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WIND TURBINES AND BATS – GUIDELINES FOR AN ASSESSMENT STUDY AND FOR PLANNING ASPECTS

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Abstract

The problem of bats and wind farms is first described. Then guidelines for an assessment methodology are developed in order to take account of this problem in planning schemes. During the studies a distinction between two populations can be made: local and migratory. The local population are those animals present during the breeding period; migratory animals are those, which, especially in early and late summer, and autumn, undertake transfer flights. In doing so, they are killed in significant numbers by wind turbines. For the study we recommend a combination of methods, the bat detector and the "automatic bat registration box". In woodland areas we also recommend mist-netting to evaluate impacts due to the siting and construction of wind farms. In all current research methods, the flight activity of bats at altitudes of more than 100m is virtually unknown – so that here is a special research need. Bat behaviour is different during the summer and the migration period, so the results have to be evaluated and presented separately. Different ways to reduce the impacts are shown. Finally, so that future planning can take this problem into account, we describe fields of research which are urgently needed.

1. The Problem

Wind turbines have been described as a problem for birds for many years (REICHENBACH 2002, 2004): discussion is mainly about their negative effect through bird-strike, but also the avoidance of wind farms during breeding and migratory times by some bird species (REICHENBACH 2002). Since the 1990s, parallel to the discussions and findings about birds, it has been assumed that bats foraging in open air could be similarly affected. As in the mid-1990s wind energy concerned mainly coastal areas, and the problems about "bats and wind energy" were discussed for the first time in German-speaking Europe in two papers published in 1999 (BACH *et al.* 1999, RAHMEL *et al.* 1999). At about the same time, in the USA, JOHNSON *et al.* (2000) published bird-strike findings, and showed in the same article that the number of dead bats found under wind turbines was sometimes higher than the number of dead birds. Meanwhile other reports have corroborated the findings of bat collisions on wind farms, both in Germany and abroad (AHLÉN 2002 [Sweden], ALCALDE 2003 [Spain] and DÜRR 2001, TRAPP *et al.* 2002, DÜRR & BACH 2004 [Germany]).

Several studies have shown that in the course of a year most dead bats are found in late summer and autumn (AlCalde 2003, JOHNSON et al. 2000, JOHNSON et al. 2003, JOHNSON [in press]). It is clear that those bats found most frequently are the migratory species (AHLÉN 1997, AHLÉN 2002, JOHNSON *et al.* 2003, PETERSONS 1990). From this we know that for an environmental impact assessment, we need to include both periods: summer and migration time. This is especially true because now wind turbines are not only a coastal phenomenon: the modern high-performance turbines are also found inland and bat migration is not restricted to coasts and river systems. Especially in mountainous and hilly regions, wind turbines are preferentially built on hill-tops because of the bigger wind potential: such locations are often at the edge of, or even in, woodland. In these locations not only the functioning of the wind farm can have an effect, as is typical in the plains, but its siting and construction in forest areas can accentuate that effect. Bat foraging habitats can be affected and roosts destroyed by the site clearance for the turbines, the building of access roads, and the connecting works to the power network.

The assessment methodology must take into account the summer and migration aspects, in order to avoid and mitigate the impacts satisfactorily.

2. Areas of Conflict

Table 1 shows the most important effects related to the siting and functioning of wind turbines, and to which extent they affect on either the local or migratory population. More details are found in BACH & RAHMEL (2004).

Impacts related to siting		
Impact	**Summer time**	**During migration**
Loss of hunting habitats during construction of access roads, fundaments etc.	Small to medium impact, depending on the species	Small impact
Loss of roost sites due to construction of access roads, fundaments etc.	Probably high or very high impact	High or very high impact, e.g. loss of mating roosts
Impacts related to functioning		
Impact	**Summer time**	**During migration**
Ultrasound emission	Probably a limited impact	Probably a limited impact
Loss of hunting areas because the bats avoid the area	Medium to high impact	Probably a minor impact in spring, a medium to high impact in autumn and hibernating habitats
Loss or shifting of flight corridors	Medium impact	Small impact
Collision with rotors	Small to medium impact	High to very high impact

3. Assessment standards

The aim of bat studies for the impact assessment is to identify the species potentially at risk within the selected study area. These results form the basis for a corresponding evaluation and conflict analysis, and for subsequent advice about avoiding, mitigating, or adjusting for the impacts.

3.1. Study of the local population (summer aspect)

By **local population** (summer aspect), we mean those animals of the same species present during the breeding season or which live all year round in a local habitat. We assume that these animals know their environment and can recognise danger and learn to avoid it. As for the individuals of a local population, most flights are foraging flights, therefore evidence of their presence can be confirmed by the use of ultrasound detectors. And as the foraging areas are probably inherited, it should be possible from a defined number of survey nights to get reproducible results.

For the impacts related to the functioning of the turbines, the species to look for are those that forage high in the sky, and are therefore directly threatened by the rotors. In Germany, at least for the modern wind turbines with a very high rotor axle, the species considered to be most at risk are the two *Nyctalus* species (*Nyctalus noctula* and *Nyctalus leisleri*), the Serotine bat (*Eptesicus serotinus*), the Northern bat (*Eptesicus nilssonii*) (in the higher altitudes of the midlands), the Parti-coloured bat (*Vespertilio murinus*), and probably also *Pipistrellus* species.

At least five whole-night survey sessions with ultrasound detectors need to be carried out within the defined study area, between May and July. Beside using detectors, a visual survey is important during dusk and dawn to be able to identify flight corridors used regularly. Depending on the size and the accessibility of the study area, a corresponding number of assistants will be necessary to ensure total coverage of the site. “Automatic bat registration boxes” will be very useful and will complement the study, as these allow continuous recording over extended time periods. These are equipped with an ultrasound converter (detector) and voice-activated recording equipment, and can record bats at a particular point all night long (see also RAHMEL *et al.* 1999). For each survey night, an automatic bat registration box, tuned to record between 20 kHz and 30 kHz, is to be placed at every point where a wind turbine is to be located. To enable better comparison of general bat activity nearby with the results of bat activity at the proposed wind turbine locations, more automatic bat registration boxes should be set up near other chosen landscape features. The exact number of boxes used will depend on the nature of the site.

The limits of ultrasonic surveys, whether with an automatic bat registration box or a hand-held bat detector, depend on the possibilities of bat identification through their echolocation calls and the range of the latter. Some calls reach further than others. In most observational situations, an expert with a detector can easily identify the species we have named for the study. Moreover, species can also be identified from sound recordings of animals foraging in open-air, where individual cases can later be checked and replayed.

The range of the different bat calls may be a problem. The Noctule bat (*Nyctalus noctula*) can be detected 100m or even 150m away with a high quality detector. But the calls of *Nyctalus leisleri*, *Eptesicus serotinus*, *Eptesicus nilssonii*, *Vespertilio murinus* and especially *Pipistrellus* species do not reach so far. The louder the calls of a species and the lower the frequencies, the better the chances of detecting them from a distance. A bat detector or an automatic bat registration box used in “normal” conditions cannot give a complete idea of bat activity at the height of the rotor axle of a modern wind turbine (100 m and more). In principle it must be possible to raise the recording unit with some sort of device to the necessary height, without compromising air safety. Animals on transfer flights which do not echolocate or echolocate with large gaps between the calls, cannot be reliably contacted. Reliable recording of bats flying at height is currently only possible with the use of high-quality thermal imaging cameras. These require quite a lot of technical expertise which has to be calculated in the study costs.

If wind turbines are built in woodland, it is important to record the effect of their location and installation on the whole spectrum of species present, by using mist-nets as well as detectors. This type of study needs at least six to seven survey sessions throughout the summer. Moreover, it is necessary to check if bats are roosting in nearby trees (see also BRINKMAN 2004).

The study area must be carefully delineated, taking into account the landscape features. In most cases, it should be enough to take a 1,000m radius from the outer turbines of an array to study the impact of their functioning. This area corresponds to the radius of activity known for the above mentioned species and includes their foraging habitat. The area which needs to be studied to evaluate the effects of siting is smaller.

3.2. Studying migration periods

Some native bat species are known to occasionally fly long distances between their summer and winter roosts. The best known examples are *Nyctalus noctula*, *Nyctalus leisleri* and *Pipistrellus nathusii* (BOYE *et al.* 1999, PETERSONS 1990). All other European species, especially the Pipistrelle bat (see SIMON *et al.* 2004), also make transfer flights between their summer, winter and mating roosts. There are a number of clues that bats which otherwise orientate themselves by landscape features, e.g. the Pipistrelle bat, make these transfer flights at a higher altitude, so, unlike the animals which belong to the local population, these bats are probably not familiar with local dangers. Consequently, wind farms pose a much greater threat to them than to the local population. This assumption comes from the fact that most dead bats are found during migratory periods in summer and autumn (ALCALDE 2003, DÜRR & BACH 2004, JOHNSON *et al.* 2000 and 2003, own observations). It is also evident that most of the dead bats belong to species which regularly undertake long distance transfer flights (AHLÉN 1997 and 2002, JOHNSON in press). This means that in the study a corresponding significance must be given to migrating bats. During the months when the migratory animals are on the move, additional survey sessions in the study area are necessary. According to our current knowledge, transfer flights are made during April, May, August and September and, depending on the region in Germany, also in October. As with birds, to record these transfer flights at least one survey per week is necessary. So, in addition to the sampling of the local population another 16 to 20 field sessions are necessary. The exact number depends on regional conditions. During migratory periods it is not absolutely necessary to record complete nights: in early summer, the main focus is the first part of the night, because it is known, at least in that season, that this is when some of the species of concern are most active. In the autumn, from mid-September, migrating bats can sometimes be expected in the late afternoon hours. During this period recording sessions should be started sufficiently early.

Direct observation of migrating animals is apparently only possible with a high quality thermal imaging camera. Indirect information on migrating bats can be taken from the increasing number of *Pipistrellus nathusii* and *Nyctalus* bats in the spring and late summer months. At least a measurable increase of activity (e.g. from ultrasonic contacts and new individuals in bat boxes) or the appearance of more *Nyctalus* bats and/or *Pipistrellus nathusii*, where in the summer there had been only a few, can indicate migrating bats. In late summer or autumn it is possible to identify migration areas because of the increase in the number of courting *Pipistrellus nathusii* and *Nyctalus* bats as males probably do their advertising displays mainly along the migration routes. The mating season is in August or

September, depending on the area. As the peak of *Nyctalus* advertising calls is mostly during the second half of the night, recording sessions during these two months are whole-night affairs.

A general problem in the assessment of bat migration is that there are serious gaps in our knowledge of migration routes, migration physiology and orientation (see also AHLÉN 1997 and 2002, BACH 2002, PETERSONS 1990). The height of the bats during their long distance flights is not known, nor whether they orientate along landscape features, or whether they chose traditional routes where mating areas form some sort of "stepping stones". And there is also a lack of knowledge on how they orientate in space. It is assumed that visual orientation could partly happen (EKLOEF 2003). Certainly for animals which fly above 50m we can safely assume that echolocation is of lesser importance because the intensity of the ultrasound calls is too weak for the echoes to reflect from the ground. If this assumption is correct, then the animals can register the wind turbines and the fact that the rotors move, but they are unable to assess the movement of the blades and the speed at which they rotate. This would explain the high number of collisions with wind turbines.

But this also brings important uncertainties for the study methodology. Insofar as migrating animals emit just a few calls or fly above 100m, they can hardly be heard with a detector. If they are silent and do not make any calls (at any height), then during darkness we cannot identify their presence using this standard method. So it is important to extend the observation period to include directly before and directly after sunset. During darkness, the use of thermal imaging cameras could be a sensible addition. In principle it is possible to track bats and birds by radar although there is not much known about the use of this technology with bats so far, and some experts say it is not possible to distinguish bats from birds using the available civil radar equipment.

To summarise the requirements for a bat study:

Study area

- For impacts related to the functioning of turbines: a minimal radius of 1,000m from the wind turbines.
- For impact related to siting (woodlands): a smaller area in the encroachment zone.

Study periods and number of recording sessions

Local population in the summer

5 sessions between May and July, using bat detectors, automatic bat registration boxes (whole nights). If the wind farm is planned in the forest this should be completed by 6 mist-netting sessions throughout the season and the search for roost-trees.

Migratory species

- from mid-April until mid-May, depending on the location: 4 x 4-6 hours of detector transects, automatic bat registration boxes (half night). An average of 1 session per week.

- from August, September to October 10-14 x 4-6 hours of detector transects, automatic bat registration boxes (half night), of which 4 survey sessions should long 10-12 hours (all night) for the main mating season. This gives an average of 1 session per week.

4. Background information and processing of results

For assessment and replication of the results a detailed description of the methods cannot be avoided, as the data must also be interpreted by a third party. It is at this point that you need to be careful, so that the project should be admissible in court, research standards should be current state-of-the-art. The field protocols guarantee the transparency of the results and they should be appended to the respective report. These should have the exact location of species as well as observable or deduced behaviour (foraging, transit flight, flight route, mating behaviour, roosts). According to the above shown method, the results should also be sorted according to the time of year, so that results for the local or migratory populations are presented in a replicable way into spring migration, birth giving, and late summer/autumn migration. Another parameter which needs to be included is the phase of the night in which the activity was recorded.

Such a procedure will enable the results to be used for an impact analysis as well as for measures which will help avoid or minimise the disturbance.

5. Evaluation

Evaluation is done according to local and regional conditions. Important criteria to take into account are Red Lists, the EUROBATS Agreement, the European habitat directive Annex II and IV, as well as the status of the animals according to the Law on Protected Species. Whenever possible, relationships to the type of biotope/habitat structure should be worked out, and the function of the area should be described (foraging area, flight corridor, roosts, hibernation sites, etc., daily and annual aspects).

This means that the observed species spectrum is compared to the expected species number defined for any given landscape section. The more complete the species spectrum, in principle the higher the value of the sites. At this point we need to take into consideration that a bat study at wind farms on open land aims at the impacts related to the functioning of turbines and concerns preferably the defined species. Whereas in woodland the whole species spectrum is the subject of study, so as to be able to predict the impacts related to siting as well.

The evaluation should state both the functioning and the siting threats for each proven bat species, considering at the same time the regional Red List status.

Results from detector and automatic bat registration box recordings allow areas to be classified on a scale of daily and annual use. Both the individual functions (foraging habitat, flight corridor), as well as daily/seasonal aspects (e.g. foraging activity in the early evening, or a maximum of activities in August) must be worked out, analysed and portrayed as a “layer” which is superimposed to give a more complete picture. From the superimposition of layers we can deduce areas which show few conflicts. On the other hand, the separate layers represent the bases for the analysis of partial effects, which will be taken up later in the avoidance and mitigation measures.

6. Conflict analysis and disturbance limitation

- Conflict analysis should be done for each proven species and for each use of the site, concentrating on those species most affected. It needs to be decided if the disturbance is significant or not. To deduce the impacts to be expected, statements should be made for each assessment, for each of the following:

  - loss of habitat (according to its function e.g. feeding area, roost, migration corridor),
  - risk of collision,
  - barrier effect, displacement,
- Evaluation of the individual conflict points (significant, not significant),
- Justification of the degree of significance.

As described before, a planned wind farm would interfere with only some aspects of functional relationships, in time and space, of bat habitats. Conflict analysis must confront individual layers of results and of evaluations with each wind turbine siting and must submit every location to an individual examination. Any occurring conflict is to be dealt with according to impact regulation rules. Available regional agreements may provide a suitable basis, for example in Lower Saxony there are "Nature Conservation Notes about Intervention, for use by Building Supervisors" (BREUER 1994) to be used with "Guidelines for impact regulation in the Lower Saxony Nature Conservation Law for the building of wind turbines" (MINISTRY FOR THE ENVIRONMENT 1993).

According to the federal law on nature preservation, avoiding impacts is a clear priority. According to the order of avoiding after §19BnatSchG, natural heritage and landscape should not be disturbed more than absolutely necessary. Unavoidable disturbance should be compensated in an appropriate way. Compensation means that the functions which have been lost in the natural environment, for example living space for particular fauna and flora species, should ideally be reconstructed as soon as possible at the same site. This is not realistically possible for bats.

If this compensation is not possible then it must be decided whether nature conservation and the landscape have priority over other needs. If the impact cannot be compensated but has priority, then the agent responsible for the intervention must provide a substitute or replacement. These are usually some distance away, but should be within the natural area affected by the installation and should be proportionate to the impact identified.

A number of solutions can be put forward so that wind turbines are not such a threat to bats. A planning situation could occur which only partly affects bat habitats and only at certain times in the year, e.g. migration. Where it is about space (e.g. destruction of a valuable foraging or mating habitat by one turbine), it could be possible to move the turbine to an area of lesser impact (minimal distance should be at least 250m away from a foraging or mating area) or to cancel the planned wind turbine installation. Problems may only occur at certain hours and seasons. This is particularly true with the use of flight corridors outside of foraging habitats. Such routes are used by lots of bats shortly after dusk and then again before dawn. The collision risk with wind turbines can be reduced, for example, by reducing the daily operational times, so that between mid-March and the end of October the turbines in the flight corridor do not rotate for between 90 and 120 minutes around sunset and before dawn. Another planning case is the annual bat migration during the late summer and autumn migration, and during mating times. In such cases it could be necessary to restrict the wind farm operational times in, for example, the months of August and September, to the daylight hours. The risk to migrating bats would thus be avoided, or at least minimised. To double-check operational time limitations it is recommended after the wind farm has started up, to monitor and carry out intensive dead bat collections during operational times and other surveys during standstill periods. This would allow the operational times to be adapted appropriately.

As for compensation for the effects, there are various solutions which re-create and optimise roosts and foraging habitats in forests and open land. For solutions in woodland, see MESCHEDE & HELLER (2000). Such plans should not be implemented in wind farm areas, because hedge planting, ponds, lakes or the creation of other features in the planned wind farm could attract bats and raise the probability of bat collision.

7. Research needed

The subject of "Bats and Wind Energy" is one which still needs a considerable amount of research: whereby we can distinguish between individual studies and basic research.

Examples of the former are the systematic and effective search for collision victims under the blades (see DÜRR & BACH 2004), the analysis of wind turbine and weather data for the different surveys (temperature, wind speed and direction, running times, rotor speed, etc.) in relation to the fauna correlation/mortality (searches), the checking of the attractiveness of lit and unlit turbines at night for insects and bats.

Research is also needed on the effects of wind turbines on the use of foraging habitats by species hunting high in the sky.

General research needs including the height at which bats fly while foraging and migrating, and their systems of orientation during long distance flights. How do bats establish a flight corridor? How do they follow it? It is still unclear to what extent the mating areas and their attractiveness for bats may induce problems related to wind turbines and what effect the turbines own ultrasound emissions have on bats.

The aim of the work described here is to learn and to document the massive problems which the bats have, and from this to be able to use and improve this source of renewable energy in a bat-friendly way.

8. References and authors' addresses

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8 Literaturverzeichnis

ALCALDE, J.T. (2003). Impacto de los parques eólicos sobre las poblaciones de murciélagos. - Barbastella 2: 3-6.

AHLÉN, I. (1997): Migratory behaviour of bats at south Swedish coasts. - Z. Säugetierk. 62: 375-380.

AHLÉN, I. (2002): Fladdermöss och fåglar dödade av vindkraftverk. - Fauna och Flora 97, 3:14-22.

BACH, L. (2001): Fledermäuse und Windenergie – reale Probleme oder Einbildung? – Vogelkund. Ber. Niedersachs. 33 (2): 119-124.

BACH, L., R. BRINKMANN, H. LIMPENS, U. RAHMEL, M. REICHENBACH & A. ROSCHEN (1999): Bewertung und planerische Umsetzung von Fledermausdaten im Rahmen der Windkraftplanung. - Bremer Beiträge für Naturkunde und Naturschutz Band 4: 162-170.

BACH, L. & U. RAHMEL (2004): Effekte von Windenergieanlagen auf Fledermäuse. In diesem Band

BOYE, P., DIETZ, M. & WEBER, M. (1999): Fledermäuse und Fledermausschutz in Deutschland. - Bundesamt für Naturschutz (Hrsg.), Münster: Landwirtschaftsverlag.

BREUER, W. (1994): Naturschutzfachliche Hinweise zur Anwendung der Eingriffsregelung in der Bauleitplanung. Inform. d. Naturschutz Niedersachs. 14 (1): 1-60.

BRINKMANN, R. (2004): Welchen Einfluss haben Windkraftanlagen auf jagende und wandernde Fledermäuse in Baden-Württemberg? - Tagungsführer der Akademie für Natur- und Umweltschutz Baden-Württemberg, Heft 17, "Windkraftanlagen – eine Bedrohung für Vögel und Fledermäuse?" (in Vorbereitung).

DÜRR, T. (2001): Fledermäuse als Opfer von Windkraftanlagen. – Naturschutz und Landschaftspflege in Brandenburg 10: 182.

DÜRR, T. & L. BACH (2004): Fledermäuse als Schlagopfer von Windenergieanlagen - Stand der Erfahrungen mit Einblick in die bundesweite Fundkartei. I.d.Bnd

EKLÖF, J. (2003): Vision in echolocating bats. – Dissertation an der Univ. Göteborg: 106 S.

JOHNSON, G. D., W. P. ERICKSON, M. D. STRICKLAND, M. F. SHEPHERD & D. A. SHEPHERD (2000): Avian monitoring studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a 4-year study. – unveröff. Bericht der Northern States Power Company, Minnesota: 262 pp..

JOHNSON, G. D., W.P. ERICKSON, M.D. STRICKLAND, M.F. SHEPHERD & D.A. SHEPHERD (2003): Mortality of bats at a Large-scale wind power development at Buffalo Ridge, Minnesota. – Am. Midl. Nat.150: 332-342.

JOHNSON, G. D. (im Druck): What is known and not known about impacts on bats? – Proceedings of the avian interactions with wind power structures, Lackson Hole, Wyoming.

MESCHEDE, A. & K.-G. HELLER (2000): Ökologie und Schutz von Fledermäusen in Wäldern. – Schriftenr: Landschaftspflege u. Naturschutz, Heft 66.

NIEDERSÄCHSISCHES UMWELTMINISTERIUM (1993): Leitlinie zur Anwendung der Eingriffsregelung des Niedersächsischen Naturschutzgesetzes bei der Errichtung von Windenergieanlagen. - Inform. d. Naturschutz Niedersachs. 13(5): 170-174.

PETERSONS, G. (1990): Die Rauhhautfledermaus, Pipistrellus nathusii (Keyserling u. Blasius, 1839), in Lettland: Vorkommen, Phänologie und Migration. - Nyctalus 3: 81-98.

RAHMEL, U., L. BACH, R. BRINKMANN, C. DENSE, H. LIMPENS, G. MÄSCHER, M. REICHENBACH & A. ROSCHEN (1999): Windkraftplanung und Fledermäuse. Konfliktfelder und Hinweise zur Erfassungsmethodik. – Bremer Beiträge für Naturkunde und Naturschutz, Band 4: 155-161.

Reichenbach, M. (2002): Auswirkungen von Windenergieanlagen auf Vögel – Ausmaß und planerische Bewältigung. – Diss. an der TU Berlin: 207 S..

REICHENBACH, M. (2004): Ein Blick über den Tellerrand – ein Überblick über internationale Studien zu Auswirkungen von Windenergieanlagen auf Vögel. In diesem Band

SIMON, M., HÜTTENBÜGEL, S. & SMIT-VIERGUTZ unter Mitarbeit von BOYE, P. (2004): Ökologie von Fledermäusen in Dörfern und Städten. – Schriftenr. Landschaftspflege u. Naturschutz, Heft 76, Bonn.

TRAPP, H., D. FABIAN, F. FÖRSTER & O. ZINKE (2002): Fledermausverluste in einem Windpark der Oberlausitz. – Naturschutzarbeit in Sachsen 44: 53-56.

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