GREAT KAROO WIND FARM
AMENDMENT APPLICATION IMPACT ASSESSMENT

On behalf of

Savannah Environmental (Pty) Ltd

April 2019

Prepared By:

Arcus Consultancy Services South Africa (Pty) Limited

Office 220 Cube Workspace
Icon Building
Cnr Long Street and Hans Strijdom Avenue
Cape Town
8001

T +27 (0) 21 412 1529 l **E** AshlinB@arcusconsulting.co.za
W www.arcusconsulting.co.za

Registered in South Africa No. 2015/416206/07

TABLE OF CONTENTS

1 INTRODUCTION

Great Karoo Wind Farm (Pty) Ltd are requesting the Department of Environmental Affairs (DEA) to amend the approved wind farm layout, the project description, turbine specifications, turbine foundation and laydown area, as well as the EA validity period as described in the environmental authorisation dated 12 August 2014, and in the associated Environmental Impact Assessment Report (EIAR) dated April 2014. Savannah Environmental (Pty) Ltd have contracted Arcus to undertake an assessment of the amendments with respect to potential impacts to bats. The amendments being applied for are as follows:

- Increase hub height to **up to** 150m;
- Increase rotor diameter to **up to** 180m;
- Increase rated power of turbines to up to 6.5MW per WTG;
- Potential increase to WTG foundation area and laydown area;
- Update the layout as required; and
- Extend the validity period by an additional 5 years[1].

Arcus assumes that "up to" implies that any size of hub height and rotor diameter that is appropriate (based on the client's needs) and available to be supplied by turbine manufacturers may be selected for the Great Karoo wind farm.

1.1 Terms of Reference

The report has been compiled under the following terms of reference and provides:

- An assessment of all impacts related to the proposed changes;
- Advantages and disadvantages associated with the proposed changes;
- A comparative assessment of the impacts before the changes and after the changes; and
- Measures to ensure avoidance, management and mitigation of impacts associated with such proposed changes.

The assessment, undertaken according to the methodology of Savannah Environmental, clarifies whether the proposed changes will:

- Increase the significance of impacts originally identified in the EIA report, or subsequently identified in the previous amendment report, or lead to any additional impacts; or
- Have a zero or negligible effect on the significance of impacts identified in the EIA report, or subsequently identified in the previous amendment report; or
- Lead to a reduction in any of the identified impacts in the EIA report or identified in the previous amendment report.

2 METHODOLOGY

In carrying out this assessment, Arcus conducted a literature review on bats and wind energy impacts with a focus on the relationship between turbine size and bat fatality. The literature review was carried out using the Web of Science® and Google Scholar using the following search terms:

bat OR fatality OR wind energy OR turbine OR wind turbine OR fatalities OR mortality OR mortalities OR kill* OR tower height OR height OR rotor swept zone OR rotor zone OR rotor swept area OR blades OR turbine blades OR influence OR increas* OR trend OR positive OR decreas* OR relation* OR wind farm OR wind energy facility OR carcass* OR chiroptera OR rotor diameter OR correlat* OR size*

[1] Note that the pre-construction bat monitoring data are valid until April 2020. Thus any assessments that are required after this date may require additional bat activity data to be collected.

In addition to the outputs from the above search, the following documentation were reviewed and used to provide context for the impact assessment:

- David Hoare Consulting cc (2012). Specialist ecological study on the potential impacts of the proposed Hidden Valley wind energy facility Project near Matjiesfontein, Northern Cape.
- Savannah Environmental (2014). Proposed Hidden Valley wind energy facility (comprising three development phases) on a site south of Sutherland, Northern Cape Province. Final Impact Assessment Report.
- Savannah Environmental (2014). Proposed Great Karoo wind farm (Phase 3 of the Hidden Valley wind energy facility) Northern Cape Province. Construction and operation environmental management programme (EMPr).
- Animalia (2014). Long Term Bat Monitoring Study. For the proposed Hidden Valley Wind Energy Facility, Western Cape Province.
- Savannah Environmental (2016). Great Karoo wind energy facility near Sutherland in the Northern Cape Province (DEA REF: 12/12/20/2370/3). Motivation for amendment of environmental authorisation.
- Animalia (2016). EA Amendment Assessment Report for the 12-month preconstruction bat monitoring study. For the Great Karoo Wind Energy Facility situation in the Western Cape Province.
- Environmental Authorisations (DEA REF 12/12/20/2370/3; 12/12/20/2370/3/AM1; 12/12/20/2370/3/AM2).

3 REVIEW

The core issue relevant to this assessment is the impact to bats of increasing the size of the turbines at the Great Karoo wind farm. The proposed amendment to the turbines at the wind farm would result in a greater per turbine rotor swept area and hence a potentially greater likelihood bats would collide with turbine blades or experience barotrauma. Currently, the rotor swept area for each turbine is 15,394 m^2 but based on the amendment being applied for, this would increase to up to 25,447 m^2.

Numerous studies support the hypothesis that taller wind turbines are associated with higher numbers of bat fatalities. Rydell et al. (2010) found a significant positive correlation between bat mortality with both turbine tower height and rotor diameter in Germany. However, there was no significant relationship between bat mortality and the minimum distance between the rotor and the ground. The maximum tower height in their study was 98 m and data on rotor diameter were not given. In addition, there was no relationship between bat fatality and the number of turbines at a wind energy facility. However, the largest wind energy facility in this study only has 18 turbines (Rydell et al. 2010) which is significantly fewer than the Great Karoo wind farm.

In Greece, Georgiakakis et al. (2012) found that fatalities were significantly positively correlated with tower height but not with rotor diameter. In their study, maximum tower height and rotor diameter were 60 m and 90 m respectively. In Minnesota and Tennessee, USA, both Johnson et al. (2003) and Fiedler et al. (2007) showed that taller turbines with a greater rotor swept area killed more bats. The maximum heights of turbines in these two studies were 50 m and 78 m respectively. In Alberta, Canada, bat fatality rates differed partly due to differences in tower height but the relationship was also influenced by bat activity (Baerwald and Barclay 2009). For example, sites with high activity but relatively short towers had low bat fatality and sites with low activity and tall towers also had low bat fatality. At sites with high bat activity, an increase in tower height increased the probability of fatality. Maximum turbine height and rotor diameter in this study was 84 m and 80 m respectively. Despite the above support for the hypothesis that taller wind turbines kill more bats, in a review of 40 published and unpublished studies in North America, Thompson et al. (2017) found no evidence that turbine height or the number of turbines influences bat mortality. Berthinussen et al. (2014) also found no evidence of modifying turbine design to reduce bat fatalities. The relationship between bat mortality and turbine size, or number of turbines at a wind energy facility, is therefore equivocal.

Turbine size has increased since the above studies were published and no recent data of the relationship between bat fatality and turbine size are available. The maximum size of the turbines in the literature reviewed (where indicated in each study) for this assessment had towers of 98 m and blade diameters of 90 m. Some towers were as short as 44 m and had blade tips extending down to only 15 m above ground level. The towers and blades under consideration in this assessment are significantly taller than this. The approved turbine dimensions would have a maximum ground clearance of 50 m assuming that the maximum dimensions (120 m high height and 140 m rotor diameter) currently authorised are used. The amendment would result in the blade tips extending from 60 m above ground level to 240 m, based on the maximum dimensions being applied for (i.e. a turbine with 90 m blades and a 150 m hub height).

It is possible that some bats species, particularly those not adapted to use open air spaces, are being killed at the lower sweep of the turbine blades so increasing the blade length and having a shorter distance between the ground and the lowest rotor point may have a negative impact and potentially place a greater diversity of species at risk. In South Africa, evidence of fatality for species which typically do not forage in open spaces high above the ground, is available from several wind energy facilities (Aronson et al. 2013; Doty and Martin 2012; MacEwan 2016). Although Rydell et al. (2010) did not find a significant relationship between bat mortality and the minimum distance between the rotor and the ground, data from Georgiakakis et al. (2012) suggest that as the distance between the blade tips and the ground increases, bat fatality decreases.

It is not known what the impact of turbines of the size proposed for the Great Karoo wind farm would be to bats because of a lack of published data from wind energy facilities with turbines of a comparative size. Hein and Schirmacher (2016) suggest that bat fatality should continue to increase as turbines intrude into higher airspaces because bats are known to fly at high altitudes (McCracken et al. 2008; Peurach et al. 2009; Roeleke et al. 2018). However, McCracken et al. (2008), who recorded free-tailed bats in Texas from ground level up to a maximum height of 860 m, showed that bat activity was greatest between 0 and 99 m. This height band accounted for 27 % of activity of free-tailed bats, whereas the 100 m to 199 m height band only accounted for 6 %.

In South Africa, simultaneous acoustic monitoring at ground level and at height is a minimum standard for environmental assessments at proposed wind energy facilities. Based on unpublished data from 16 such sites Arcus has worked at, bat activity and species diversity is greater at ground level than at height. Therefore, even though bats are recorded at heights that would put them at risk from taller turbines, the proportion of bats that would be at risk might be less. Further, the number of species that might be impacted would decrease because not all bat species use the airspace congruent with the rotor swept area of modern turbines owing to morphological adaptations related to flight and echolocation. Bats that are adapted to use open air space, such as free-tailed and sheath-tailed bats, would be more at risk.

In the United Kingdom, both Collins and Jones (2009) and Mathews et al. (2016) showed that fewer species, and less activity, were recorded at heights between 30 m and 80 m compared to ground level. In two regions in France, Sattler and Bontadina (2005) recorded bat activity at ground level, 30 m, 50 m, 90 m and 150 m and found more species and higher activity at lower altitudes. Roemer et al. (2017) found that at 23 met masts distributed across France and Belgium, 87 % of bat activity recorded was near ground level. However, the authors also showed a significant positive correlation between a species preference for flying at height and their collision susceptibility, and between the number of bat passes recorded at height and raw (i.e. unadjusted) fatality counts. In a similar study in Switzerland, most bat activity was recorded at lower heights for most species but the European free-tailed bat had greater activity with increasing height (Wellig et al. 2018). These results suggest that on average, bat activity is greater at lower heights but that there are important differences across species – those species adapted to using open air spaces are at greater risk.

4 IMPACT ASSESSMENT

During the pre-construction bat monitoring, microphones were placed at 10 m and 50 m on two met masts respectively. The activity data showed that in October and between January and April, Egyptian free-tailed bat activity at 50 m was up to twice that at 10 m but that the average number of bat passes per night was less than six. The Cape serotine was recorded more often at 50 m at one met mast but not the other, and generally less than one bat pass on average was recorded per night at 50 m for this species. Therefore, bat activity at 50 m at the Great Karoo wind farm is low. At a nearby site were Arcus undertook pre-construction bat monitoring, activity at 80 m was also lower compared to near ground level.

The exact turbine dimensions being applied for are up to 150 m for the hub height, and up to 180 m for the rotor diameter. Within this range, the impacts to bats and associated buffer zones needed to limit impacts (as an initial mitigation) will vary depending on the size of the turbines used. Turbines with a lower ground clearance will need to be placed further away from buffers than turbines with a higher ground clearance. For example to determine the buffer distances required to ensure that no turbine blades enter the bat buffer, the following formula should be used (Mitchell-Jones and Carlin 2014):

$$b = \sqrt{(bd + bl)^2 - (hh - fh)^2}$$

Where: bd = buffer distance, bl = blade length, hh = hub height and fh = feature height (zero in this instance)

Thus, based on the above, assuming a buffer of 200 m for example, a turbine with a rotor diameter of 180 m and hub height of 120 m (i.e. 30 m ground clearance) will need to be 264 m away from the buffered feature. A turbine with a rotor diameter of 140 m and hub height of 150 m (i.e. 80 m ground clearance) will need to be 224 m away. The original assessment stipulated a buffer of 100 m from blade tip to the nearest feature of moderate sensitivity and a 500 m buffer from blade tip to the nearest feature of high sensitivity. Therefore, the distance between these features and the turbine base will need to be calculated using the above equation once the turbine size is selected. Any turbines within bat buffers will need to be relocated.

No bat activity data are available in the area between the heights of 10 m and 50 m, between 50 m and 80 m, or over 80 m. Despite the available pre-construction monitoring data showing that bat activity at 50 m and 80 m is low, it would be preferential to maximize the distance between the ground and blade tips by using turbines with the shortest possible blades and the highest possible hub height. This would reduce the number of species potentially impacted upon by turbine blades during the operational phase. It would also be preferential to use shorter blades so that they don't intrude into higher airspaces and in so doing reduces the potential impact to high flying species such as free-tailed bats. Despite the low activity at height, increasing evidence suggests that bats actively forage around wind turbines (Cryan et al. 2014; Foo et al. 2017) so the installation of turbines in the landscape may alter bat activity patterns, either by increasing activity at height and/or increasing the diversity of species making use of higher airspaces.

Of the impacts identified in the EIA, only mortality of species due to collision with turbine blades or due to barotrauma, and cumulative impacts, are relevant to this amendment.

The potential increase in the per turbine footprint should have a negligible effect on bats, and may be offset by the overall conversion of less habitat by using fewer turbines (56 turbines are currently approved with the amendment applying for 42 turbines).

The potential collision impact to bats is currently rated as medium before, and low after mitigation with adherence to the sensitivity buffers being the major mitigation measure proposed. No turbines from the approved layout are located in these sensitivity buffers. The significance of the impact after the proposed change would be dependent on the size of the turbines chosen. The assessments here (Table 1 and Table 2) is based on the scenario where turbines of the maximum dimensions being applied for are used. This would increase risk to high flying species such as free-tailed bats because the turbines blades would extend higher into the air.

Table 1: Impact Assessment Table for Increasing Turbine Size at the Great Karoo Wind Farm

Nature: Mortality of bats due to collision with turbine blades or barotrauma caused by turbine operation.

	Authorised (Animalia 2016)		**Proposed Amendment**	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Extent	Low-medium (2)	Low-medium (2)	Low-medium (2)	Low-medium (2)
Duration	Long term (4)	Long term (4)	Long term (4)	Long term (4)
Magnitude	Moderate (6)	Low (4)	Moderate (7)	Low (4)
Probability	Probable (3)	Improbable (2)	Probable (3)	Improbable (2)
Significance	**36 (Medium)**	**20 (Low)**	**39 (Medium)**	**20 (Low)**
Status (positive or negative)	Negative	Negative	Negative	Negative
Reversibility	Low	Low	Low	Low
Irreplaceable loss of resources?	Yes	No	Yes	Yes
Can impacts be mitigated?	Yes		Yes	

Mitigation:

Mitigation measures

- All currently proposed mitigation measures proposed by Animalia (2014) and Animalia (2016) should be adhered to. This includes adhering to the sensitivity map and buffer zones which may require repositioning turbines depending on the size of the turbines used.
- All mitigation measures to protect bats proposed in the EMPr (2014) must be adhered to which includes adaptive management and the use of curtailment if and when required.

Additional mitigation measures

- The impacts presented can be mitigated by using turbines which maximise the ground clearance as much as possible, and by minimising the tip height (i.e. the distance between the ground and the blade tip at its highest point).

To be included in the EA: a minimum buffer **to blade tip** of 100 m for moderate, and 500 m for high sensitivity bat features must be applied.

Cumulative Impact: see Table 2

Residual Impacts: Residual impacts may still remain even if the moderate and high sensitivity buffers are adhered too and by using turbines of an appropriate size to limit bat fatalities. Bat fatalities are a widely occurring phenomenon having been reported across Europe, North America, Central America, Brazil, India, Australia and South Africa (Baerwald and Barclay 2011; Barros et al. 2015; Hein and Schirmacher 2016; Kumar et al. 2013; Rodríguez-Durán and Feliciano-Robles 2015; Rydell et al. 2010). Further, evidence has shown that pre-construction monitoring data may not be able to adequately predict post-construction fatality risk (Hein et al. 2013), and that bats actively investigate and forge around turbines (Cryan et al. 2014; Foo et al. 2017). This suggests that there may still be fatality impacts. Residual impacts can likely be reduced to very low if curtailment is used when appropriate and this has been shown to be one of the most effective mitigation measures (Arnett and May 2016).

Table 2: Cumulative Impact Assessment

Nature: Cumulative mortality of bats due to collision with turbine blades or barotrauma caused by turbine operation across multiple wind energy facilities.

The cumulative impacts will depend on the number of wind energy facilities in the region, the species involved, the levels of bat mortality and mitigation measures implemented at each wind energy facility. Bats reproduce slowly

(Barclay and Harder 2003) and their populations can take long periods of time to recover from disturbances so the cumulative impacts can be high if appropriate management and mitigation is not implemented.

There are approximately 17 wind energy facilities planned within a 50 km radius of the Great Karoo wind farm. The assessment below assumes all 17 facilities implement appropriate mitigation measures.

	Authorised (Animalia 2014)[2]		**Proposed Amendment**	
	Without Mitigation	With Mitigation	Without Mitigation	With Mitigation
Extent	Medium (3)	Medium (3)	Medium (3)	Medium (3)
Duration	Long term (4)	Long term (4)	Long term (4)	Long term (4)
Magnitude	High (8)	High (8)	High (8)	Moderate (6)
Probability	Definite (5)	Improbable (2)	Definite (5)	Probable (3)
Significance	**75 (High)**	**30 (Medium)**	**75 (High)**	**39 (Medium)**
Status (positive or negative)	Negative	Negative	Negative	Negative
Reversibility	Low	Low	Low	Low
Irreplaceable loss of resources?	Yes	No	Yes	Yes
Can impacts be mitigated?	Yes		Yes	

Mitigation:

Mitigation measures

- All currently proposed mitigation measures proposed by Animalia (2014) and Animalia (2016) should be adhered to. This includes adhering to the sensitivity map and buffer zones which may require repositioning turbines depending on the size of the turbines used.
- All mitigation measures to protect bats proposed in the EMPr (2014) must be adhered to which includes adaptive management and the use of curtailment if and when required.

Additional mitigation measures

- The impacts presented can be mitigated by using turbines which maximise the ground clearance as much as possible, and by minimising the tip height (i.e. the distance between the ground and the blade tip at its highest point).

Residual Impacts: Residual impacts may still remain even if the moderate and high sensitivity buffers are adhered too and by using turbines of an appropriate size to limit bat fatalities. Bat fatalities are a widely occurring phenomenon having been reported across Europe, North America, Central America, Brazil, India, Australia and South Africa (Baerwald and Barclay 2011; Barros et al. 2015; Hein and Schirmacher 2016; Hull and Cawthen 2012; Kumar et al. 2013; Rodríguez-Durán and Feliciano-Robles 2015; Rydell et al. 2010). Further, evidence has shown that pre-construction monitoring data may not be able to adequately predict post-construction fatality risk (Hein et al. 2013), and that bats actively investigate and forge around turbines (Cryan et al. 2014; Foo et al. 2017). This suggests that there may still be fatality impacts. Residual impacts can likely be reduced to very low if curtailment is used when appropriate as this has been shown to be one of the most effective mitigation measures (Arnett and May 2016).

5 CONCLUSION

Compared to the previous impact assessments undertaken by Animalia in 2014 and 2016, it is likely that the amendments to the turbine dimensions proposed at the Great Karoo would slightly increase mortality impacts to bats. This is primarily because the blades will extend higher into the air and place bats using open spaces for commuting and foraging at greater risk. Based on bat activity levels as assessed from pre-construction monitoring data, impacts to bats are likely to be of a medium significance before mitigation and low after mitigation. Cumulative impacts after mitigation would also increase. Cumulative impacts are likely to be of a high significance before mitigation and medium after mitigation. The magnitude of bat impacts may differ based on the exact dimensions of the turbines chosen. Turbines with longer blades that reach lower to the ground would likely have a greater impact by putting a greater diversity of species at risk. Longer blades will also extend higher into the air and place open air species such as free-tailed bats at greater risk. Therefore, we recommend maximising the ground clearance and minimising the tip

[2] Note that Animalia did not assess the impact of the first amendment on cumulative impacts. The cumulative impact assessment performed in 2014 was therefore use as a basis against which to compare the current impact assessment.

height (i.e. the distance between the ground and the blade tip at its height point) as much as possible.

The key initial mitigation measure that should be implemented at the Great Karoo wind farm would be adherence to the sensitivity map created by Animalia. The exact combination of turbine dimensions that will be selected is unknown but depending on the size of the turbines selected, turbines may need to be relocated if they are within any buffers. The final layout will therefore need to be assessed by a bat specialist to ensure this is adhered to once the turbines are chosen. Any turbine micrositing will need to be done before construction. Residual impacts that occur will need to be evaluated during the operational phase using carcass searches to monitor actual impacts. Depending on the outcome of this operational monitoring, curtailment may be needed and this has been included in the EMPr. An initial curtailment design has been provided by Animalia (2014) which can be used to guide adaptive mitigation at the wind farm if required.

6 REFERENCES

Arnett, E.B., May, R.F., 2016. Mitigating Wind Energy Impacts on Wildlife: Approaches for Multiple Taxa. Human–Wildlife Interactions: Vol. 10 : Iss. 1 , Article 5.

Aronson, J.B., Thomas, A.J., Jordaan, S.L., 2013. Bat fatality at a wind energy facility in the Western Cape, South Africa. African Bat Conservation News 31, 9-12.

Baerwald, E.F., Barclay, R.M.R., 2009. Geographic variation in activity and fatality of migratory bats at wind energy facilities. Journal of Mammalogy 90, 1341-1349.

Baerwald, E.F., Barclay, R.M.R., 2011. Patterns of activity and fatality of migratory bats at a wind energy facility in Alberta, Canada. The Journal of Wildlife Management 75, 1103-1114.

Barclay, R.M.R., Harder, L.D., 2003. Life histories of bats: Life in the slow lane, In Bat Ecology. eds T.H. Kunz, M.B. Fenton, pp. 209-253. The University of Chicago Press, Chicago.

Barros, M.A.S., Magalhães, R.G.d., Rui, A.M., 2015. Species composition and mortality of bats at the Osório Wind Farm, southern Brazil Studies on Neotropical Fauna and Environment 50, 31-39.

Berthinussen, A., Richardson, O.C., Altringham, J.D., 2014. Bat Conservation - Global evidence for the effects of interventions. Pelagic Publishing.

Collins, J., Jones, G., 2009. Differences in bat activity in relation to bat detector height: implications for bat surveys at proposed windfarm sites. Acta Chiropterologica 11, 343-350.

Cryan, P.M., Gorresen, P.M., Hein, C.D., Schirmacher, M.R., Diehl, R.H., Huso, M.M., Hayman, D.T.S., Fricker, P.D., Bonaccorso, F.J., Johnson, D.H., Heist, K., Dalton, D.C., 2014. Behavior of bats at wind turbines. Proceedings of the National Academy of Sciences 111, 15126-15131.

Doty, A.C., Martin, A.P., 2012. Assessment of bat and avian mortality at a pilot wind turbine at Coega, Port Elizabeth, Eastern Cape, South Africa. New Zealand Journal of Zoology, 1-6.

Fiedler, J.K., Henry, T.H., Tankersley, R.D., Nicholson., C.P., 2007. Results of bat and bird mortality monitoring at the expanded Buffalo Mountain Windfarm, 2005, Tennessee Valley Authority, Knoxville, Tennessee.

Foo, C.F., Bennett, V.J., Hale, A.M., Korstian, J.M., Schildt, A.J., Williams, D.A., 2017. Increasing evidence that bats actively forage at wind turbines. PeerJ 5, e3985-e3985.

Georgiakakis, P., Kret, E., Carcamo, B., Doutau, B., Kafkaletou-Diez, A., Vasilakis, D., Papadatou, E., 2012. Bat fatalities at wind farms in north-eastern Greece. Acta Chiropterologica 14(2), 459-468.

Hein, C.D., Gruver, J., Arnett, E.B., 2013. Relating pre-construction bat activity and post-construction bat fatality to predict risk at wind energy facilities: a synthesis. A report submitted to the National Renewable Energy Laboratory. Bat Conservation International, Austin, TX, USA.

Hein, C.D., Schirmacher, M.R., 2016. Impact of wind energy on bats: a summary of our current knowledge. Human–Wildlife Interactions 10(1):19–27.

Hull, C.L., Cawthen, L., 2012. Bat fatalities at two wind farms in Tasmania, Australia: bat characteristics, and spatial and temporal patterns. New Zealand Journal of Zoology 40, 5-15.

Johnson, G.D., Erickson, W.P., Strickland, M.D., Shepherd, M.F., Shepherd, D.A., Sarappo, S.A., 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. The American Midland Naturalist 150, 332-342.

Kumar, S., Ali, A., Arun, P., 2013. Bat mortality due to collision with wind turbines in Kutch District, Gujarat, India. . Journal of Threatened Taxa, 5(13), 4822-4824.

MacEwan, K., 2016. Fruit bats and wind turbine fatalities in South Africa. African Bat Conservation News 42.

Mathews, F., Richardson, S., Lintott, P., Hosken, D., 2016. Understanding the Risk of European Protected Species (Bats) at Onshore Wind Turbine Sites to Inform Risk Management. Report by University of Exeter. pp 127.

McCracken, G.F., Gillam, E.H., Westbrook, J.K., Lee, Y.-F., Jensen, M.L., Balsley, B.B., 2008. Brazilian free-tailed bats (Tadarida brasiliensis: Molossidae, Chiroptera) at high altitude: links to migratory insect populations. Integrative and Comparative Biology 48, 107-118.

Mitchell-Jones, T., Carlin, C., 2014. Bats and Onshore Wind Turbines Interim Guidance, In Natural England Technical Information Note TIN051. Natural England.

Peurach, S.C., Dove, C.J., Stepko, L., 2009. A decade of U.S. Air Force bat strikes. Wildlife Conflicts 3:199–207.

Rodríguez-Durán, A., Feliciano-Robles, W., 2015. Impact of Wind Facilities on Bats in the Neotropics. Acta Chiropterologica 17, 6.

Roeleke, M., Bumrungsri, S., Voigt, C.C., 2018. Bats probe the aerosphere during landscape-guided altitudinal flights. Mammal Review 48, 7-11.

Roemer, C., Disca, T., Coulon, A., Bas, Y., 2017. Bat flight height monitored from wind masts predicts mortality risk at wind farms. Biological Conservation 215, 116-122.

Rydell, J., Bach, L., Dubourg-Savage, M.-J., Green, M., Rodrigues, L., Hedenström, A., 2010. Bat mortality at wind turbines in northwestern Europe. Acta Chiropterologica 12, 261-274.

Sattler, T., Bontadina, F., 2005. Grundlagen zur ökologischen Bewertung von zwei Windkraftgebieten in Frankreich aufgrund der Diversität und Aktivität von Fledermäusen. Unveröffentlichter Kurzbericht. SWILD, Zürich im Auftrag von Megawatt Eole, Stuttgart, 23 Seiten.

Thompson, M., Beston, J.A., Etterson, M., Diffendorfer, J.E., Loss, S.R., 2017. Factors associated with bat mortality at wind energy facilities in the United States. Biological Conservation 215, 241-245.

Wellig, S.D., Nusslé, S., Miltner, D., Kohle, O., Glaizot, O., Braunisch, V., Obrist, M.K., Arlettaz, R., 2018. Mitigating the negative impacts of tall wind turbines on bats: Vertical activity profiles and relationships to wind speed. PloS one 13, e0192493.