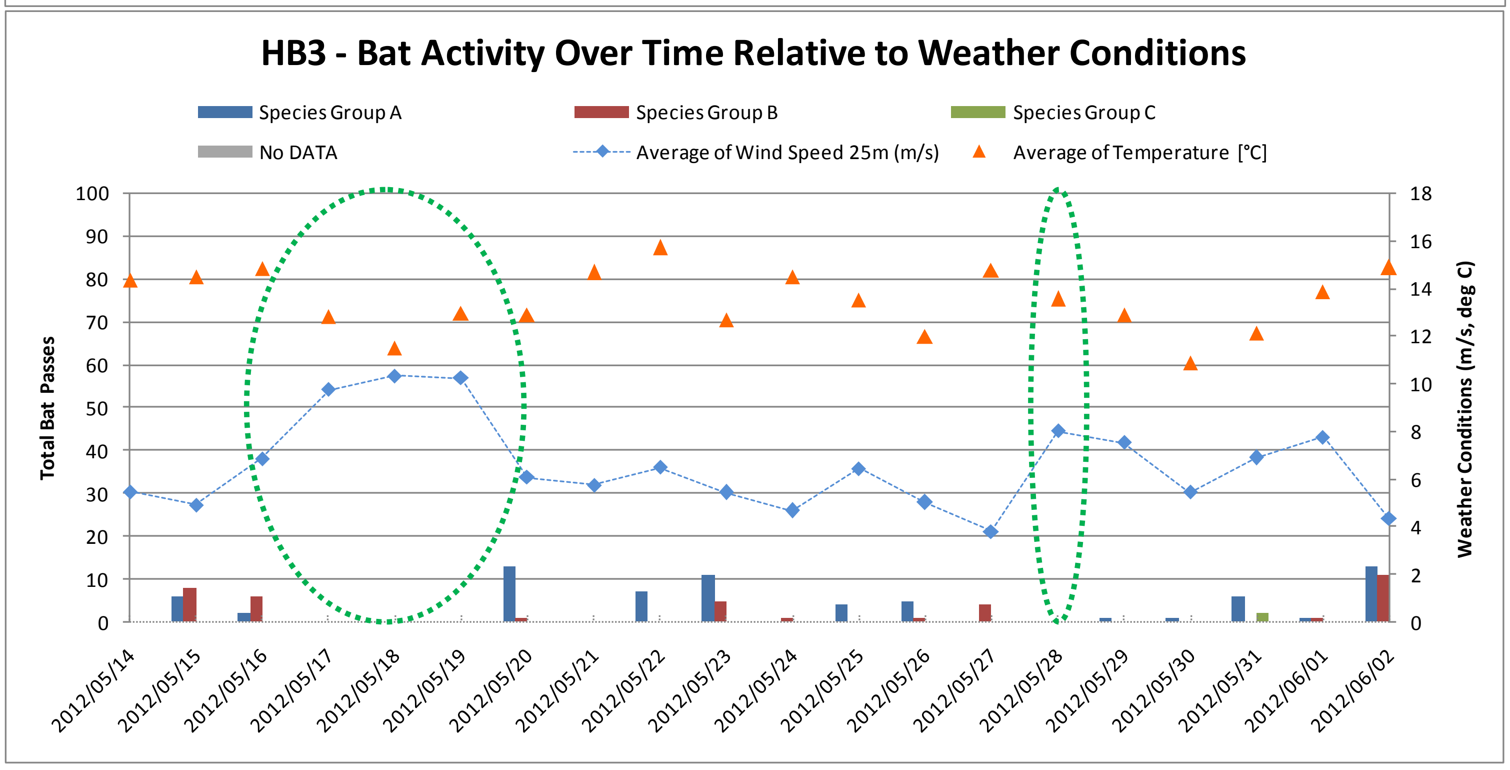


Figure 7-12: Weather correlations with bat activity

In this report wind direction was also considered as an important variable with relation to bat activity on site. The total number of 10-minute wind events recorded according to direction at the Banna Ba Pifhu site are shown in **Figure 7-13** and **Figure 7-14** indicates the total number of recorded wind events with bat passes according to wind direction at the Banna Ba Pifhu site.

The prevailing wind direction for the two season monitoring is west-north-westerly (WNW) and as expected, due to the high activity index, the majority of the recorded bat passes occurred during these winds. However, the important information from these data is the bat activity during the east-north-easterly (ENE) winds. At all stations, it was calculated that the average number of bat passes per 10-minute wind event in this direction was higher than any of the other directions, meaning that bats would prefer to fly during these winds. **Figure 7-15** below shows that the east-north-easterly ENE) winds on average have lower wind speeds than that of the west-north-westerly (WNW) winds, which may explain the bats' preference for these wind directions. Further investigations into the wind direction and season will be included in the final monitoring report.

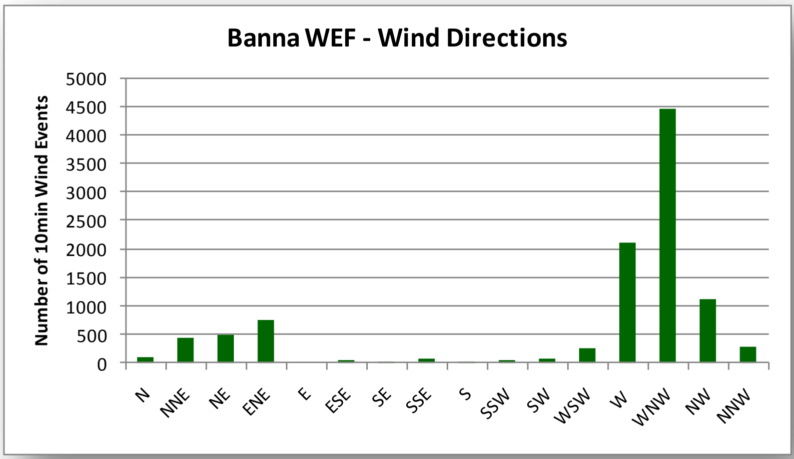


Figure 7-13: Number of wind events per wind direction

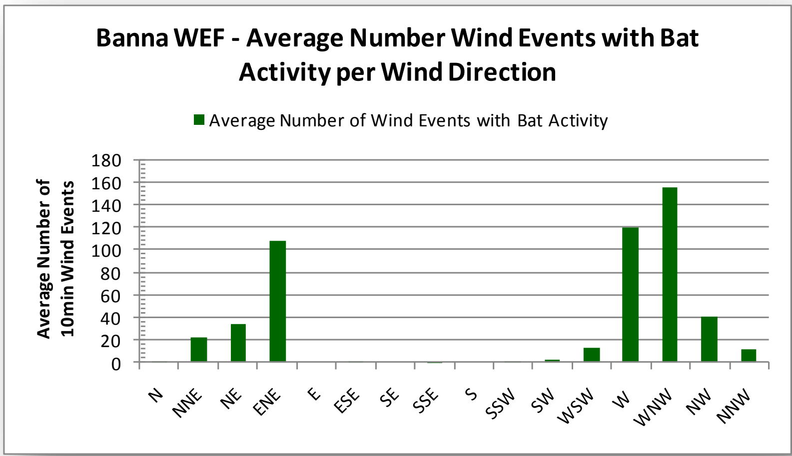


Figure 7-14: Average number of wind events with bat activity according to wind direction

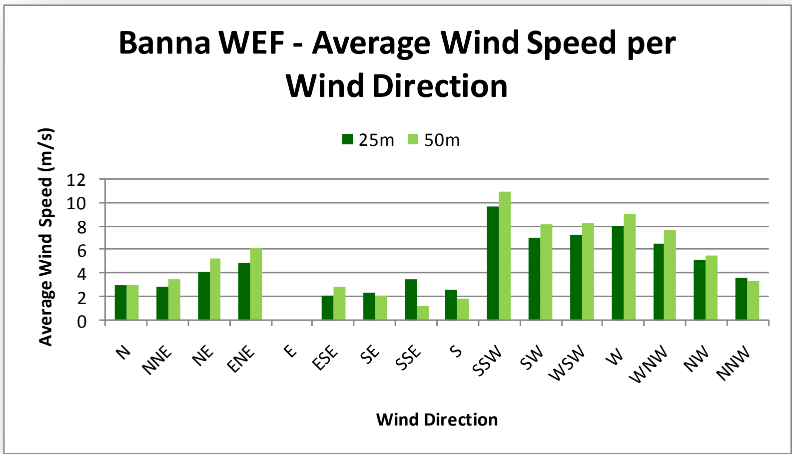


Figure 7-15: Average wind speed according to wind direction

7.3.3.8 Bat Activity and Moonlight

Moonlight may affect the foraging activities of the bats on site and therefore it is important to understand the bat activity during the different moon phases. The activity index (**Figure 7-16**) shows that the two highest moon phases had 1) the most light (Full Moon) and 2) very little light (Waning Cresent). This indicates that from the two seasons of monitoring, moonlight didn't have a major effect on the bat activity. Further monitoring may reveal seasonal differences and changes in these results.

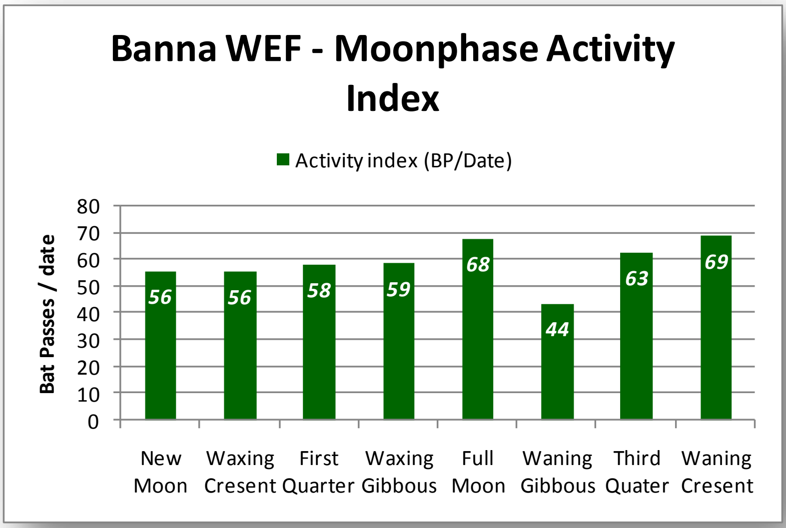


Figure 7-16: Bat Activity according to Moonphases.

7.3.3.9 <u>Evidence of Seasonal Migration</u>

Only two seasons have been monitored thus far at the Banna Ba Pifhu site. In the final report, data will be analysed to determine whether there is sufficient evidence of seasonal migration. Specifically Species Group C bats will be examined and the bat activity difference between seasons will be determined.

For this report, NSS has investigated the activity of Species Group C bats which have been recorded on site (**Appendix C & D**). These bats are Conservation Important, cave dwelling, migratory bats and are expected to travel great distances to forage and drink nightly. Although seasonal migration patterns can't be determined at this stage of the project, evidence shows that these bats may be utilising the site to reach other foraging grounds as only 52% of the recorded night time activity takes place between 17:30 – 19:30, peaking at 18:20, almost an hour after sunset. The rest of the activity takes place throughout the evening as shown in **Figure 7-17** below. Similar graphs for each station have been included in **Appendix C.** Further investigations will determine the extent to which the site is being utilised by this Species.

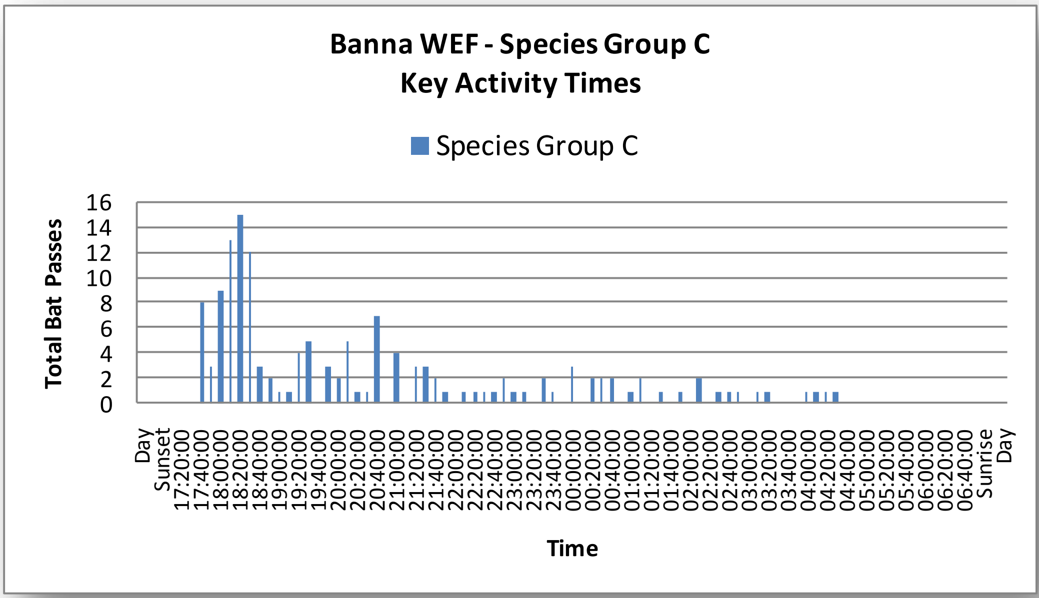


Figure 7-17: Key Activity Times for Species Group C

To understand the nature of the winds in which these bats fly in on site, the wind speeds and directions were investigated. The majority of the Species Group C bats fly in wind speeds under 8 m/s as seen in **Figure 7-18**.

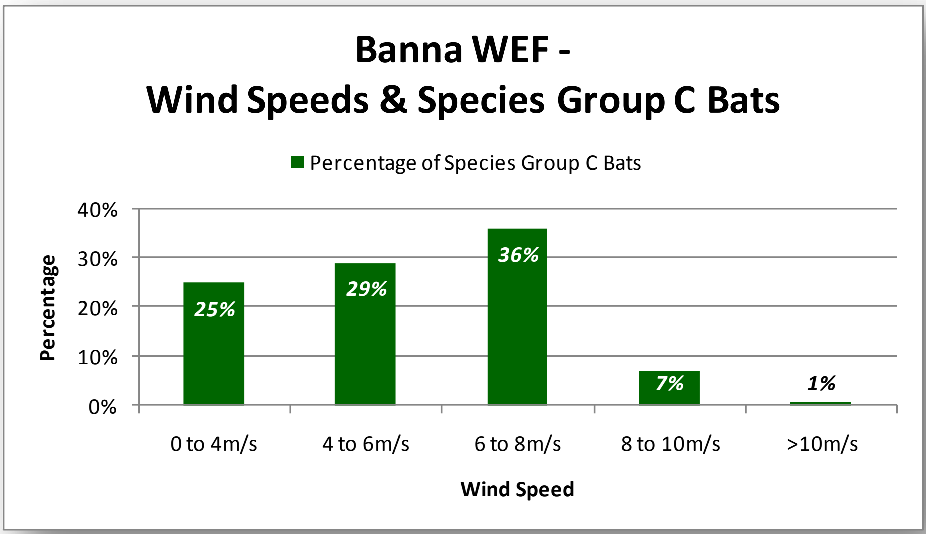


Figure 7-18: Flying wind speeds for Species Group C

7.3.3.10 Transects

Two sets of transects have been driven for the project along the transect route shown on **Figure** 7-6. The results from the latest set of transects are depicted on **Figure 7-19** and **Figure 7-20** below. Unfortunately the data from the first set of transects cannot be interpreted due to the detector not working correctly.

As seen in the transect figures below, all three species groups were detected on the driven route within the site. Species Group A activity was highest on the western side of the proposed WEF site in both directions. The greatest activity was experienced immediately after sunset, compared with later in the evening.

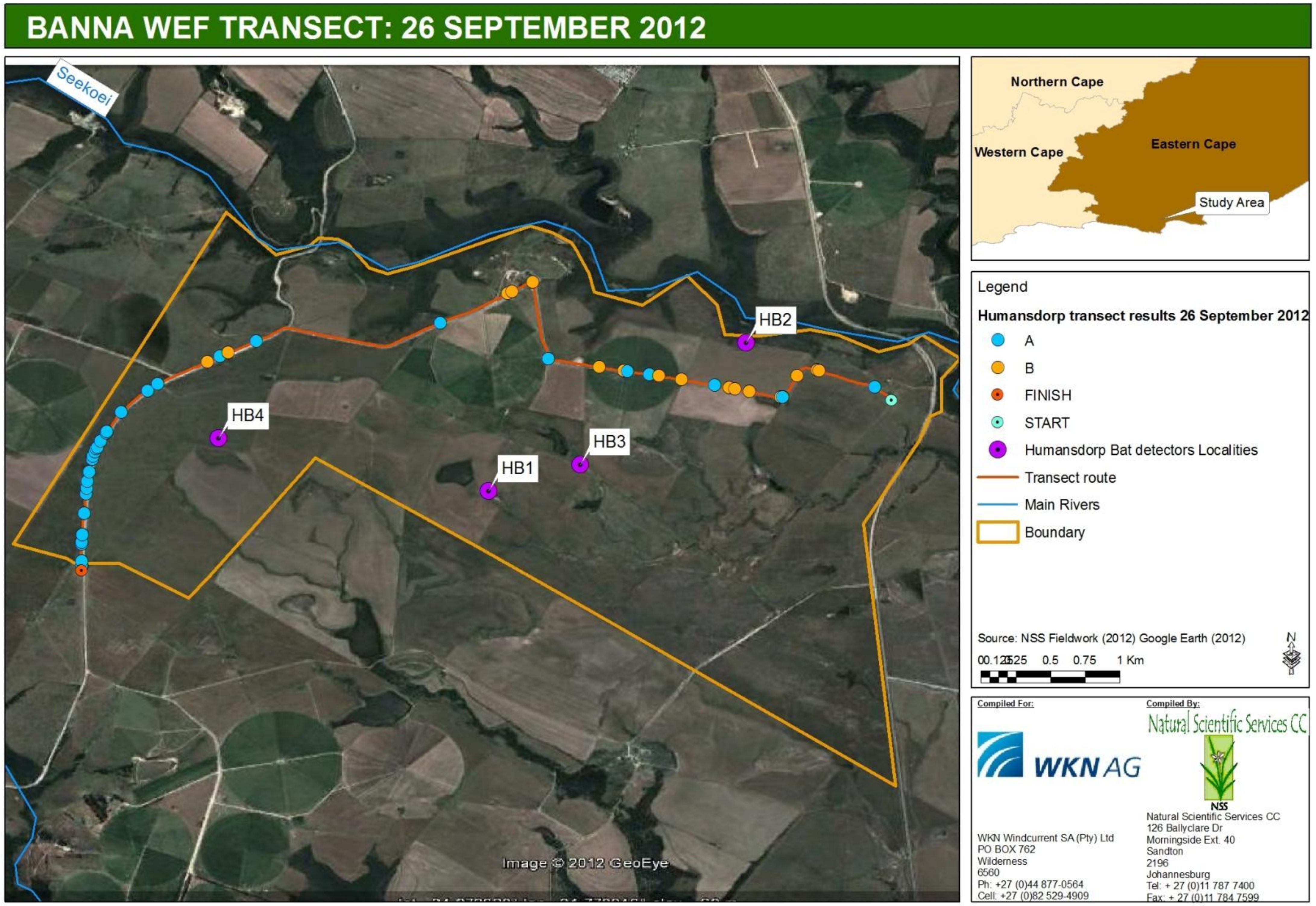


Figure 7-19: Banna Ba Pifhu site Transect 1 – 26 September 2012

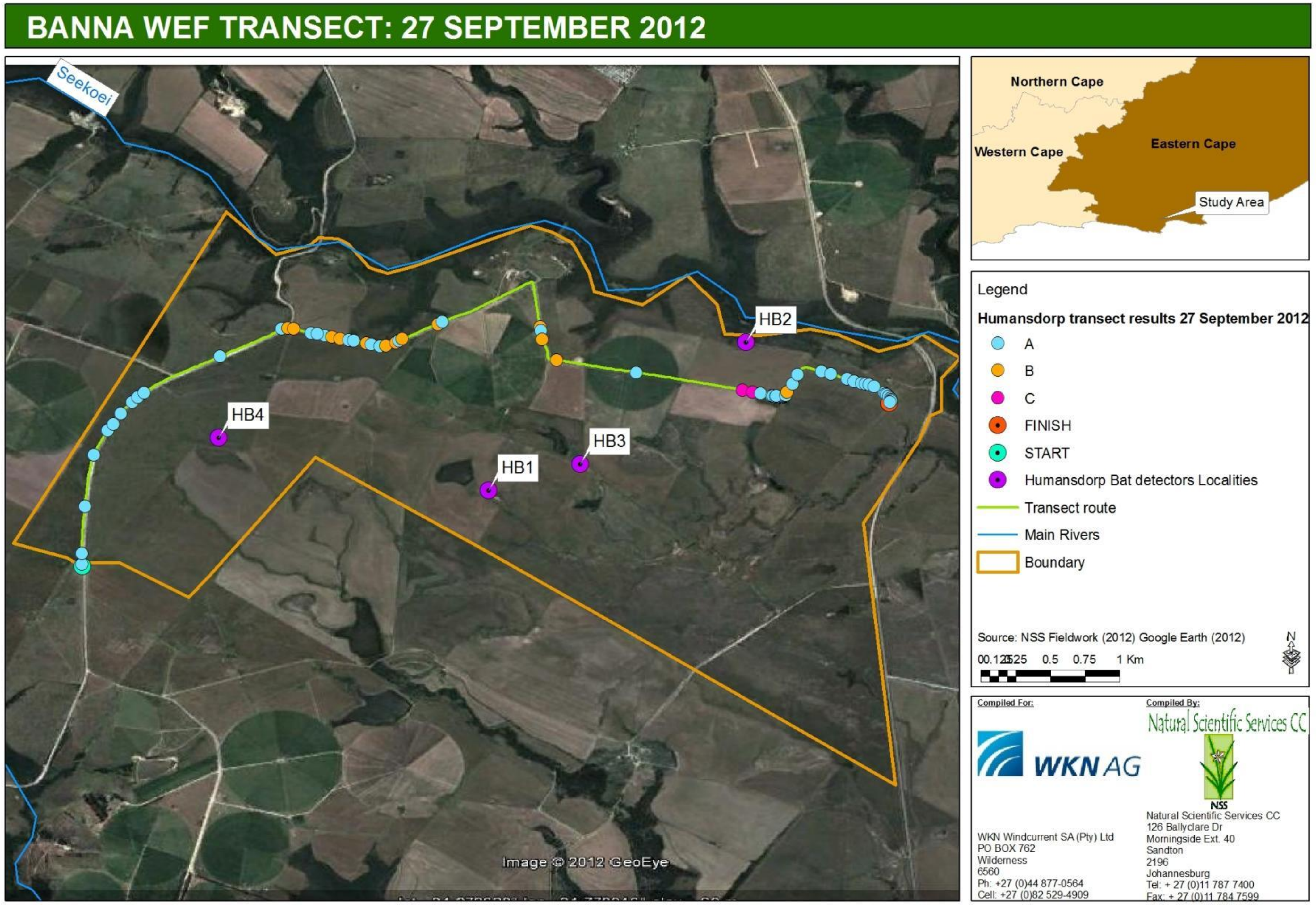


Figure 7-20: Banna Ba Pifhu site Transect 2 – 27 September 2012

7.3.3.11 <u>Roosting Survey</u>

A number of possible roosts have been identified on site. These include, but are not limited to buildings and palm trees, as seen in **Figure 7-21** below. Further investigations will be conducted in spring and summer, when mist netting will be conducted to confirm the species residing at the identified roosts.

Figure 7-21: Possible Roosting Sites at the Banna Ba Pifhu site

A number of caves have also been identified in the region of the Banna Ba Pifhu site, these include, but are not limited to:

- Howieson's Poort Shelter – near Grahamstown
- Klasies River Caves – near Humansdorp
- Makkedaat Grot/Cave – situated in Baviaanskloof
- Bee-se-bos Cave – near Hankey
- Maitland Mines – near Port Elizabeth
- Bloukrans Cave – near Pearston

NSS plans to investigate some of the caves in the area as part of the roost survey. Any other identified roosting sites or caves in close proximity to the site will also be investigated during the spring and summer field trips. For the purpose of this report a map has been included (**Figure 7-22**) indicating the Banna Ba Pifhu site in relation to the known caves in the area. Species Group C bats have been recorded on site and therefore, caves are relevant for this site as possible roosting habitats, though it is unknown where the bats originated from. A 30 km buffer around each known cave is shown on the map,as Vincent *et al* (2011) recorded *Miniopterus* species travelling similar distances in one night for foraging purposes. This map indicates that the site is located outside of the 30 km radius. This could mean that a) the bats are flying further than 30 km from their roost per night, b) another cave from which the recorded bats come from has not yet been recorded, c) these Species Group C bats do not roost in large cave-like structures but rather in smaller crevices associated with the gorges in the region, or d) cave dwelling bats are transecting the site whilst travelling between caves. All of these scenarios are very possible. More research on a national scale is required to understand how far *Miniopterus* will fly from their roosting caves in a single evening.

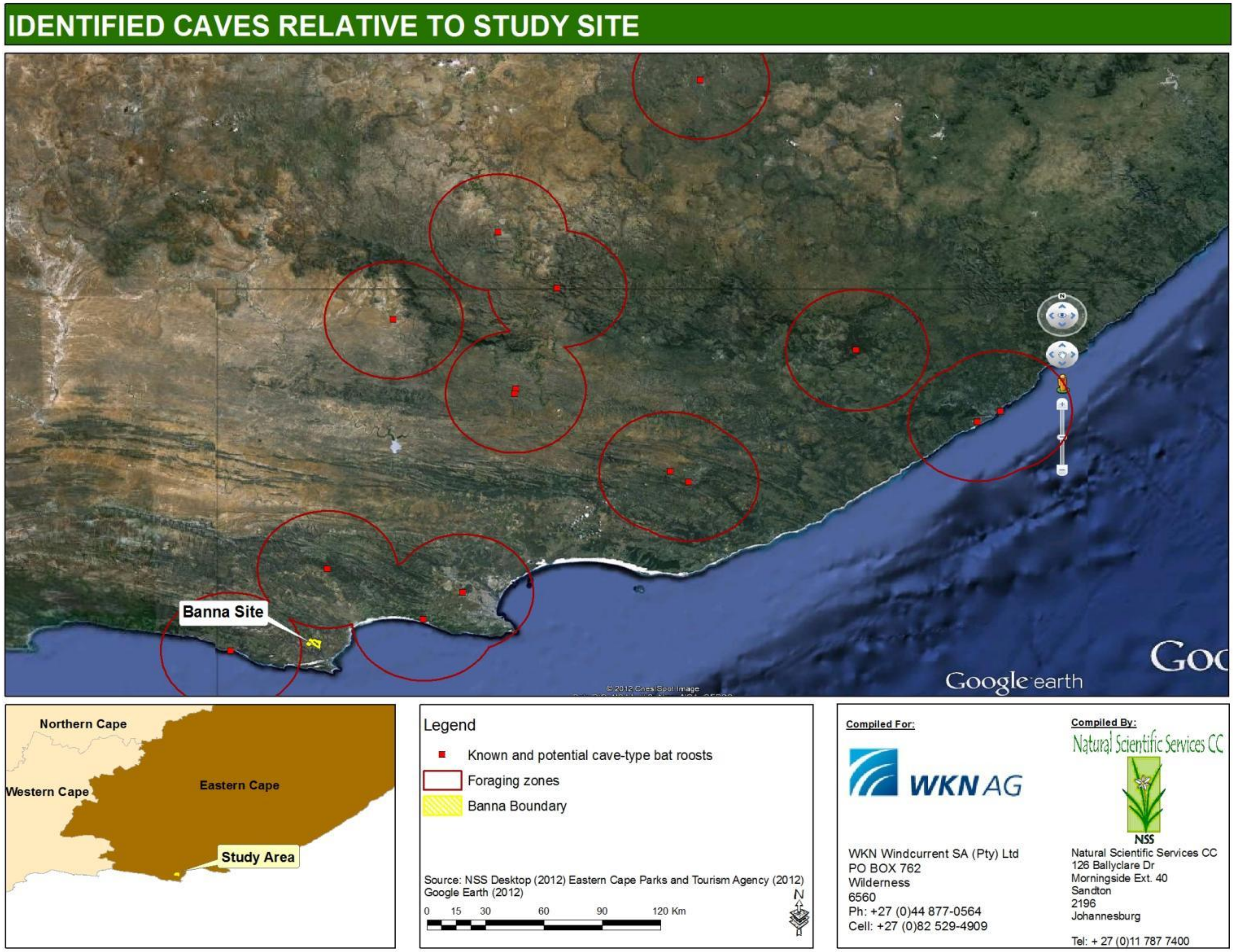


Figure 7-22: Known cave and large bat roost localities in the Southern Cape

7.3.3.12 Wind Thresholds

For each monitoring station, the wind threshold for bat activity was calculated according to **Section 7.1.4.3.3.3**. This is the wind speed in which bats will fly with a 95% significance confidence. These have been included in the **Table 7-7** below.

Table 7-7: Wind thresholds for each monitoring station

MONITORING STATION	THRESHOLD WIND SPEED (m/s)
HB1	9
HB2	9
HB3	9
HB4-10 m	9.5
HB4 – 60 m	11

7.4 IDENTIFICATION OF ISSUES AND IMPACTS

7.4.1 Monitoring Stations Scoring

Each monitoring station was scored according to the criteria in **Section 7.1.4.3.4** and data recorded at each station. The scores can be seen in **Table 7-8**. It should be noted that the scores for roosting, limitations and evidence of seasonal migration are high due to the incomplete monitoring i.e. less than 12 months of monitoring has been conducted to date. It should be noted that the final monitoring report may have different results during the risk assessment.

7.4.2 Turbine Risk Assessment

The monitoring station scores were used to calculate the impact a turbine would have on the bat population on site. Scoring was done according to **Section 7.1.4.3.4** and the results are shown in **Table 7-9.** The initial risk ratings are either medium or high. The turbines were then micro-sited so that all the turbines scored a medium risk.

7.4.3 Sensitivity Map

A sensitivity map (**Figure 7-23**) was generated with the following parameters:

- Possible Roosting Sites were given a 500 m buffer;
- Riparian zones, water bodies and Thicket vegetation were given 50 m and 100 m buffers; and
- Turbine Risk Ratings were indicated.

7.4.4 Foraging Map

The proposed Banna Ba Pifhu site is located within a very wet area characterized by extensive drainage lines, rivers, permanent water bodies and vlei areas (**Figure 7-24**). No distinct movement routes for the bats could be determined as the area as a whole is probably used as prime foraging grounds. The prevailing wind direction has been included on the map as an indicator as to which direction the turbines will be facing. .

Table 7-8:Monitoring Station Scoring

STATION	ACTIVITY INDEX	RELATIVE ABUNDANCE	THRESHOLD WIND SPEED	ROOSTING	OBSERVED EVIDENCE OF SEASONAL MIGRATION	LIMITATIONS	CI SPECIES	SPECIES AT RISK	FINAL MONITORING STATION SCORE
HB1	4	3	5	4	4	4	2	4	**3.75**
HB2	2	3	5	4	4	4	2	3	**3.38**
HB3	2	1	5	4	4	4	2	4	**3.25**
HB4 - 10m	2	2	5	4	4	4	2	4	**3.38**
HB4 - 60m	2	2	5	4	4	4	2	5	**3.50**

Table 7-9: Turbine Risk Assessment at Canopy and Nacelle Heights

TURBINE	CO-ORDINATES	FOOTPRINT HABITAT		DISTANCE FROM RIPARIAN ZONE (m)		DISTANCE FROM WATER BODY (m)		SITE COMPARISON		APPLICABLE MONITORING STATION (10 m)		RISK RATING CANOPY (10 m)		HB4 – 60 m	RISK RATING NACELLE (60 m)	
WTG01	34° 4.515'S, 24° 44.670'E	Renosterveld	**5**	330	**2**	530	**0**	>10% higher	**4**	HB4	**3.38**	2.88	**Medium**	**3.50**	2.90	**Medium**
WTG02	34° 4.617'S, 24° 45.094'E	Cultivated	**1**	340	**2**	394	**1**	>10% higher	**4**	HB4	**3.38**	2.28	**Medium**	**3.50**	2.30	**Medium**
WTG03	34° 4.171'S, 24° 44.981'E	Cultivated	**1**	165	**3**	530	**0**	>10% higher	**4**	HB4	**3.38**	2.28	**Medium**	**3.50**	2.30	**Medium**

TURBINE	CO-ORDINATES	FOOTPRINT HABITAT		DISTANCE FROM RIPARIAN ZONE (m)		DISTANCE FROM WATER BODY (m)		SITE COMPARISON		APPLICABLE MONITORING STATION (10 m)		RISK RATING CANOPY (10 m)	HB4 – 60 m	RISK RATING NACELLE (60 m)		
WTG04	34° 4.337'S, 24° 45.358'E	Cultivated	**1**	252	**2**	264	**2**	>10% higher	**4**	HB4	**3.38**	2.48	**Medium**	**3.50**	2.50	**Medium**
WTG05	34° 4.019'S, 24° 45.380'E	Cultivated	**1**	56	**4**	236	**2**	>10% higher	**4**	HB3	**3.25**	2.85	**Medium**	**3.50**	2.90	**Medium**
WTG06	34° 3.774'S, 24° 45.695'E	Cultivated	**1**	275	**2**	280	**2**	>10% higher	**4**	HB4	**3.38**	2.48	**Medium**	**3.50**	2.50	**Medium**
WTG07	34° 4.155'S, 24° 45.891'E	Cultivated	**1**	60	**4**	492	**1**	>10% higher	**4**	HB3	**3.25**	2.65	**Medium**	**3.50**	2.70	**Medium**
WTG08	34° 4.200'S, 24° 46.377'E	Cultivated	**1**	127	**3**	138	**3**	>10% higher	**4**	HB4	**3.38**	2.88	**Medium**	**3.50**	2.90	**Medium**
WTG09	34° 3.912'S, 24° 46.667'E	Cultivated	**1**	240	**2**	388	**1**	>10% higher	**4**	HB4	**3.38**	2.28	**Medium**	**3.50**	2.30	**Medium**
WTG10	34° 4.240'S, 24° 46.803'E	Cultivated	**1**	53	**4**	210	**2**	>10% higher	**4**	HB3	**3.25**	2.85	**Medium**	**3.50**	2.90	**Medium**
WTG11	34° 3.954'S,	Cultivated	**1**	212	**2**	471	**1**	>10% higher	**4**	HB4	**3.38**	2.28	**Medium**	**3.50**	2.30	**Medium**

TURBINE	CO-ORDINATES	FOOTPRINT HABITAT		DISTANCE FROM RIPARIAN ZONE (m)		DISTANCE FROM WATER BODY (m)		SITE COMPARISON		APPLICABLE MONITORING STATION (10 m)		RISK RATING CANOPY (10 m)	HB4 – 60 m	RISK RATING NACELLE (60 m)		
	24° 47.159'E															
WTG12	34° 4.271'S, 24° 47.287'E	Cultivated	**1**	105	**3**	167	**3**	>10% higher	**4**	HB4	**3.38**	2.88	**Medium**	**3.50**	2.90	**Medium**
WTG13	34° 4.546'S, 24° 46.987'E	Cultivated	**1**	48	**5**	372	**1**	>10% higher	**4**	HB2	**3.38**	2.88	**Medium**	**3.50**	2.90	**Medium**
WTG14	34° 3.975'S, 24° 47.581'E	Cultivated	**1**	335	**2**	351	**1**	>10% higher	**4**	HB4	**3.38**	2.28	**Medium**	**3.50**	2.30	**Medium**
WTG15	34° 4.290'S, 24° 47.736'E	Cultivated	**1**	109	**3**	369	**1**	>10% higher	**4**	HB4	**3.38**	2.48	**Medium**	**3.50**	2.50	**Medium**
WTG16	34° 4.715'S, 24° 47.428'E	Transformed	**3**	120	**3**	430	**1**	>10% higher	**4**	HB4	**3.38**	2.88	**Medium**	**3.50**	2.90	**Medium**
WTG17	34° 5.035'S, 24° 47.489'E	Transformed	**3**	101	**3**	360	**1**	>10% higher	**4**	HB4	**3.38**	2.88	**Medium**	**3.50**	2.90	**Medium**

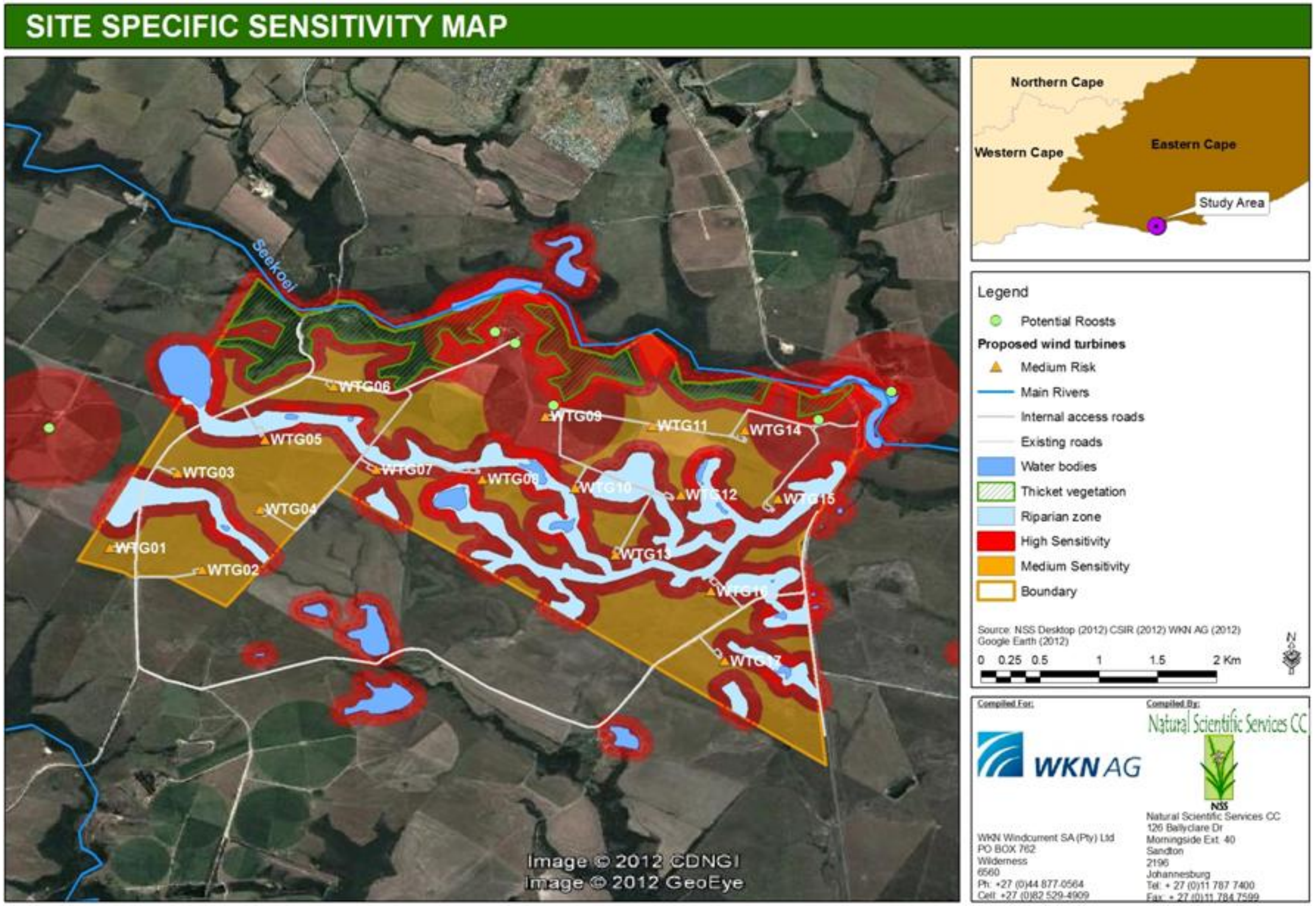


Figure 7-23: Bats site sensitivity map

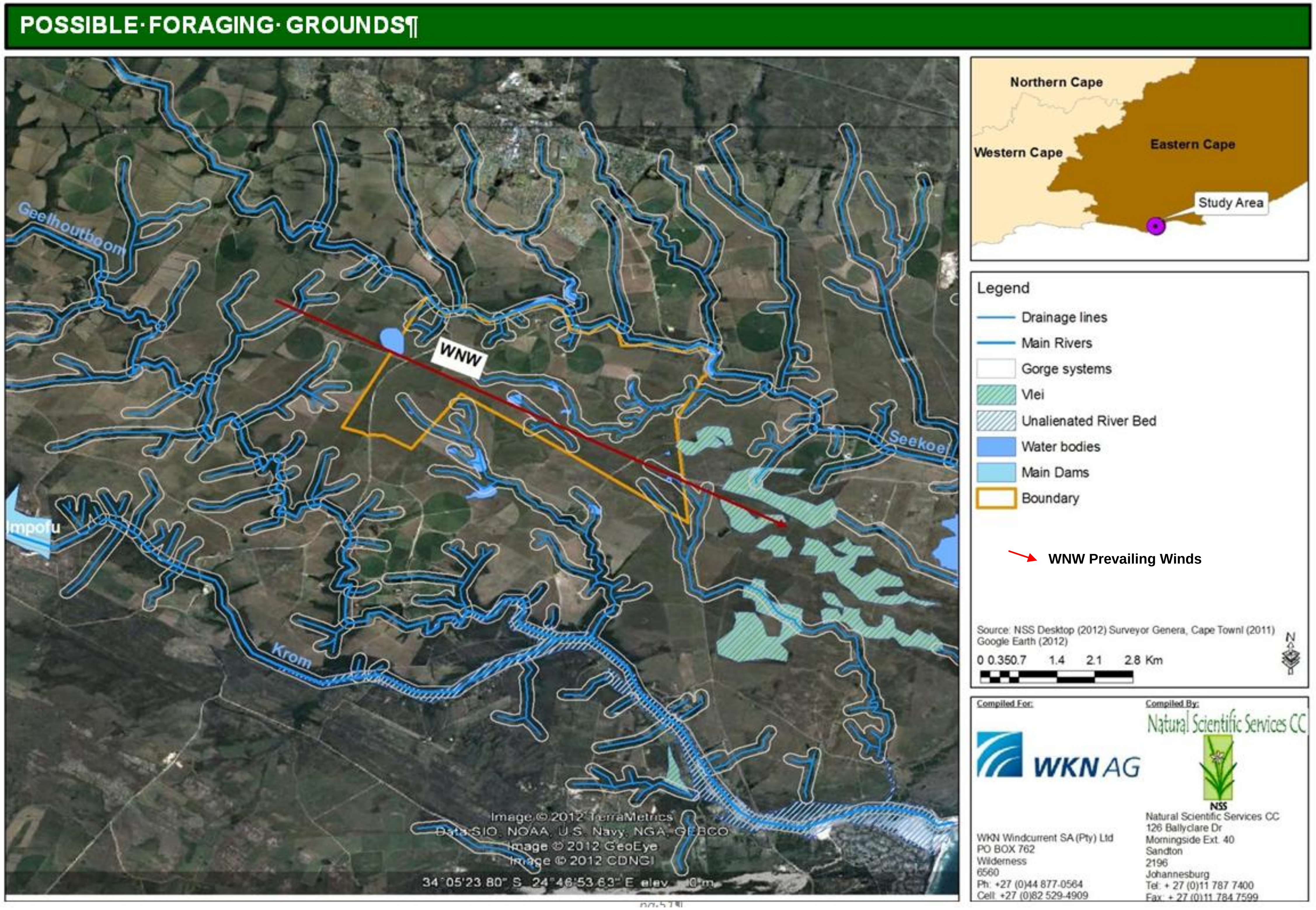


Figure 7-24: Possible foraging grounds Map

7.5 PERMIT REQUIREMENTS

Feedback from the Bat Mitigation Workshop held on 1st October 2012 indicated that the intentional killing of bats species and conservation important bat species may require permits through the Eastern Cape Department of Economic Development and Environmental Affairs under the National Environmental Management: Biodiversity Act. Evidence has shown that wind turbines will definitely kill bats and international literature and test turbines in South Africa confirm this statement.

7.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

7.6.1 Impact Assessment

7.6.1.1 Overall Impacts

The overall impacts address the site as a whole regarding the information gathered, and the impacts are assessed according to construction and operational phases. The overall impact assessment can be seen in **Table 7-10.** The following impacts are possible for the site:

1. Bat roost disturbance and/or destruction due to construction activities

    - The types of roosts at the Banna Ba Pifhu site include buildings, trees (alien and indigenous), gorges and bridges. Construction activity will involve site clearance, hence the removal of vegetation, possibly some rock blasting and possibly the removal of some out buildings for the construction of each turbine and associated infrastructure. Some construction activities may occur near to these roosts. This will destroy or disturb these roost sites in the vicinity of each turbine. A more detailed roost survey still needs to be done and therefore this impact has been assessed conservatively.

2. Fragmentation to and displacement from foraging habitat due to wind turbine construction and operation

    - Construction and operational practices can lead to the disturbance of foraging behaviour and habitats. For example, the large turbines, especially if placed close together, create physical barriers for bats travelling to foraging areas. Light/ illumination disturbances and changes in micro-climate alters the foraging environment.

3. Bat fatalities due to collision or barotrauma during foraging activity

    - Deaths caused by wind turbines are well documented. Bat mortality increases near moving, but not static, turbine blades at WEFs (Arnett *et al*., 2008, Durr & Bach, 2004, Horn *et al*., 2008, and Kunz *et al*., 2007). It is not known why bats are not able to avoid the moving turbine blade, but the following study is interesting to consider. Bates and Simmons (2011) have shown that bats have a perceptual mechanism for rejecting echoes from clutter that is off to the side or some distance away in order to focus on more important targets directly in front of them. They liken the bats' ability to ignore misaligned echoes to our peripheral vision; just as we can vaguely distinguish objects on our periphery but not see them in high resolution, big brown bats don't perceive far-off clutter as accurately as a moth right in front of them. Hence, bats may not "see" wind turbines when concentrating on catching food.

- The dominant types of bats at the current study area are species that are at high or medium-to high risk of fatality due to their foraging behaviour.

- There is evidence to suggest that larger turbines cause higher mortalities in bats (Baerwald & Barclay 2011; Rydell *et al*., 2010; NWCC, 2010), hence, smaller turbines are recommended.

- The potential consequences of high death rates are:

    - Loss of essential ecosystem services (Kunz *et al*., 2011);

    - Social breakdown amongst the gregarious colonies (Kerth *et al*., 2011); and

    - Loss of Conservation Important species, for example, the Near Threatened *M. natalensis*, the calls have been recorded from all sites, and thousands have been confirmed to be roosting in surrounding regional caves and mines.

4. <u>Bat fatalities due to collision or barotrauma due to attraction of bats to towers for roosting or out of curiosity</u>

- Bats have been shown, through thermal imagery studies, to be attracted to wind turbines, either looking for potential roosting sites or out of curiosity and are often struck by the moving blades (Horn *et al*., 2008). This has been further confirmed by Rollins *et al*. (2012).

5. <u>Bat fatalities due to collision or barotrauma during migration</u>

- International research has shown that migrating bats are at higher risk of fatality, due to either their higher flights or other reasons still being researched. Most of the bats killed by turbines in the USA thus far have been migratory species that roost in trees throughout the year, and the highest fatality events appear to coincide with autumn migration (Cryan and Brown, 2007). They found that relatively low wind speeds, low moon illumination, and relatively high degrees of cloud cover were important predictors of bat arrivals and departures, and that low barometric pressure was an additional variable that helped predict bat arrivals. In South Africa, our migratory species are cave-dwelling bats, for example *Miniopterus natalensis, Myotis tricolor* and possibly *Rousettus aegyptiacus*. With the presence of caves possibly hosting these migrating species being within a 200 km of the site, there is a potential risk. The extent of the risk can only be determined when the spring and summer monitoring has been done.

6. Bat fatalities due to electrocution from overhead power lines

   - Whilst there have been no reports to date of this occurring in South Africa, hundreds of flying-foxes are electrocuted annually on power lines in Australia. This occurs when they make contact with two wires. Electrocuted flying-foxes die from cardiac fibrillation (heart attack) or asphyxiation (paralysis of respiratory muscles). (Bat Care Brisbane, http://www.bats.org.au). Until all monitoring is complete the risk to the various species found on site cannot be determined and has therefore been assessed conservatively.

7.6.1.2 Cumulative Impacts

1. Loss of Conservation Important Bat Species from the area due to construction and operation activities

   - One confirmed (*Miniopterus natalensis*) bat species in the Banna Ba Pifhu study area is Red Data Listed as Nationally Near Threatened (Friedmann and Daly, 2004) and Globally Near Threatened (IUCN Redlist category: www.iucnredlist.org).

     M. natalensis has a medium to high risk of fatality due to wind turbines (Sowler & Stoffberg, 2011). *M. natalensis* was found at all monitoring stations, and has been historically recorded in the thousands in surrounding regional cave systems. This species may also be flying through the proposed site as part of their foraging habits.

2. Loss of bats providing important ecosystem services

   - Insectivorous bats provide essential pest control services to farmers worldwide because they prey on agricultural insect pests and significantly limit damaging herbivory by arthropods (Kalka et al., 2008). Cleveland et al. (2006) estimates that Brazilian free-tail bats (*Tadarida brasiliensis*) in Texas USA saves the US economy in a range of between $121 000 to $1 725 000 of the $4.6 to $6.4 million in cotton production per year by eating cotton bollworm adult moths. In a study in Sacramento USA, it was reported that the presence of sufficient numbers of bats reduced fruit crop damage to pears by corn ear moth, by 55% (Long et al., 1998)., Though little work to quantify the economic value of the pest control provided by insectivorous bats exists in South Africa, examples of agricultural pests, where bats most likely control numbers but research is needed include: the Diamondback moth (*Plutella xylostella*) that causes damage to cabbage and cauliflower in the Eastern Cape, the false coddling moth (*Thaumatotibia leucotreta*) that causes damage to fruit in the Western Cape, the Eldana moth (*Eldana saccharin*) in KwaZulu Natal (Atkinson et al., 1981).

     Bats also eat significant quantities of disease vector carrying insects such as mosquitoes (Taylor, 2000; Monadjem *et al*., 2010). Additionally, seed-dispersal and pollination of many ecologically and economically important plants are carried out almost solely by certain species of fruit bats (Fleming *et al*., 2009; Kunz *et al*., 2011). The potential loss of the provision of these ecosystem services should be considered when assessing the environmental impact of wind energy projects.

Tadarida brasiliensis has been shown to make up the majority of bat fatalities at some wind turbine sites in southern North America (Kunz *et al*., 2007; Piorkowski & O'Connell, 2010). Although it is locally very abundant and not protected in USA, this species is of tremendous economic and ecological value (McCracken, 1996; Cleveland *et al*., 2006).

It is possible that the bats located in the region play an important ecosystem function with regard to the endemic fynbos vegetation types found exclusively in the Eastern and Western Cape. Large scale bat fatalities caused by numerous WEFs proposed within these provinces may affect the functioning of the fynbos ecosystem as a whole. However, more investigation into the roles of the Eastern and Western Cape bats is required to confirm this.

7.6.1.3 Reversibility of Impacts

Impacts relating to roosts and habitats can be mitigated, as well as remediated, should rehabilitation efforts take place.

Impacts involving bat fatalities can be mitigated (prevented) but cannot be remediated or reversed due to bat population difficulty to bounce back from disturbance and fatalities.

7.6.1.4 Assessment of impacts of Alternative 1 comprising 50 MW

The 50 MW alternative 1 layout was assessed in the bat specialist study prepared by Stefanie Dippenaar and was included in the Draft EIA Report (CSIR 2012). Based on the existing limited information available at the time and the findings of the site visit, the potential impact of the wind turbines on bats at the proposed Banna Ba Pifhu was anticipated to be **negative and of medium significance with mitigation, and medium – high without mitigation**. Ms Dippenaar stated that the overall confidence levels were low as only one month of monitoring data has been incorporated into the study and proposed that further pre-construction monitoring be undertaken. Additional pre-construction monitoring was undertaken by NSS and informed the revised bat study that is included in the Final EIA report.

7.6.1.5 "No-Go" Option

Turbines rated with a high to very high significance should not be built in the proposed location and the developer should consider another site for these turbines. No turbines have been rated as high or very high risk in this preliminary report, hence only operational mitigation measures would be required. However, this may change in the final monitoring report. Authorities must take this into account when issuing the environmental authorization. Construction of the turbines must not commence until the 12 months monitoring has been completed.

Authorities should also institute restrictions in this region with regard to the number of / density of wind energy facilities, as the bat activity is considered to be high relative to international literature. An applicable density of turbines per square kilometre should be established for the region to ensure that impacts to bats are limited on a large scale.

Table 7-10: Overall Impact Assessment

No.	IMPACT		Type	Status	Extent		Duration		Intensity		Probability		Significance		Confidence	
					Details	Rating	Details	Rating	Details	Rating	Details	Rating	Details	Total	Details	Rating
CONSTRUCTION PHASE																
1	Bat roost disturbance and/or destruction due to construction activities	Without Mitigation	Direct	Negative	Local	2	Short Term	2	Low	2	Definite	4	Medium	24	Low	1
		With Mitigation	Direct	Negative	Site Specific	1	Short Term	2	Negligible	1	Improbable	1	Very Low	4	High	3
2	Fragmentation to and displacement from foraging habitat due to wind turbine construction.	Without Mitigation	Indirect	Negative	Local	2	Medium Term	3	Medium	3	Highly Probable	3	Medium	24	High	3
		With Mitigation	Indirect	Negative	Site Specific	1	Medium Term	3	Low	2	Probable	2	Low	12	High	3
3	Loss of Conservation Important Bat Species from the area due to construction activities	Without Mitigation	Cumulative	Negative	Site Specific	1	Permanent	5	High	4	Highly Probable	3	Medium	30	Low	1
		With Mitigation	Cumulative	Negative	Site Specific	1	Permanent	5	High	4	Probable	2	Medium	20	High	3
OPERATIONAL PHASE																
4	Bat fatalities due to collision or barotrauma due to attraction of bats to towers for roosting or out of curiosity	Without Mitigation	Direct	Negative	Local	2	Long Term	4	Medium	3	Probable	2	Medium	18	Low	1
		With Mitigation	Direct	Negative	Site Specific	1	Long Term	4	Low	2	Probable	2	Low	14	High	3
5	Bat fatalities due to collision or barotrauma during foraging activity	Without Mitigation	Direct	Negative	Regional	3	Long Term	4	High	4	Highly Probable	3	High	33	Low	1
		With Mitigation	Direct	Negative	Local	2	Long Term	4	Low	2	Improbable	1	Low	8	High	3
6	Bat fatalities due to collision or barotrauma during migration	Without Mitigation	Direct	Negative	Regional	3	Long Term	4	High	4	Highly Probable	3	High	33	Low	1
		With Mitigation	Direct	Negative	Regional	3	Long Term	4	Low	2	Improbable	1	Low	9	High	3
7	Bat fatalities due to electrocution from overhead powerlines	Without Mitigation	Direct	Negative	Regional	3	Long Term	4	Low	2	Probable	2	Medium	18	Low	1
		With Mitigation	Direct	Negative	Regional	3	Long Term	4	Negligible	1	Improbable	1	Low	8	High	3
8	Loss of Conservation Important Bat Species from the area due to operation activities	Without Mitigation	Cumulative	Negative	Regional	3	Long Term	4	Medium	3	Definite	4	High	40	Low	1
		With Mitigation	Cumulative	Negative	Regional	3	Medium Term	3	Low	2	Probable	2	Medium	16	High	3
9	Loss of bats providing important ecosystem services	Without Mitigation	Cumulative	Negative	Regional	3	Medium Term	3	Medium	3	Definite	4	High	36	Low	1
		With Mitigation	Cumulative	Negative	Regional	3	Medium Term	3	Negligible	1	Probable	2	Low	14	High	3

7.6.2 Mitigation and Management Measures

7.6.2.1 Mitigation and Management Measures for Roost Disturbance / Destruction

- Identified roosting sites must be avoided during construction and recommended buffer zones must be adhered to;
- Riparian zones must be avoided during construction;
- Thicket habitat must be avoided during construction;
- Keep all construction activities away from steep rocky slopes and distinct rock out crops.
- Avoid road and powerline crossings over rivers and gorges where possible;
- Minimizing the extent of the footprint area to be disturbed by pre-construction and construction activities at the turbine locality; and
- Minimize the extent, as far as practicable, to be developed as roads, power lines, fences, and other infrastructure associated with the wind energy project.

7.6.2.2 Mitigation and Management Measures for Fragmentation / Displacement from foraging grounds

- A minimum distance of 250m from blade tip to blade tip should be kept open between each turbine;
- Keep lighting to minimum;
- Lights should be hooded downward and directed to minimize horizontal and skyward illumination. Minimize use of high intensity lighting, steady-burning, or bright lights such as sodium vapour, quartz, halogen, or other bright spotlight;
- All internal turbine nacelle and tower lighting should be extinguished when unoccupied; and
- Minimize impacts to wetlands and water resources by following all applicable provisions of the National Water Act and keep all turbines outside of No-Go areas.

7.6.2.3 Mitigation and Management Measures for Bat Fatalities

- Completion of the Long-term Pre-construction Monitoring. NSS has completed a third of the current monitoring. All impacts and mitigation measures should only be finalised after the completion of the monitoring.
- Turbine placement and dimensions:
    - There is very little knowledge available with regard to optimal turbine spacing in terms of distances between turbines and bat impacts. However, NSS would recommend:
        - Gaps of at least 250m are left open between turbine, 250m from blade tip to blade tip; and
        - Smallest feasible rotor diameter of the turbines.
    - WKN Windcurrent also proposed that fewer turbines with larger blades as an alternative to the current layout. A study conducted by Barclay *et al* (2007) compared bird and bat fatalities from older smaller turbines with newer larger turbines. Bird fatalities dropped with the bigger turbines, whereas, an increase in bat fatalities was witnessed at the same turbines. It can be stated then that fewer larger and taller turbines are not a solution for avoiding bat fatalities onsite. Rotor blade length should be kept as short as possible to ensure that blade tip speeds are as slow as possible.

- High Sensitive areas or high – very high rated turbines should be "No-Go".
- In Medium Sensitive areas or for Medium Rated Turbines, WKN Windcurrent should commit to implementing operational mitigation measures, as will be specified in the final bat monitoring report, to reduce fatalities and negative impacts on local bat populations.
- Foraging and Migration
  - As there is no specific mitigation measures proven to be effective for preventing this specific aspect, most mitigation recommended is the same as for reducing fatalities in flying bats. Deterrent features could be a possible additional measure in the future, if specific turbines show mortalities and as such technology is proved to be effective. This would be in addition to curtailment measures, an example includes:
    - Electromagnetic Radar: Nicholls & Racey (2009) showed that bat activity and foraging effort per unit time were significantly reduced during experimental trials when a radar antenna was fixed to produce a unidirectional signal therefore maximising exposure of foraging bats to the radar beam.
  - Post construction monitoring will be done to determine the actual extent of the impacts.
- Species of Conservation Importance
  - The same measures proposed above will be applicable. In addition, should any new cave or tunnel roosts be discovered near to site, revised buffers must be placed on these systems.
  - Post construction monitoring to determine actual impact. Should impacts be considered high from migration activities then additional measures to protect these species must be considered.

The preconstruction monitoring for the Banna Ba Pifhu project is not complete and further mitigation measures may be instituted when season behaviour has been recorded. Transects will also be analysed and the findings included. These mitigation measures should be seen as preliminary recommendations and not the final findings.

7.6.3 Post Construction Monitoring

The long-term post-construction monitoring must be conducted according to Sowler and Stoffberg's (2012) guidelines and should be conducted to monitor the effectiveness of the mitigation and residual bat impacts, in order to readjust mitigation measures.

The long term post construction monitoring will include the following:

- First 2 years of static acoustic monitoring at each nacelle to determine whether the bats are attracted to the turbines.
- Carcass search for the first 2 years daily in the months of April and September. Additional months or time frames may be included should the findings of the 12 month monitoring indicate other high activity periods.
- Carcass findings must be documented. Should conservation important species be amongst the fatalities, additional mitigation measures to protect these species must be instituted.
- Continual monitoring throughout operation maybe required to ensure Environmental Authorisation / permit requirements are met.

7.7 CONCLUSION

Natural Scientific Services was commissioned by WKN Windcurrent to conduct a 12 month pre-construction bat monitoring survey at the Banna Ba Pifhu site. Only a third of the monitoring has been completed and due to time constraints for the issuing of this report, not all the data recorded thus far could be included into this report. NSS will generate a final bat monitoring report in May 2013. This chapter is therefore not the final bat monitoring report and NSS reserves the right to make changes to the findings, impact assessment and sensitivity mapping at the completion of the twelve months of monitoring. The final monitoring results and any updates in the findings and sensitivity mapping will be included in the project EMP as part of the detailed design phase.

The findings of this report only represent the static acoustic monitoring for the Autumn and Winter months of 2012. The following important findings are relevant:

- The Banna Ba Pifhu site is considered to have a relatively high bat activity index for the Southern Cape region. Compared to another site similarly located, the site is considered to be similar and slightly higher bat activity levels were recorded. Further monitoring may reduce this number; however, spring and summer seasons may have higher levels of activity due to warmer nightly temperatures or migration activity. The final activity index will be indicated in the final monitoring report.

- *Miniopterus natalensis,* a Conservation Important species, has been confirmed to utilise the proposed Banna Ba Pifhu site. Further mitigation measures may be recommended as part of the final monitoring report to protect this species from fatalities.

- 91% of all bat activity occurs between 17:30 and 19:30 in the evening.

Further monitoring is required for the preconstruction bat monitoring to be in line with Sowler and Stoffberg (2012) bat guidelines. Mitigation measures recommended by the specialist on the completion of the 12 months pre-construction monitoring must be adhered to by the developer and built into the management plan for the site. Any decisions regarding the feasibility of a “No-Go” option should only be done once all the preconstruction long term monitoring is complete.

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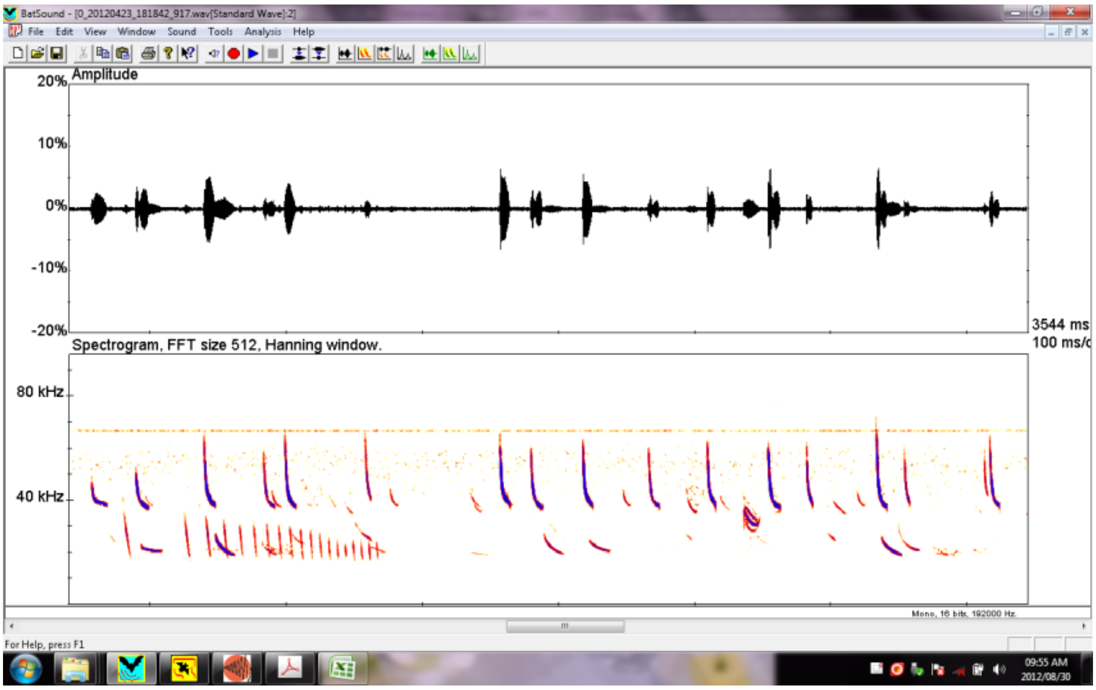
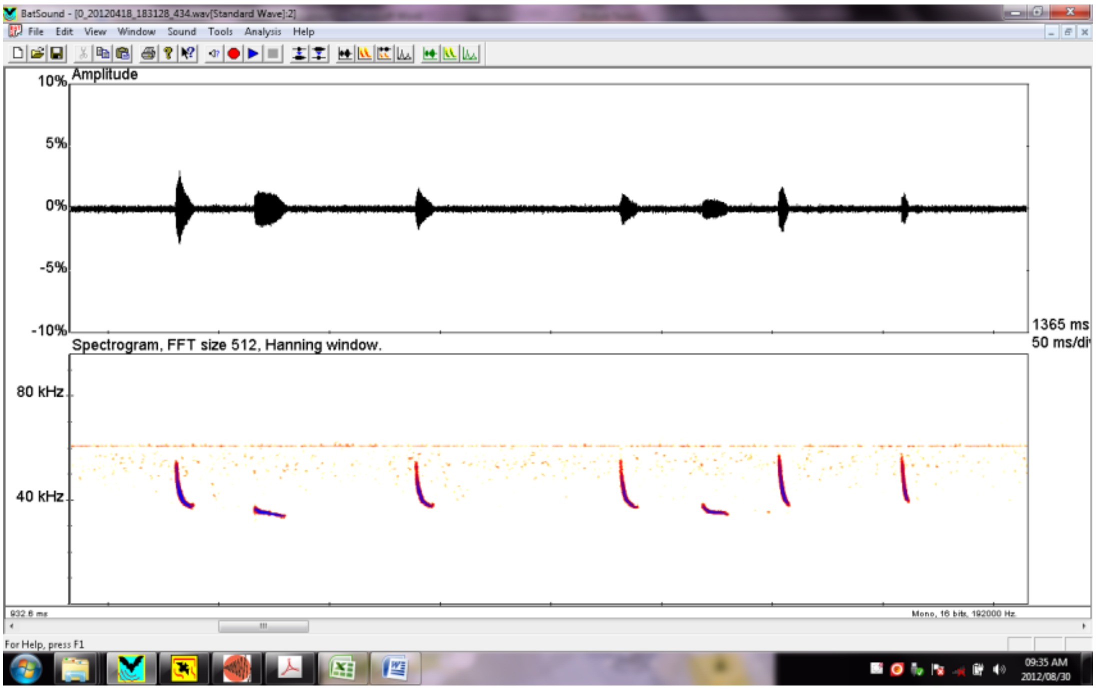
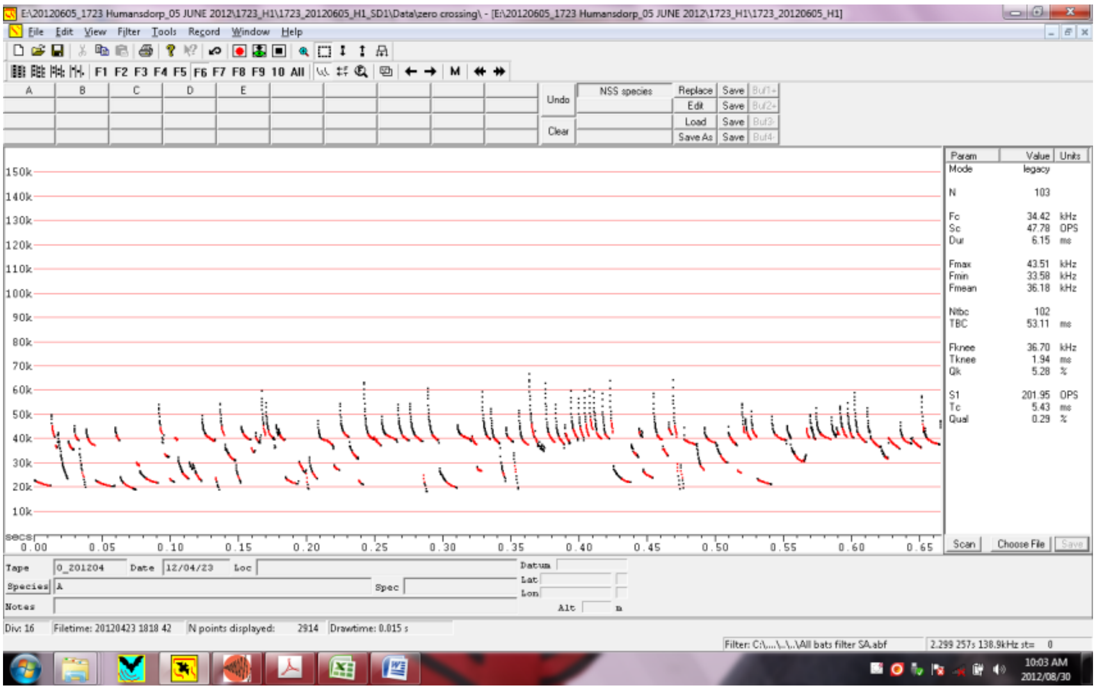
7.9 APPENDIX A: BAT CALL EXAMPLES



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Tools
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NSS species
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Save As
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150k
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100k
90k
80k
70k
60k
50k
40k
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10k
secs
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
Param Value Units
Mode legacy
N 103
Fc 34.42 kHz
Sc 47.78 OPS
Dur 6.15 ms
Fmax 43.51 kHz
Fmin 33.58 kHz
Fmean 36.18 kHz
Ntbc 102
TBC 53.11 ms
Fknee 36.70 kHz
Tknee 1.94 ms
Qk 5.28 %
S1 201.95 OPS
Tc 5.43 ms
Qual 0.29 %
Scan
Choose File
Tape
Date
Loc
Species
Spec
Notes
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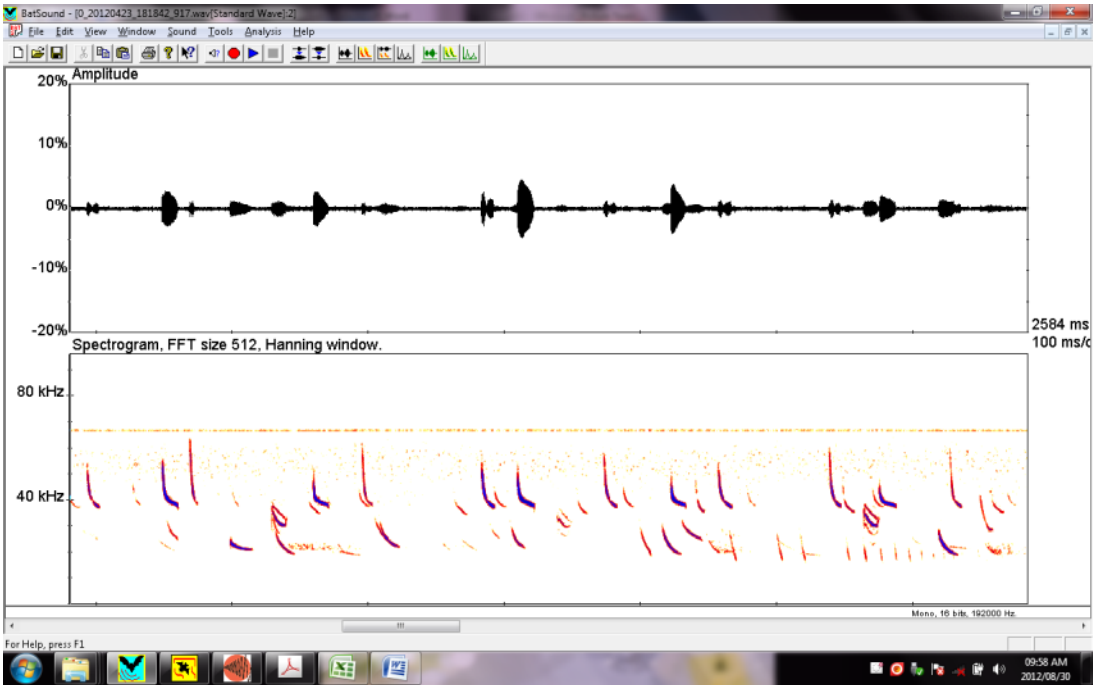
File
Edit
View
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Sound
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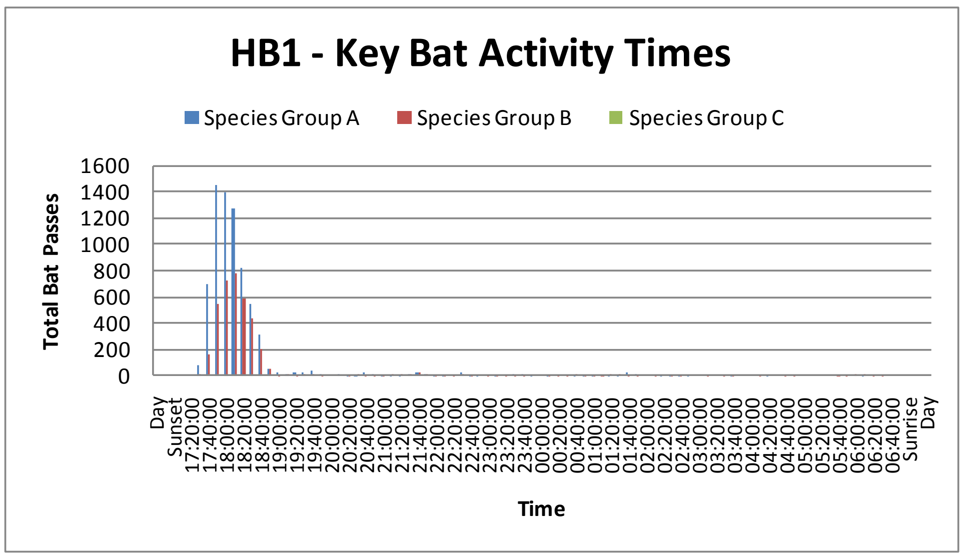
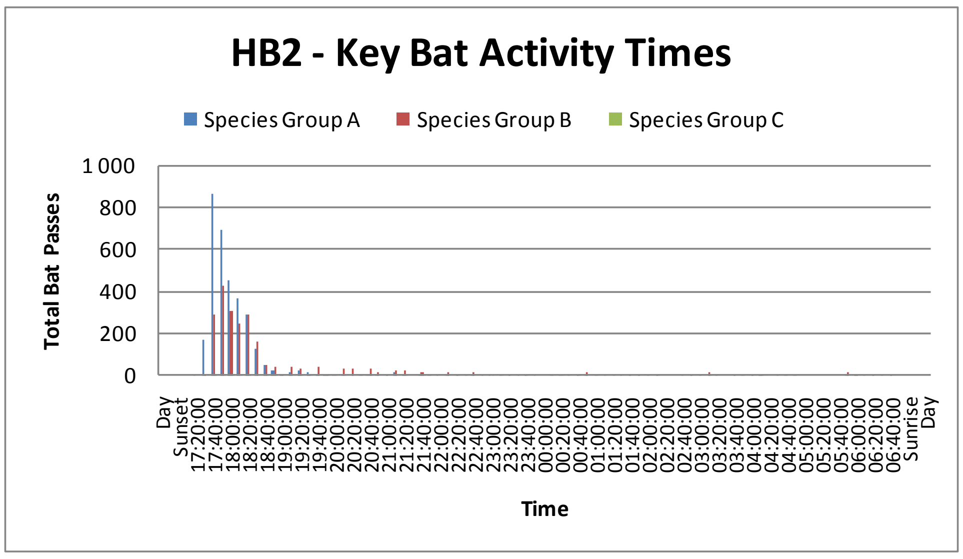
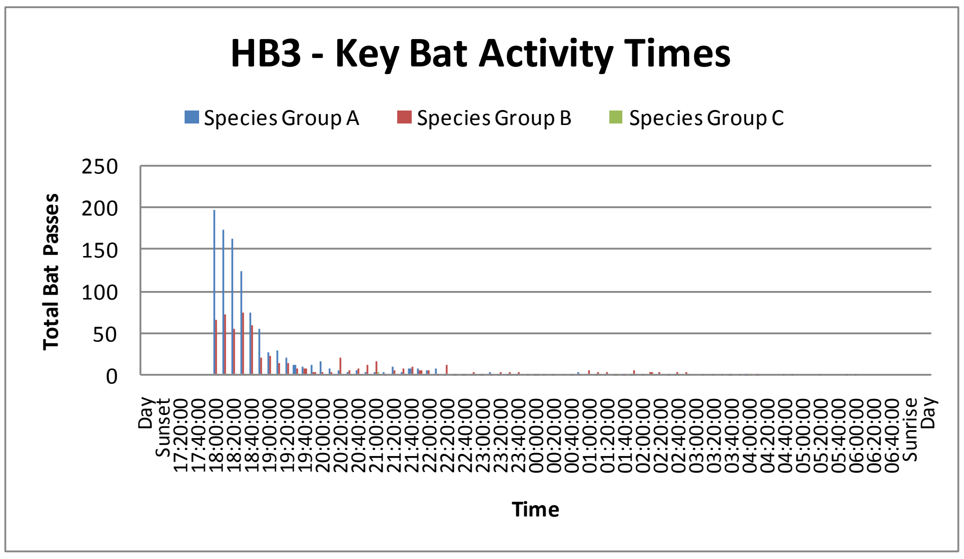
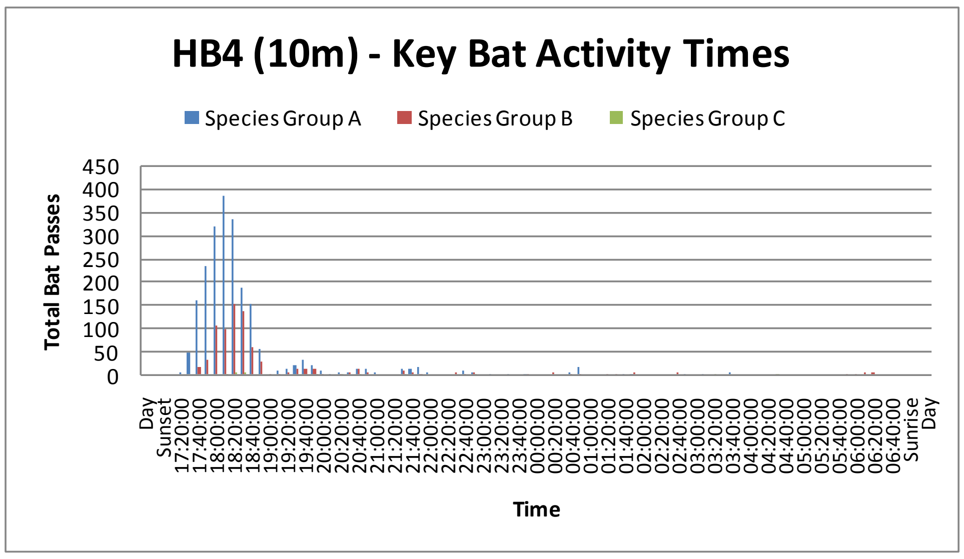
Analysis
Help
Amplitude
20%
10%
0%
-10%
-20%
2584 ms
Spectrogram, FFT size 512, Hanning window.
80 kHz
40 kHz
For Help, press F1

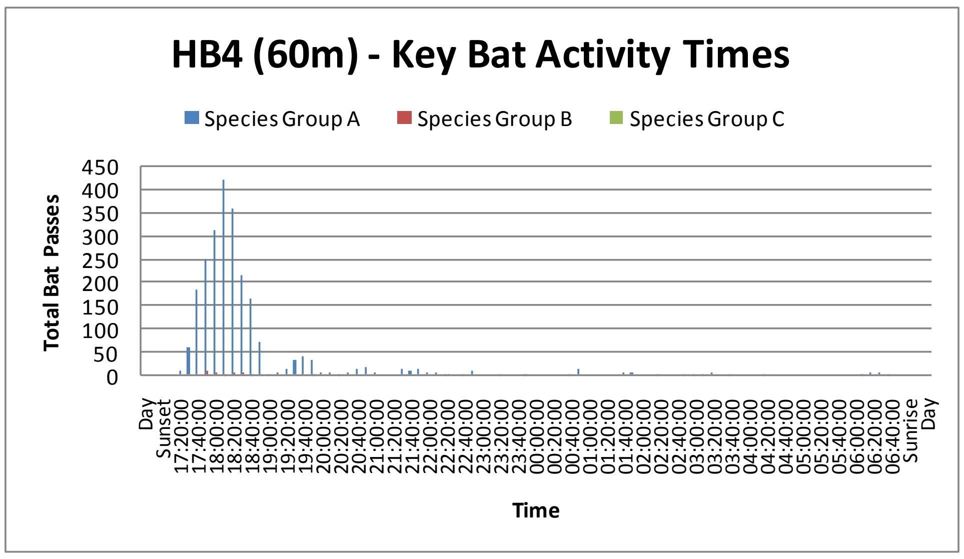
7.10 APPENDIX B: KEY ACTIVITY TIMES FOR EACH MONITORING STATION



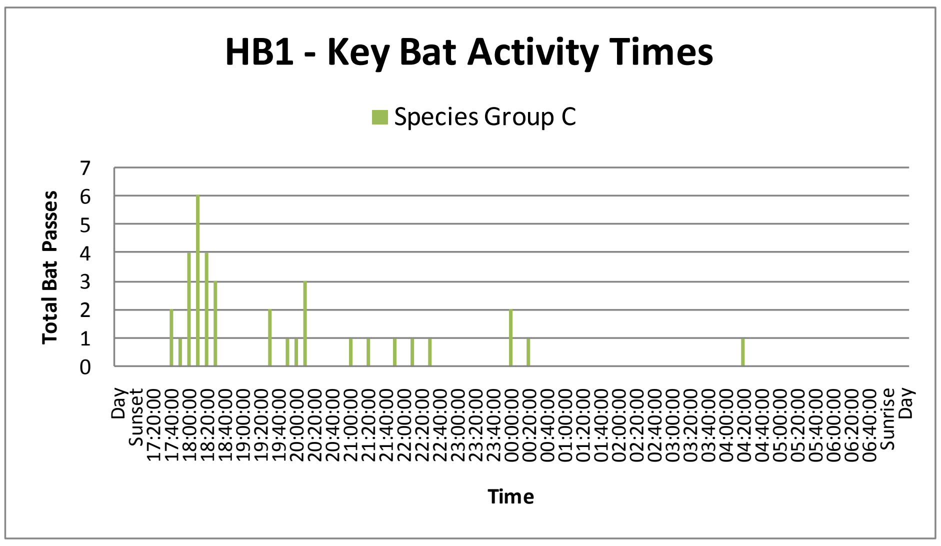


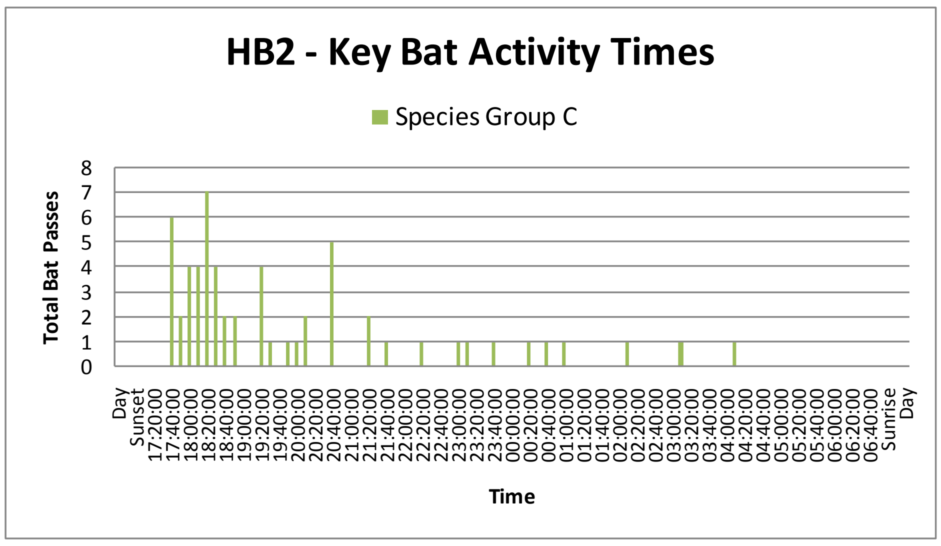


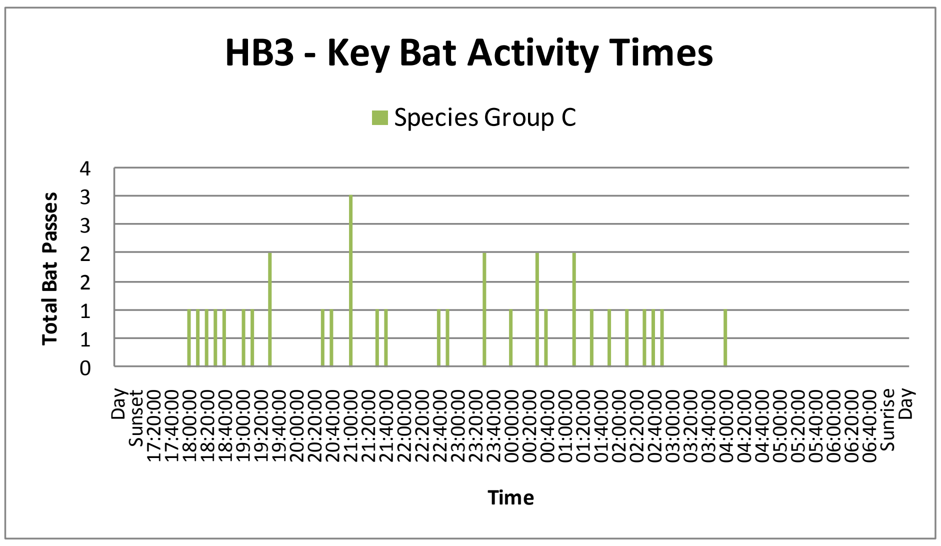


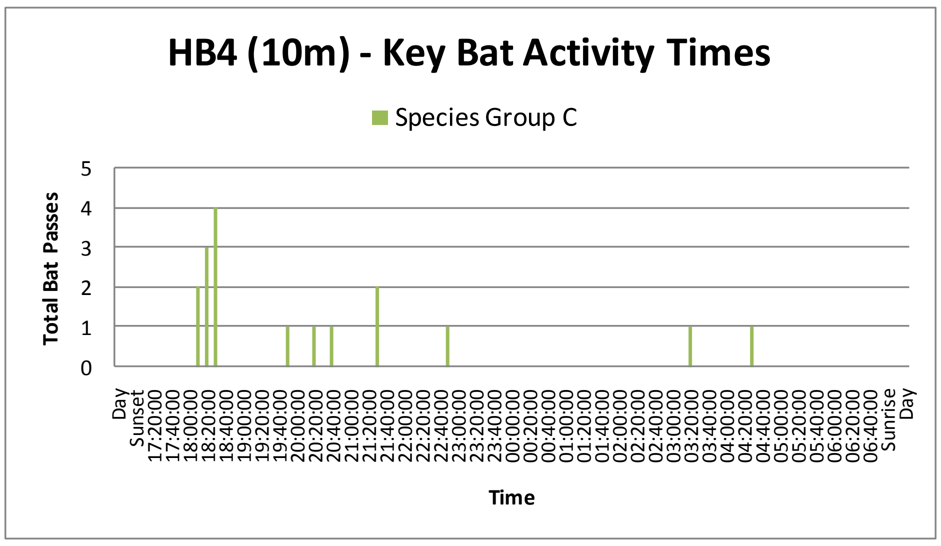


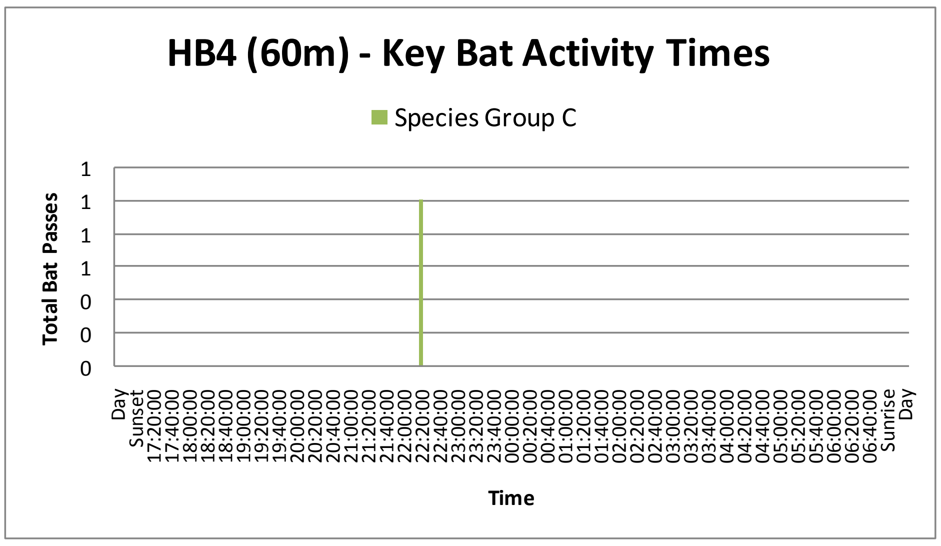
7.11 APPENDIX C: KEY ACTIVITY TIMES FOR SPECIES GROUP C BATS











7.12 APPENDIX D: SPECIES GROUP C RECORDINGS