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Progress Report of the IWG on

"Wind Turbines and Bat Populations"

Members

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Subgroups

To simplify the work, several sub-groups were created:

Sub-group	Coordinator (c) and members
Update/reorganizing of the list of references	Marie-Jo Dubourg-Savage (c) Laurent Biraschi
Compilation of data on bat mortality per country	Marie-Jo Dubourg-Savage (c) Lothar Bach
Updating of tables on monitoring studies done in Europe and on bats´ behaviour in relation to windfarms	Anna Nele Herdina (c) Marie-Jo Dubourg-Savage Laurent Biraschi Christine Harbusch
Mitigation and compensation measures	Luisa Rodrigues (c) Lothar Bach Martin Celuch Dino Scaravelli
Estimation of mortality rate taking into consideration predation, efficiency and controlled area; choose of best estimator for Europe	Lothar Bach (c) Luisa Rodrigues Eeva-Maria Kyheröinen Martin Celuch
Impact of mortality rate on populations	Martin Celuch (c) Lothar Bach Luisa Rodrigues Christine Harbusch
Deterrents	Lothar Bach (c) Luisa Rodrigues Dino Scaravelli
Table on maximum foraging distances of species	Marie-Jo Dubourg-Savage (c) Eeva-Maria Kyheröinen
Collect national guidelines (including information on feathering/stopping WTs)	Andrzej Kepel (c) Branko Mićevski
Use of dogs *vs* humans during carcass searches	Martin Celuch
Comparing measurement of activity at ground level and rotor height	Lothar Bach (c) Marie-Jo Dubourg-Savage Lisa Hundt

Small Wind Turbines	Kirsty Park (c) Lothar Bach Lisa Hundt
Offshore windfarms	Lothar Bach (c) Lisa Hundt
Update of guidelines	Marie-Jo Dubourg-Savage Luisa Rodrigues Lothar Bach Martin Celuch Andrzej Kepel Branko Mićevski Christine Harbusch Katherine Walsh / Jean Matthews Kirsty Park Lisa Hundt

The IWG thanks Joana Bernardino for comments on “Estimation of mortality rate taking into consideration predation, efficiency and controlled area; choice of best estimator for Europe”.

<u>Results</u>

Results are presented by sub-group.

Update/reorganizing of the list of references

Annex 1 includes new references and is the update to the list of references which had been presented in AC17 (*Doc.EUROBATS.AC17.6*).

Compilation of data on bat mortality per country

The following table updates the data per species and per country regarding bat fatalities found both accidentally and during post-construction monitoring studies from 2003 to March 2013. It reflects by no means the real extent of bat mortality at wind turbines.

Available data show that at least 27 species have been killed by wind turbines in Europe.

Species	AT	BE	CH	CR	CZ	DE	ES	EE	FI	FR	GR	IT	NL	NO	PT	PL	SE	UK	Total
Nyctalus noctula	24				3	647	1			12	10				1	5	1		**704**
Nyctalus lasiopterus							21			5	1				6				**33**
N. leisleri			1		1	83	15			32	57	2			192				**383**
Nyctalus spec.							2								16				**18**
Eptesicus serotinus					7	40	2			14	1		1		0	3			**68**
E. isabellinus							117								1				**118**
E. serotinus / isabellinus							11								15				**26**
E. nilssonii						3		2	6					1		1	8		**21**
Vespertilio murinus					2	77				2	1					3	1		**86**
Myotis myotis						2	2			2									**6**
M. blythii							4												**4**

M. dasycneme						3													**3**
M. daubentonii						5									2				**7**
M. bechsteinii										1									**1**
M. emarginatus							1			1									**2**
M. brandtii						1													**1**
M. mystacinus						2					2								**4**
Myotis spec.						1	3												**4**
Pipistrellus pipistrellus		5			3	375	73			263		1	14		229	1	1		**965**
P. nathusii	2				2	446				83	34	2	7			12	5		**593**
P. pygmaeus						41				120					28	1	1	1	**192**
P. pipistrellus / pygmaeus			1				483			24	54				34	1			**597**
P. kuhlii				4			44			82					32				**162**
P.pipistrellus / kuhlii															18				**18**
Pipistrellus spec.					2	21	20			85	2				81			3	**214**
Hypsugo savii				4		1	44			28	28	10			40				**155**
Barbastella barbastellus						1	1			2									**4**
Plecotus austriacus	1					6													**7**
Plecotus auritus						5													**5**
Tadarida teniotis							23			1					19				**43**
Miniopterus schreibersii							2			4					2				**8**
Rhinolophus ferrumequinum							1												**1**
Rhinolophus mehelyi							1												**1**
Chiroptera spec.		1				44	320	1		175	8	1			96	2	30	7	**685**
Total	**27**	**6**	**2**	**8**	**20**	**1804**	**1191**	**3**	**6**	**936**	**198**	**16**	**22**	**1**	**812**	**29**	**47**	**11**	**5139**

AT = Austria, CH = Switzerland, CR = Croatia, CZ = Tchech Rep., D = Germany ES= Spain, EE = Estonia, FI = Finland, FR = France, GR = Greece IT = Italy, NL = Netherlands NO = Norway, PT = Portugal, PL = Poland, SE = Sweden, UK = United Kingdom

Updating of tables on monitoring studies done in Europe and on bats´ behaviour in relation to wind farms

Annex 2 contains new data of studies done in Europe; this table is an update to Table 1 of *EUROBATS Publication Series nº 3,* Annex 3 of *Doc.EUROBATS.AC14.9.Rev1,* Annex 3 of *Doc.EUROBATS.StC4-AC15.22.Rev.1,* and Annex 2 of *Doc.EUROBATS.AC17.6)*

It was decided not to update the table on bats´ behaviour in relation to wind farms because some information is no longer valid and there are other topics considered to be more important. A new table will be prepared for the revision of the Guidelines.

Mitigation and compensation measures

We did not find any recent information on mitigation and compensation measures. Current knowledge continues to suggest two measures for reducing the mortality of bats: change of the cut-in speed to higher wind speed values and the use of blade feathering position during low wind speeds (preventing turbines from freewheeling or only spin at very low rpms, generally less than 1 rpm). To avoid excessive production losses, the ideal is that these measures are applied to particularly vulnerable situations, with species-specific algorithms regarding low wind speed and high temperature. The difficulty is to establish the values, because studies in different countries and years show that there are changes in activity and wind tolerance. As an example, Amorim *et al.* (2012) showed that 94% of bat mortality at wind farms happened at temperatures higher than 13.0ºC and wind speeds lower than 5.0 m/s. Bach & Niermann (2011, 2013) concluded that the wind tolerance (95%-level of activity) varied between 6.3m/s in 2009 and 2010 to 7.3m/s in 2012.

The IWG recommends that countries start implementing the increase of cut-in speed and blade feathering. This should be implemented on a site-specific basis according to the groups of species that occur in the area, as some species are more tolerant to higher wind speeds than others.

There are already several examples of implementation:

- In Canada, since 2011 it is established that if estimated mortality is over 10 bats/turbine/year (considered as significant mortality), the cut-in speed will be changed to 5.5 m/s (measured at hub height) or blades will be feathered when wind speeds are below 5.5 m/s; this measure will be implemented across the wind power project (i.e. at all turbines) from sunset to sunrise, from July 15 to September 30, continuing for the duration of the Project (Ontario Ministry of Natural Resources (2011). Should site-specific monitoring indicate a shifted peak mortality period (e.g. due to higher latitude projects), operational mitigation may be shifted to match the peak mortality, with mitigation maintained for a minimum of 10 weeks. Any shift in the operational mitigation period to match peak mortality should be determined in coordination with and confirmed by Ministry of Natural Resources. Where post-construction mitigation is applied, an additional 3 years of effectiveness monitoring is required. The IWG considers that this measure is very important, but highlights that the value regarding "significant mortality" is not adequate for Europe since populations in Europe are smaller than those in North America and also because in Europe all species are protected and several have an endangered status. Prior to the definition of European National values of "significant mortality" it is necessary to agree on a European estimator to be able to compare results from all countries with mortality monitoring programmes.
- A wind turbine regulating system was developed in France taking into account wind speed, temperature values and bat activity. This system, named Chirotech©, has being tested these last years. Two tests have been carried out in two wind farms, both on control and regulated turbines, and showed a mortality decrease of respectively 64% (5 regulated turbines and 3 control turbines, carcass search 12 weeks, tests during 2009 and 2010) and 90,7 % (4 regulated turbines and 4 control turbines, carcass search 7 weeks, tests in 2011 and 2012). Calculated production loss was always under 0.15% (Lagrange *et al.*, 2012a, b). However regulation is not performed exactly as in other countries. The system is based on a variable cut-in wind speed, modulated by correcting factors affecting bat activity: season, temperature, wind direction and hours, etc. For example, an average

cut-in speed of 6.5 m/sec is defined by bat activity monitoring on the site, but this cut-in speed can be increased or decreased according to previously cited factors: during mid-summer a factor of 1.11 would increase cut-in speed from 6.5 m/sec to 7.2 m/sec (over-risk); if temperature rises to 16°C a coefficient of 1.08 would increase cut-in speed from 7.2 m/sec to 7.8 m/sec and if wind direction is a positive element for bats, another coefficient 1.03 would be applied to increase cut-in speed from 7.8 m/sec to 8.0 m/sec. These coefficients are defined on a site-specific modelling of bat activity. The same mechanism would apply for under-risk conditions, but the other way round. In 2012 the system has also been tested in Canada but up to now no data is available.

- In Germany, an algorithm was developed by Behr *et al*. (2011) to stop wind turbines taking into account activity in nacelle height, wind speed, season (particularly related to temperature) and night time and it has being tested. Raising the start-up speed of turbines is the most common mitigation measure used in Germany, but there is yet no national agreement on how to determine it. Additionally, since in Germany it is not allowed to kill even individual bats intentionally the mortality has to be reduced to a level of accidental collision, what is usually determined as 1 bat/species/WT/year.
- In Poland, the most recent project of national guidelines (already in use) have introduced a scale that divides bat activity into low, moderate, high and very high. Values separating these categories were set to 3, 6 and 12 bat contact per hour. There are lower limit values for individual bat genera – a table of limit values was created (Kepel *at al.* 2011a). If a pre-investment study in a specific location shows an average very high bat activity, it is recommended that this location is abandoned, but if a "very high" bat activity is recorded only for a short period in the year – a limit wind speed value below of 8 m/s can be adopted for wind turbine cut-off (*cut in / blade feathering*). This cut-off limit is recommended for the known period of a very high activity plus 10 days before and 10 days after this period, between sunset and sunrise, except for nights with heavy rainfall. In the case of a "high" bat activity, equally good mitigating measures that are recommended are either abandonment of the location (especially if a high activity is recorded during most of the season) or adopting a limit cut-off wind speed value of 6 m/s. This cut-off value should be applied during the known period of a high activity plus 10 days before and after this period, between sunset and sunrise, except for nights with heavy rainfall. However, if a high bat activity is observed always only at a particular time of night (e.g. in the first two hours after sunset), this mitigating measure can be limited to this particular time of night. In the case of a "moderate" bat activity that occurs steadily over a longer period, a limit cut-off wind speed value of 6 m/s can be adopted in this period as a cautionary measure (on nights without heavy rainfall). Next, adoption of appropriate measures or lack thereof can be decided on the basis of a post-investment monitoring study. If results of a monitoring study to estimate bat mortality under operating wind turbines show that bat

mortality exceeds 1 individual/turbine/year, temporary cut-off of the turbines under which dead bats were found should be adopted during rainless nights in the period of the higher bat mortality plus 10 days before and after this period, at wind speed below 6 m/s. If bat mortality exceeds 10 individuals/turbine/year, cut-offs should be adopted during rainless nights at wind speed below 8 m/s. After the cut-off measure is applied, its effectiveness should be tested in the following season using the same methods. As regards monitoring bat activity near rotors, its results should be followed by the same recommendations on turbine cut-off as in the case of a monitoring study carried out prior to wind farm construction. Because these recommendations are new (Kepel *at al*. 2011b), no data on their effectiveness are available yet.

- In Portugal, a project including 7 turbines, one located 158 m from one important hibernating roost (around 4000 *Miniopterus schreibersii* and 150 *Rhinolophus ferrumequinum*) was authorized with cut-in speed increased to 5 m/s in October, November, December, March and April.

Amorim, F., H. Rebelo & L. Rodrigues (2012): Factors influencing bat activity and mortality at a wind farm in the Mediterranean region. – Acta Chiropterologica 14(2): 439-457.

Bach L. & I. Niermann (2011) *Monitoring der Fledermausaktivität im Windpark Langwedel – Endbericht 2010*. unpubl.report to PNE Wind AG: 72 pp.

Bach L. & I. Niermann (2013) *Monitoring der Fledermausaktivität im Windpark Langwedel – Bericht 2012 – Überprüfung des Abschaltalgorithmus*. unpubl.report to PNE Wind AG: 28 pp.

Behr O., R. Brinkmann, I. Niermann & F. Korner-Nievergelt (2011) Fledermausfreundliche Betriebs-algorithmen für Windenergieanlagen. In: Brinkmann, R., Behr, O., Niermann, I. & Reich, M. (ed.): *Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen*. Umwelt und Raum Bd. 4, 354-383, Cuvillier Verlag, Göttingen.

Kepel A., Ciechanowiski M., Jaros R. 2011a. How to asses the potential impact of wind turbines on bats using bat activity surveys? A case study from Poland. XII European Bat Research Symposium, Vilnius, Lithuania August 22-26, 2011: p. 72. http://www.bio.uaic.ro/cercetare/contracte/pd326-pocora/src/pdf%205.pdf

Kepel A., Ciechanowiski M., Jaros R. 2011b. Wytyczne dotyczące oceny oddziaływania elektrowni wiatrowych na nietoperze - projekt. Generalna Dyrekcja Ochrony Środowiska: 74 pp. http://www.ekoefekt.pl/dokumenty/dokument_29.pdf.

Lagrange H., E. Roussel, A.-L. Ughetto, F. Melki & C. Kerbirou (2012a) *Chirotech - Bilan de 3 années de régulation de parcs éoliens pour limiter la mortalité des chiroptères*. Rencontres nationales « chauves-souris » de la SFEPM (France).

Lagrange H., E. Roussel, A.-L. Ughetto, F. Melki & C. Kerbirou (2012b) *Chirotech, tres años de test de mitigación para reducir las mortalidad de quirópteros en parques eólicos*. Talk presented in I Congreso Ibérico sobre Energía Eólica y Conservación de la Fauna. Jerez de la Frontera (Spain).

Ontario Ministry of Natural Resources (2011) *Bats and bat habitats - Guidelines for Wind Power Projects*.

Estimation of mortality rate taking into consideration predation, efficiency and controlled area; choice of best estimator for Europe

Usually the estimation of bat mortality (number of bats really killed at a wind farm) takes into account how many dead bats were found on the search plot of each turbine, multiplied by a coefficient, which takes under account the probability that a carcass was overlooked (searchers efficiency), taken away (predation, decay) and/or impossible to be found due to the type and height of the vegetation on the search plot. Some of the disadvantages of this estimator are: (i) it does not take into account that the carcasses are not distributed normally in the searched area, although a large percentage is found within a range of some meters, (ii) if no bat is found under the turbine there is no possibility to estimate the number of bat fatalities, and (iii) no confident intervals can be assumed together with this estimation.

There are recently two new estimators that are discussed, which takes some of these disadvantages into account:

- Huso (2010) developed an estimator which takes into account the partial coverage of the area beneath the turbines. It is mainly developed for localities with high numbers of fatalities.
- A German estimator was developed in a BMU financed national project (Niermann *et al*. 2011; Korner-Nievergelt *et al*. 2011a). In contrast to the estimator from Huso (2010) they take into account that a confident interval cannot be below the number of real bats found under the wind turbine. Additionally in the same project Korner-Nievergelt *et al*. (2011b) developed a formula to estimate the number of fatalities based on activity data at nacelle height. The aim is to reduce the costs of monitoring studies. Based on that knowledge they developed an algorithm for cut-in speed as a mitigation measure (Behr *et al*. 2011).

As a result of these recent studies, mortality estimators have become ever more complex, requiring, in some cases, a great effort and statistical expertise from users.

The Portuguese Wildlife Fatality Estimator (www.wildlifefatalityestimator.com) was created by Bio3 in partnership with Regina Bispo and aims to help users to properly apply methodologies and save time in the data analysis (Bispo *et al.* 2010). The platform is still under development, yet with 2 of the 3 application modules ("Carcass Persistence", "Search Efficiency" and "Fatality Estimation") already fully operational. The Wildlife Fatality Estimator is a free on-line platform that can be used to estimate bat mortality associated with wind farms or other human infrastructures, using three commonly used estimators: Jain *et al.* 2007, Huso 2010 and Korner-Nievergelt *et al.* 2011a.

In France, two monitoring studies (Cornut & Vincent 2010; Sané 2012) have compared different estimators. Winkelman's formula, Erickson's, Jones' and Huso's for one study, Winkelman's, Erickson's, Jones', Huso's and Brinkmann's 2006 for the other. Both studies came to the same conclusion: Huso's estimator was the most reliable (Korner-Nievergelt estimator was at that time unknown to the authors).

Recently, a new paper from Bernardino *et al*. (2013) compared seven widely used estimators (including Huso 2010 and Korner-Nievergelt *et al*. 2011a see above) and pointed out the assumptions and limitations of all estimators. It turned out that there is still missing a universal estimator that produces unbiased estimates under any study design or circumstances. The authors highlight the necessity of a short termed search interval constant for all seasons, a sufficient search area and high searcher efficiency as factors raising the quality of the estimates produced by the available estimators.

Behr O., R. Brinkmann, I. Niermann & F. Korner-Nievergelt. 2011 Fledermausfreundliche Betriebs-algorithmen für Windenergieanlagen. In: Brinkmann, R., Behr, O., Niermann, I. & Reich, M. (ed.): *Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen*. Umwelt und Raum Bd. 4, 354-383, Cuvillier Verlag, Göttingen.

Bispo R., G. Palminha, J. Bernardino, T. Marques, & D. Pestana. 2010. A new statistical method and a web-based application for the evaluation of the scavenging removal correction factor. In *Proceedings of the VIII Wind Wildlife Research Meeting*, Denver, EUA.

Bernardino, J.,R. Bispo, H. Costa & M. Mascarenhas. 2013. Estimating bird and bat fatalities at wind farms:a practical overview of estimators, their assumptions and limitations. New Zealand Journal of Zoology. Vol. 40, No. 1, 63-74.

Cornut J. & S. Vincent. 2010. *Suivi de la mortalité de chiroptères sur deux parcs éoliens du sud de la région Rhône-Alpes*. GCRA & LPO Drôme, Le Bièvre 24, 51-57 http://coraregion.free.fr/images/bievre/bievre24.pdf

Huso, M.M.P. 2010 An estimator of wildlife fatality from observed carcasses. *Environmetrics*. DOI: 10.1002/env.

Jain, A., Kerlinger, P., Curry, R. & Slobodnik, L. 2007. Annual Report for the Maple Ridge Wind Power Project: Post-construction Bird and Bat Fatality Study - 2006. Final Report. Curry and Kerlinger, LLC.

Korner-Nievergelt F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann & B. Hellriegel. 2011a. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. *Wildl. Biol*. 17: 350-363, DOI: 10.2981/10-121.

Korner-Nievergelt F., O. Behr, I. Niermann & R. Brinkmann. 2011b. Schätzung der Zahl verunglückter Fledermäuse an Windenergieanlagen mittels akustischer Aktivitätsmessungen und modifizierter N-mixture Modelle. In: Brinkmann, R., Behr, O., Niermann, I. & Reich, M. (ed.): *Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen*. Umwelt und Raum Bd. 4, 323-353, Cuvillier Verlag, Göttingen.

Niermann I., R. Brinkmann, F. Korner-Nievergelt & O. Behr. 2011. Systematische Schlagopfersuche - Methodische Rahmenbedingungen, statistische Analyseverfahren und Ergebnisse. In: Brinkmann, R., Behr, O., Niermann, I. & Reich, M. (ed.): *Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen*. Umwelt und Raum Bd. 4, 40-115, Cuvillier Verlag, Göttingen.

Sané F. 2012. *Contrôle de l'impact post-implantation du parc éolien de Lou Paou sur les habitats, l'avifaune et les chiroptères : Bilan de 3 années de suivi (2008-2009-2010)*. ALEPE unpublished report for EDF EN.

Impact of mortality rate on populations

Impact of mortality rate on bat populations is one of most serious issues connected to wind farms. Although, there are serious problems in assessment – population sizes with precise data are still not available for most species due to cryptical behaviour of bats, night activity and frequent roost switching. On the other side bats are very long-lived, some individuals reach an age of more than 30 years, and they have an extremely low reproductive output (Barclay & Harder 2003). In this species group, called "slow species", increased mortality rate is very critical. It is also unknown over what geographical distances wind turbines are affecting bat populations. A German study on stable hydrogen isotopes in fur recently discovered that German turbines are killing individual bats not only from local populations (mostly *Pipistrellus pipistrellus*), but also bats migrating from Estonia or Russia (*Pipistrellus nathusii*). Yet, impact of individual wind farm can have negative impact beyond political borders. International regulations are needed to prevent large-scale detrimental effect on bat populations (Voigt *et al.* 2012).

Hedenström & Rydell (2013) showed in a very simple model, based on simple assumptions that the planned increase of wind turbines in Sweden will have a negative effect on the Swedish population of *Nyctalus noctula*, even when the numbers of wind turbines do not increase anymore, if no mitigation measures are taken.

The IWG believes that in the near future the best approach would be the development of studies at regional or local (particularly important for rare species) levels. Any new project should take into account the cumulative impacts that all wind farms in the vicinity will have on the populations either of local bats or migrating ones. In the case of projects located near borders, the potential transboundary effect should also be considered.

Barclay R.M.R. & Harder L.M. 2003. Life histories of bats: life in the slow lane. Bat Ecology (eds T.H. Kunz & M.B. Fenton), University of Chicago Press, Chicago, IL.: 209–253 pp.

Hedenstöm A. & Rydell J. 2013. Effect of wind turbine mortality on bat populations in Sweden: predictions from a simple population model. – Talk at CWE2013, Stockholm, 5-7 February 2013, Naturvardsverket rapport 6546:58.

Voigt Ch.C., Popa-Lisseanu A.G., Niermann, I. & Kramer-Schadt, S. 2012.: The catchment area of wind farms for European bats: A plea for international regulations. Biological Conservation 153:80-86.

Deterrents

There is little new knowledge about deterrent studies.

Arnett *et al*. (2011) implemented a 2-year study testing the effectiveness of an ultrasonic acoustic deterrent for reducing bat fatalities at a wind energy facility in Pennsylvania, and estimates of fatality, corrected for field biases, were compared between treatment and control turbines. In 2009, they estimated 21–51% fewer bats were killed per treatment turbine than per control turbine; estimated twice as many hoary bats were killed per control turbine than treatment turbine, and nearly twice as many silver-haired bats. In 2010, when accounting an approximate 9% inherent difference between treatment and control turbines, between 2% more and 64% fewer bats were killed per treatment turbine relative to control turbines; although they estimated nearly twice as many hoary bats and nearly 4 times as many silver-haired bats killed per control turbine than at treatment turbines during the treatment period, these only represented an approximate 20% increase in fatality relative to the pre-treatment period for these species when accounting for inherent differences between turbine sets. These findings suggest broadband ultrasound broadcasts may reduce bat fatalities by discouraging bats from approaching the sound source. However, effectiveness of ultrasonic deterrents is limited by distance and area ultrasound can be broadcast, in part due to rapid attenuation in humid conditions. They caution that an operational deterrent device is not yet available and further experimentation and modifications of this type of deterrent method are needed. Future efforts must also evaluate cost-effectiveness of deterrents in relation to curtailment strategies to allow a cost-benefit analysis for mitigating bat fatalities.

Herman & Furmankiewicz (2013) presented a study about high intensity ultrasound emission that reduced the bat activity significantly within 15m.

Arnett EB, C Hein, M Schirmacher, M Baker, MMP Huso & JM Szewczak. 2011. Evaluating the effectiveness of an ultrasonic acoustic deterrent for reducing bat fatalities at wind turbines. Final Report.

Herman K. & Furmankiewicz J. (2013): An effect of high power ultrasound on bat activity – the implication for the protection of bats at wind farms. - Poster at the CWE2013-Conference in Stockholm, Naturvardsverket rapport 6546:144. (http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6546-1.pdf).

Table on maximum foraging distances of species

The table included in the previous report will be included in the update of the guidelines, with the used referenced.

Detectability coefficients to compare activity indices

The table included in the previous report will be included in the update of the guidelines.

Beside the species-specific detectability several different detector systems are available and used nowadays. Since the detector systems are highly variable (Adams *et al*. 2012) and different settings can be changed at each detector system, activity data as contacts/hour are different between different systems and/or settings. Also the sensitivity of a microphone, which may be significantly reduced over time, especially under the influence of humidity, can substantially affect the results obtained. To compare activity data from automatic recordings, as a temporary measure some detectability coefficient tables can be developed for most commonly used detectors and the unification of use of settings can be included in the guidelines.

Adams, A.M., M.K. Jantzen, R.M. Hamilton & M.B. Fenton (2012) Do you hear what I hear? Impications of detector selection for acoustic monitoring of bats. *Methods in Ecology and Evolution*, 3: 992-998.

Collect national guidelines

Some new guidelines were prepared (Bat Conservation Ireland - Ireland, SFEPM – France, SECEMU – Spain).

Parties	**EUROBATS guidelines officially recommended**	**National guidelines exists**		
		unofficial	**officially recommended**	**copy provided to IWG WT**
Albania	no	no	no	
Belgium	yes (in Wallonie)	no	no	
Bulgaria	no	**YES**	no	**YES** http://www.nmnhs.com/downloads/brcc/bats-en.pdf
Croatia	no		**YES**	**YES** http://www.zastita-prirode.hr/content/download/393/2127/file/Smjernice%20za%20izradu%20studije%20utjecaja%20na%20okoliš%20za%20vjetroelektrane%20-%20šišmiši.pdf
Czech Republic	**YES** (with some local adaptations)	no	no	no (for adaptations)
Denmark	no	no	no	
Estonia	no	no	no	
Finland	yes	no	no (not for bat surveys)	(Only general guidance concerning windfarms and planning procedures, section on bats very short, EUROBATS guidelines mentioned) http://www.ymparisto.fi/download.asp?contentid=138870&lan=fi)
France	**YES**	**YES**	**YES**	**YES** **SFEPM presurvey (2010):** http://www.sfepm.org/pdf/chiroptere_document_cadrage_version_final

				e_signee.pdf **Survey (2012):** http://www.sfepm.org/pdf/Diag-SFEPM-eolien_vFinale.pdf **Monitoring (2013):** http://www.sfepm.org/pdf/SFEPM_suivi_FINAL_08032013.pdf **Official general guidelines (2010) at:** http://www.developpement-durable.gouv.fr/IMG/pdf/guide_eolien_15072010_complet.pdf
Georgia	no	no	no	
Germany	no	**YES** (for several regions)	no	**YES** For instance: http://www.nlt.de/pics/medien/1_1320062111/Arbeitshilfe.pdf http://www.repowering-kommunal.de/uploads/tx_tcdownloadmngr/NLT_Naturschutz_und_Windenergie_Januar_2011.pdf; http://www.umweltdaten.landsh.de/nuis/upool/gesamt/windenergie/windenergie.pdf http://www.um.baden-wuerttemberg.de/servlet/is/89544/Windenergieerlass_BW.pdf?command=downloadContent&filename=Windenergieerlass_BW.pdf http://www.stmug.bayern.de/umwelt/oekoenergie/windenergie/doc/windenergie_erlass.pdf
Hungary	no	no	no	
Ireland	no	**YES**	no	http://www.batconservationireland.org/pubs/reports/BCIreland%20Wind%20Farm%20Turbine%20Survey%20Guidelines%20Version%202%208.pdf (ver. 2012)
Italy	no	no	no	
Latvia	no	no	no	
Lithuania	**YES**		YES	no
Luxembourg	no	no	no	
Macedonia, FYR	no	no	no	
Malta	no	no	no	
Moldova	no	no	no	
Monaco	no	no	no	
Montenegro	no	no	no	
Netherlands	no	no	no	
Norway	no	no	no	
Poland	no	**YES**	no	**YES** www.salamandra.org.pl/DO_POBRANIA/Nietoperze/Guidelines_Poland.doc
Portugal			**YES**	**YES** **document ICNB 2009 in:** http://www.wix.com/anodomorcego/icnb/docs#!__docs/diversos
Romania	no	**YES**	no	**YES** http://www.aplr.ro/index.php?lang=ro&cat=9&page=2
San Marino	no	no	no	
Slovak Republic	no	no	no	
Slovenia	no	no	no	
Sweden	no	no	no	
Ukraine	no	no	no	
United Kingdom		**YES**	**YES** (in certain circumstances the "stand-off" distance recommended in the EUROBATS Guidelines is used instead of the national guidelines)	**YES** **Onshore wind turbines:** http://publications.naturalengland.org.uk/file/490077 **Single large turbines:** http://publications.naturalengland.org.uk/file/96013 **BCT – surveying:** http://www.bats.org.uk/data/files/Surveying_for_onshore_wind_farms_BCT_Bat_Surveys_Good_Practice_Guidelines_2nd_Ed.pdf **Single Wind Turbines and bats - Cornwall Council:** http://www.cornwall.gov.uk/idoc.ashx?docid=66ca8fc5-609a-4fae-b4da-e76ccd5c5af9&version=-1
Range states				
Algeria	no	no	no	
Andorra	no	no	no	
Armenia	no	no	no	
Austria	no	no	no	
Azerbaijan	no	no	no	
Belarus	no	no	no	
Bosnia and Herzegovina	no	no	no	
Cyprus	no	no	no	
Egypt	no	no	no	
Greece	no	no	no	
Holy See	no	no	no	
Iran	no	no	no	
Iraq	no	no	no	

Israel	no	**YES** (Israel Nature and Parks Authority)	no	no
Jordan	no	no	no	
Kazakhstan	no	no	no	
Kuwait	no	no	no	
Lebanon	no	no	no	
Libya	no	no	no	
Liechtenstein	no	no	no	
Morocco	no	no	no	
Palestinian Authority Territories	no	no	no	
Russian Federation	no	no	no	
Saudi Arabia	no	no	no	
Serbia	no	yes	**YES** (chapter about bats in national EIA guidelines)	**YES** http://www.nhmbeo.rs/upload/images/ove_godine/Promocije2011/bats_and_environmental_impact_assessment_web_lq.pdf
Spain	no	**Yes**	no	Waiting for the PDF version
Switzerland	no	no	no	
Syrian Arab Republic	no	no	no	
Tunisia	no	no	no	
Turkey	no	no	no	

In 2011 wind turbines have been classified in France as presenting a risk for the environment and most wind farms are now answerable to the ICPE (listed installations for the protection of the environment) rules and regulations. Therefore new guidelines for pre-construction bat survey and post-construction monitoring have been produced by the SFEPM.

The volume, content and specificity of national guidelines vary to a high extent. They range from a few general recommendations to very detailed, thick documents. Some of the national guidelines are consistent with the EUROBATS Guidelines while others stand to a greater or lesser extent in contradiction with them. There are countries in which the guidelines are updated along with progress of knowledge but in most of cases the adopted recommendations have never been updated yet. There are also cases where several, very different, guidelines are in use in one country.

It is understandable that expectations and demands of investors are that research requirements and restrictions on the location of wind turbines should be as low as possible. For this reason, it is common practice that environmental impact assessments or post-investment monitoring are at best carried out in line with the minimum acceptable requirements set in the guidelines for a given country. It is also common practice to demand that requirements formulated in the guidelines correspond to the mildest and lowest requirements adopted in other countries. It is therefore recommended that the next version of EUROBATS Guidelines specifies the minimum recommended scope of national guidelines.

It is also important that the national guidelines are not in contradiction with the general EUROBATS Guidelines. Small deviations are acceptable only when they stem from specific national conditions and their inclusion should be based on an informed and well-justified decision.

Use of dogs vs humans during carcass searches

Trained sniffing dogs are more accurate and effective in searching for bat carcasses under wind turbines. This was proved in studies in USA (Arnett *et al*. 2005, Arnett 2006), Great Britain, Australia (Paulding *et al.* 2011) and Portugal (Paula *et al*. 2011). We did not find any recent information on use of dogs vs humans during carcass searches.

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Paulding E., Nowakowski J. & Grainger W., 2011. *The use of dogs to perform mortality searches: cost effective and efficient.* Conference on Wind Energy and Wildlife Impacts, 2-5 May 2011, Trondheim, Norway, NINA Report 693, poster abstract p.114

Comparing measurement of activity at ground level and rotor height

Especially in forests, it has been questioned if ground level surveys can lead to reliable data for assessing the potential impact of wind turbines on bats. There are few studies done in Europe that investigated bat activity in different forest strata. Some of these studies suggested that the activity in the tree canopy was higher than at the ground (Aschoff *et al.* 2006, Fichtner 2004, Plank *et al.* 2011), but in contrast Bach *et al.* (2012) showed that the total bat activity above the canopy was much lower than at ground level. Additionally, Bach *et al*. (2012) showed that the species composition was different at ground level and above the canopy; they also turned out that the activity at ground level decreased during summer, while the bat activity above the canopy increased after beginning of August. These data show that it is impossible to assess the bat activity in or above the canopy by using activity survey at ground level. Bach *et al.* (2012) concluded that in case of wind farm projects in forests it is needed to survey bat activity above the canopy.

Nevertheless, it should be remembered that building the wind turbines in forest usually means also building the forest roads to these turbines and creation of treeless clearings around the turbine bases. This significantly affects the use of these areas by bats, reducing usefulness of the results of pre-construction studies for predicting the activity of individual species of bats after the construction of the farm. Therefore, in general it is recommended to avoid building of wind farms in forests or close to forest borders.

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Bach, L., Bach, P., Tillmann, M. & Zucchi, H. 2012. Fledermausaktivität in verschiedenen Straten eines Buchenwaldes in Nordwestdeutschland und Konsequenzen für Windenergieplanungen. – Naturschutz & Biologische Vielfalt 128: 147-158.

Fichtner, S. 2004. Räumliche und zeitliche Nutzung des Kronenraumes durch Fledermäuse im Leipziger Auenwald – Diplomthesis Univ. Leipzig: 90 pp.

Plank, M., Fiedler, K. u. Reiter, G. 2011. Use of forest strata by bats in temperate forests - J. Zool. Lond.: 1-9. 388

Small Wind Turbines

Small wind turbines (SWT, < 50kW) are now routinely installed in many European countries and the USA and, in spite of the rapid growth in numbers, there has been little study of their impact on wildlife. Consequently, the evidence-base upon which to establish planning guidance is very limited.

Research at Stirling since 2009 has focussed on examining the evidence for possible effects of micro-turbines and the magnitude of impact that they may have upon birds and bats. This work is being conducted by Dr Kirsty Park, Dr Jeroen Minderman and Cerian Tatchley.

The specific objectives and results to date are outlined below:

1. *Assess the effect of micro-turbines on flight behaviour and activity levels*

In close proximity to operating micro-turbines bat activity was substantially reduced, suggesting their use of habitat adjacent to SWT may be affected. Apparent avoidance by bats should mean that mortality rates are relatively low (see objective 2) but in order to avoid displacement effects it is suggested that SWT should be sited at least 20m from potentially valuable bat habitat (Minderman et al. 2012). On-going research is currently testing the effects of hedgerow proximity and turbine operation on bats in southern England. Research starting this year will assess whether surrounding landscape and habitat configuration influences bat responses to turbines. These results are currently being incorporated into a guidance document being produced by the Joint Agencies of the UK.

2. *Estimate the mortality rate of birds and bats from SWT*

Systematic carcass searches at 21 micro-turbine sites were conducted and scavenging rates determined experimentally. In addition, surveys from 209 SWT owners were used to assess mortality rates. These results will be published throughout the year.

3. *Examine the planning process for SWT using the UK as a case study*

A large number of enquiries by council planners and micro-turbine applicants about this project prompted us to conduct a comprehensive survey of over 400 Local Authority planning officials throughout the UK. The planning process for micro-turbines varies widely among local authorities with differences in pre-installation requirements (e.g. ecological surveys) and the criteria used to assess micro-turbines. We also assessed the likely impact of new permitted development rights (PDR); based on their location and size characteristics we found that PDR will affect relatively few micro-turbine installations and the majority will continue to require planning permission (Park et al. 2013).

4. *Examine public attitudes to SWT in the UK*

A survey of the UK public was conducted in order to assess attitudes to SWT and to determine potential drivers (e.g. knowledge of climate change issues, education, familiarity with turbines etc). Data are currently being analysed and will be published later this year (Tatchley et al. in prep).

5. *Examine willingness- to-pay for SWT mitigation measures amongst SWT owners*

A survey of potential SWT owners will be conducted to assess their willingness- to-pay (an technique used commonly in economics research) for a variety of potential mitigation measures which may result in loss of electricity production (e.g. turning off at certain periods, changes in cut-in speed) or flexibility in siting (e.g. siting restrictions). This work is still in the planning stages and will be conducted later this year.

In Germany many SMT are built and even more are planned during the next season. Up to now no standardized investigation methods have been described, or are requested. But because due to the results from the British studies it is believed that SWT might have a negative impact on bats. Therefore several SWT manufacturers have now asked for studies about the impact on bat populations and research will be conducted hopefully within the next year.

In France, Poland and many other Parties and non-party Range States no study on bats or birds is requested for SWTs.

Minderman J, Pendlebury CJ, Pearce-Higgins JW & Park KJ (2012) Experimental evidence for the effect of small wind turbine proximity and operation on bird and bat activity. *PLoS One* 7(7): e41177. doi:10.1371/journal.pone.

Park KJ, Turner A & Minderman J (2013) Integrating applied ecology and planning policy: the case of micro-turbines and wildlife conservation. *Journal of Applied Ecology* 50: 199-204.

Offshore windfarms

During the last years, bats were studied offshore and close to the coast in the Baltic and North Sea (Ahlén *et al*. 2009, Jong *et al*. 2013, Hüppop 2009, Hüppop & Hill 2013, Meyer 2011, Seebens *et al*. 2013,). All these studies show that bats occur regularly out on Sea during migration. That fit with the experience that exists from migration studies on islands about 5-10 km away from the coastline (Bach *et al*. 2009, Frey *et al*. 2012, Poerink & Haselager 2013). These findings lead to the recent development that bats are asked to be studied for offshore wind farm planning in the Baltic (Seebens *et al*. 2013). In Germany bats should be implemented in the new STUK (standardized investigation concept) for off shore wind farm planning. According the Polish national guideline, the off-shore farms require the investigation during the migration seasons (detector research done from a boat).

Ahlén, I., H. Baggøe & L. Bach (2009): Behavior of scandinavian bats during migration and foraging at sea. Journal of Mammalogy 90 (6): 1318-1323.

Bach, L., P. Bach, A. Helge, K. Maatz, V. Schwarz, M. Teuscher & J. Zöller (2009): Fledermauszug auf Wangerooge – erste Ergebnisse aus dem Jahr 2008. – Natur- und Umweltschutz (Zeitschrift Mellumrat) Band 8, Heft 1: 10-12.

Frey, K., Bach, L., Bach, P. & Brunken, H. (2012): Fledermauszug entlang der südlichen Nordseeküste. – Naturschutz & Biologische Vielfalt 128: 185-204.

Hüppop, O. (2009): Bat migration on Helgoland, a remote island in the North Sea: wind assisted or wind drifted. – Poster from the 1st International Symposium on Bat Migration, 16.-18. Januar 2009, Berlin.

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Jong, J. de, P. Bach & A. Eriksson (2013): Bat migration in the South Baltic Sea and consequences for wind power development. – Talk at CWE2013, Stockholm, 5-7 February 2013, Naturvardsverket rapport 6546:51.

Meyer, M. (2011): Method validation and analysis of bat migration in the Fehmarnbelt area between autumn 2009 and autumn 2010. - Diploma Thesis.

Poerink, B.J. & R. Haselager (2013): Monitoring migratie vleermuizen Rottumeroog, Voor- en Najaar 2012. – Report to staatsbosbeheer: 9 pp.

Seebens, A. A. Fuß, P. Allgeyer, H. Pommeranz, Mi. Göttsche, Ma. Göttsche, M. Mähler, H. Matthes, C. Paatsch & L. Bach (2013): Bat migration onm the German Baltic Sea and methods to study offshore bat activity. - Poster at 3rd International Bat Meeting, Berlin, 1-3 March 2013.

Update of guidelines

Recently the update was started, but it is still under process.

Final remarks

Available results continue to show that mortality is highly variable between different sites and between different wind turbines within one wind farm. Besides that, mortality varies between years. Furthermore monitoring of mortality follows rarely a unique method. Monitoring schedule, time interval between controls and estimator for mortality rate differ from one wind farm to the other and make comparison impossible. Tests for predation and searcher's efficiency are not always performed, not to mention the correction for the % of uncontrolled surface.

It is not possible to evaluate the impacts of wind farms without the mortality data; very few countries sent the results of the monitoring programmes. This is essential if we want to assess the cumulative impacts of wind farms on local or regional bat populations. Therefore the IWG recalls countries to send data on observed mortality, monitoring programmes and research projects, papers references, National guidelines, and all relevant information (mitigation measures, compensation measures, deterrents, etc).

Annex 1 – New references

(Update to the list of references presented in AC17)

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Amorim, F., H. Rebelo & Rodrigues L., 2012. Factors influencing bat activity and mortality at a wind farm in the Mediterranean region. – Acta Chiropterologica 14(2): 439-457.

Arlettaz R., 2013. Mitigating the potential negative effects of tall wind turbines on bats: vertical activity profiles and relationships to wind speed. Abstracts 3rd International Berlin Bat Meeting.

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Bispo R., Bernardino J., Marques T. A. & Pestana D., 2012. Modeling carcass removal time for avian mortality assessment in wind farms using survival analysis. Environ Ecol Stat.

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Annex 2 - New studies done in Europe

(update to Table 1 of *EUROBATS Publication Series nº 3* , Annex 3 of *Doc.EUROBATS.AC14.9.Rev1,* Annex 3 of *Doc.EUROBATS.StC4-AC15.22.Rev.1,* and Annex 2 of *Doc.EUROBATS.AC17.6*)

Study (author, year, area)	time	type of turbines	methods	results	Habitat-types
Amorim F. et al. (2012). Freita and Arada Hills, NW Portugal.	March to October 2007 (except July)	20 WTs in two wind farms (10 each in WF I and WF II), 2 MWt model, tower 68m, blades with 32.8 m length.	**Monitoring Bat Activity**: Weekly acoustic sampling started 45 min after sunset, for the following three hours (10-minute survey at each sampling point). 20 acoustic sampling points were defined (one point per turbine, each at a distance of 25 meters from the turbine, at a randomized azimuth). WF I and WF II were surveyed on two consecutive days, with randomized order of sampling points visited.To determine bat activity, the number of bat passes during the sampling period was counted. Bat activity was recorded with an ultrasound detector (D240X, Pettersson Elektronik; files saved in WAV format; sampling rate 44.1 kHz and 16 bits/sample) connected to a digital recorder, at ground level only. Sampling was done only on nights without rain, fog or strong winds (more than 3.5 m.s-1 at ground level). Bat vocalizations were analysed using sound-analysis software (Bat-Sound Pro 3.31, Pettersson Elektronik AB) with a 1024 pt FFT and Hamming window for spectrogram analysis. **Mortality surveys**: Carcass searches at WF I and WF II were done weekly on two consecutive days in the morning following bat acoustic sampling, in a 50 meter radius sampling plot around each of the 20 WTs. Searchers followed random transects walked at a low speed over 30 min (or 15 minutes with 2 searchers). Within each search plot, 3 visibility classes (High, Medium and Low) and non-sampling areas were mapped (GIS) following the protocol of Arnett et al. (2005). All carcasses found were collected and frozen to allow for further identification. Carcass position was determined using a GPS (Explorist 210, Magellan Europe), a 50-meter metric-tape and a military compass. The visibility class where a carcass was located also was registered.	**Detection**: 838 bat passes recorded - mean bat activity 5.90 ± 11.3 bat passes/sample. 422 bat passes were identified: 12% *N. leisleri* , 58% genus *Pipistrellus. S* pecies detected: *Eptesicus serotinus, Hypsugo savii, Myotis blythii, Myotis myotis, Nyctalus spp., Nyctalus leisleri, Pipistrellus kuhlii, Pipistrellus pipistrellus, Pipistrellus sp, Plecotus sp, Tadarida teniotis.* **Mortality surveys**: 48 dead bats (573 carcass searches; mean bat mortality of 0.08 ± 0.18 carcasses/sample). 2 *Hypsugo savii,* 14 *Nyctalus leiseri* , 25 *Pipistrellus pipistrellus* , 4 *Pipistrellus sp.,* 4 not identified.	WFs along two parallel ridges 1400 m apart and at1050–1150 m a.s.l. Low and sparse scrubland, scattered rocky areas. Within 190–3300 m from the wind farm, there are three water bodies and two abandoned mining complexes. The mines are classified as bat roosts of national importance due to the presence of large hibernating colonies of five bat species.
Bach L. & P. Bach (2012). Ellenserdammersiel near Varel, Germany.	1.July to 15.October 2012 (108 nights) acoustic monitoring. 36 days mortality control.	5 WTs, 3 Nordex, tower 90m, rotor ø 90m	**Mortality control** every 3 days (morning, 45 min per WT) under 5 WTs. Search area of 50m radius around the WT (except for areas with dense vegetation). Tests for search efficiency & predation. **Acoustic monitoring** at 3 WTs with AnaBat-SD1 per WT (rotor hight)	5 dead bats (4 Pipistrellus *nathusii, 1 Nyctalus noctula*) found. Calculation: probably 3.2 dead bats/WT/study period. Acoustic monitoring: calls of *Nyctalus noctula, Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus*	grassland, cattle and horse grazing
Bach L. & M. Tillmann (2012). Belum, Cuxhaven, Germany.	April to October 2012	2 WTs (2MW), (AN BONUS tower 69m; rotor ø 76m)	**Mortality control** every 3 days under 2 WTs. Search area of 50m radius around the WT. Tests for search efficiency & predation. **Acoustic monitoring** with AnaBat-SD1 per WT (rotor hight)	12 dead bats (1 *Pipistrellus spec* ., 8 *P. nathusii,* 1 *P. pipistrellus* , 1 *Nyctalus leisleri* , 1 *N. noctula*): mortality rate: 8.5 Bats/WT/6 month or 4.2 bats/MW/6 month	mean alt.: 3m, grassland
Bach P. & L. Bach (2013). Wiesmoor, Germany.	24.May to 31.October 2012 (165 nights)	6 WTs, ENERCON E 82, tower 102m, rotor ø 82m.	**Mortality control** every 3 days under 6 WTs. Search area of 50m radius around the WT (except for areas with dense vegetation). Tests for search efficiency & predation**. Acoustic monitoring** with two AnaBat-SD2 per WT (4m and rotor hight)	3 dead bats *(3 Pipistrellus nathusii*) found. Calculation: probably 2,7 dead bats/WT/year. Acoustic monitoring: calls of *Nyctalus noctula, Nyctalus leisleri, Vespertilio murinus, Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus, Plecotus sp* .	agricultural area
BFL (2011a). Ober-Flörsheim (Landkreis Alzey-Worms). Germany.		4 WTs: GE; NEC-Micon; Enercon. (towers: 68m; 68m; 80m rotor ø: 38m; 38m; 70m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	2 dead bats: 1 *Nyctalus leisleri* , 1 *Pipistrellus pipistrellus* .	open agricultural area, low altitude
BFL (2011b). Naurath (Landkreis Trier-Saarburg). Germany.		1 WT: Enercon E 70 (tower: 85m, rotor ø: 70m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	no dead bats.	mountain forest
BFL (2011c). Lingerhahn (Rhein-Hunsrück-Kreis). Germany.		2 WTs: REpower MM92 (tower: 100m, rotor ø: 92.5m)	**Mortality control**: Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	no dead bats.	mountain forest
BFL (2011d). Uhler (Rhein-Hunsrück-Kreis) Germany.		2 WTs: Vestas V90 (tower: 105m, rotor ø: 90m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 month. **Acoustic monitoring** with von Laar Avisoft real-time system.	no dead bats.	mountain forest
BFL (2011e). Wörrstadt-Ost (Landkreis Alzey-Worms). Germany.		2 WTs: Enercon E 82 (tower: 135m, rotor ø: 82m)	**Mortality control**: Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	2 dead bats: 1 *Pipistrellus pipistrellus* , 1 *Nyctalus leisleri* .	open agricultural area, low altitude

BFL (2012a). Beltheim (Landkreis Rhein-Hunsrück). Germany.		1 WT: Enercon E 82 (tower: 138m, rotor ø: 82m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	1 dead bat: *Nyctalus leisleri.*	mountain forest
BFL (2012b). Elmersberg, Germany.		1 WT: Enercon E53 (tower: 73m, rotor ø: 53m)	**Acoustic monitoring** with Batcorder. No mortality control.		mountain forest
BFL (2012c). Mainstockheim (Landkreis Kitzingen). Germany.	2011	1 WT: Vestas V90 (tower: 105m, rotor ø: 90m)	**Acoustic monitoring** with Batcorder. No mortality control.		open agricultural area, low altitude
BFL (2012d). Repperndorf (Landkreis Kitzingen). Germany.	2009 to 2011	1 WT: Vestas V90 (tower: 105m, rotor ø: 90m)	**Acoustic monitoring** with Batcorder. No mortality control.		open agricultural area, low altitude
BFL (2013a). Naurath (Landkreis Trier-Saarburg). Germany.		1 WT: Enercon E 70 (tower: 85m, rotor ø: 70m)	**Acoustic monitoring** with Batcorder. No mortality control.		mountain forest
BFL (2013b). Bedesbach/ Welchweiler (Landkreis Kusel). Germany.		1 WT: Vestas V90 (tower: 80m, rotor ø: 90m)	**Acoustic monitoring** with Batcorder. No mortality control.		mountain forest
BFL (2013c). Kleeberg (Landkreis Neuenkirchen). Germany.	2012	1 WT: Enercon E53 (tower: 73m, rotor ø: 53m)	**Acoustic monitoring** with Batcorder. No mortality control.		mountain forest
BFL (2013d). Beltheim (Landkreis Rhein-Hunsrück). Germany.	2011 to ?	1 WT: Enercon E 82 (tower: 138m, rotor ø: 82m)	**Mortality control**: Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	1 dead bat: *Nyctalus leisleri* .	mountain forest
BFL (2013e). Gabsheim (Landkreis Alzey- Worms). Germany.	2012	2 WTs: Enercon E 101 (tower: 138.5m, rotor ø: 101m)	**Mortality control**: Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	2 dead bats: 1 *Pipistrellus pipistrellus* , 1 *Pipistrellus nathusii* .	open agricultural area, low altitude
BFL (2013f). Heimersheim (Landkreis Alzey- Worms). Germany.	2012	3 WTs: REpower 3.4M104 (tower: 128m, rotor ø: 104m)	**Mortality control**: Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	no dead bats.	open agricultural area, low altitude
BFL (2013g). Lingerhahn (Rhein-Hunsrück-Kreis). Germany.		2 WTs: REpower MM92 (tower: 100m, rotor ø: 92.5m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	no dead bats.	mountain forest
BFL (2013h). Mainstockheim (Anlage A3) (Landkreis Kitzingen). Germany.	2012	1 WT: Vestas V112 (tower: 140m, rotor ø: 112m)	**Acoustic monitoring** with Batcorder. No mortality control.		open agricultural area, low altitude
BFL (2013i). Neuerkirch (Landkreis Rhein-Hunsrück). Germany.	2012	3 WTs: Enercon E 82 (tower: 138m, rotor ø: 82m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	no dead bats.	mountain forest
BFL (2013j). Schornsheim (Landkreis Alzey-Worms). Germany.	2012	2 WTs: Kenarsys K 100 (tower: 135m, rotor ø: 100m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	no dead bats.	open agricultural area, low altitude
BFL (2013k). Unzenberg (Landkreis Rhein-Hunsrück). Germany.	2012	3 WT: 2 Vestas V112, 1 REpower 3.4 (towers: 142m, rotor ø: 142m?; 128m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	no dead bats.	mountain forest
BFL (2013l). Waldalgesheim (Landkreis Mainz-Bingen). Germany.	2011 to 2012	2 WTs: Enercon E 82 (tower: 138m, rotor ø: 82m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	1 dead bat: *Nyctalus leisleri* .	mountain forest
BFL (2013m). Worms (Landkreis Alzey-Worms). Germany.	2012	1 WT: Vestas V112 (tower: 140m, rotor ø: 112m)	**Mortality control:** Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	1 dead bat: *Pipistrellus nathusii* .	open agricultural area, low altitude
BFL (2013n). Wörrstadt-Ost (Landkreis Alzey-Worms). Germany.	2011 to 2012	2 WTs: Enercon E 82 (tower: 135m, rotor ø: 82m)	**Mortality control**: Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 months. **Acoustic monitoring** with Batcorder.	2 dead bats: 1 *Pipistrellus pipistrellus* , 1 *Nyctalus leisleri* .	open agricultural area, low altitude

Bio3 (2012f) Terra Fria, Portugal	March-October 2011	5 WTs (of 2,0 MW) - Contim; 18 WTs (of 2,0 MW) - Facho-Colmeia; 25 WTs (of 2,0 MW) - Montalegre	Weekly searches around 37 WT (Montalegre - 19; Facho-Colmeia - 13; Contim - 5); Search area: 50m around WT; tests for search efficiency & predation	**Detection:** Barbastella barbastellus (6); Hypsugo savii (5); M. myotis / M. blythi (1); Myotis pequeno sp. (3); Myotis sp. (1); E. serotinus / E. isabellinus (26); N. leisleri / E. serotinus / E. isabellinus (2); Nyctalus leisleri (12); Nyctalus sp. (2); Pipistrellus kuhlii (1); Pipistrellus pipistrellus (59); Pipistrellus sp. (7); Plecotus sp. (1); Tadarida teniotis (2). **Shelters:** Pipistrellus sp. (90); Small Myotis (15) **Mortality:** Montalegre - Nyctalus leisleri (3), Pipistrellus pipistrellus (1); Facho-Colmeia - Pipistrellus pipistrellus (2); Contim - no bats mortality detected;. **Mortality rate (Jain et al., 2007 / Huso 2010 / Korner-Nievergelt et al. 2011):** Montalegre - 2 / 2,8 / 1,4 bats/WT in 2011; Facho-Colmeia - 1,6 / 2,3 / 1,2 bats/WT in 2011;	**Contim**: mean alt.: 1150m; shrubs; grassland; rock outcrop; forest; **Facho-Colmeia**: mean alt.: 1200m; shrubs; grassland; forest; **Montalegre**: mean alt.: 1100m; shrubs; grassland; forest; rock outcrop
BLG (2009). Nordschwarzwald, Germany.		14 WTs: 12 Vestas V90, 2 Vestas V80 (tower 114 m, rotor ø 90 m; 80 m)	**Mortality control**: Search area of 50m radius around the WT. Tests for search efficiency, predation and correction for searched area every 2 month. **Acoustic monitoring** with von Laar Avisoft real-time system.	18 dead bats: 11 *Pipistrellus pipistrellus* , 4 *Pipistrellus nathusii* , 2 *Pipistrellus pygmaeus* , 1 *Vespertilio murinus* .	mountain forest (high altitude)
Camina A. (2012). La Rioja, Soria and Aragón, Spain.	2000 to 2010	56 wind parks	Bat fatalities reported in post-construction monitoring surveys from 56 wind farms were reviewed. There were many deficiencies in their protocols that prevent comparisons with other studies nationally and internationally. Only five reports (9%) accounted for searcher efficiency or carcass removal biases. Survey data for La Rioja were provided by Dirección General del Medio Natural del Gobierno de La Rioja (monitoring period 2002–2008, 10 wind farms), Junta de Castilla y León for Soria province (monitoring 2000–2008, 14 wind farms). The Aragonese Local Government provided several bird and bat monitoring reports for the 2000–2007 period (32 wind farms) located in Zaragoza, Huesca and Teruel provinces (all these unpublished reports are available on request from the author).	147 dead bats. 68 *Pipistrellus pipistrellus* (59%), 16 *P. kuhlii* (14%), 21 *Hypsugo savii* (18%), 1 Barbastella barbastellus, 5 Nyctalus lasiopterus, 1 N. leisleri and 4 Tadarida teniotis (< 5% each). In the mostly low elevations sites in Aragon, fatalities occurred between March and December and peaked (76%) from July to October. In La Rioja and Soria, where wind farms mostly are located at higher elevations, fatalities occurred between May and October and without any obvious late summer peak. Sex and age of the dead bats were not provided in any of the reports.	Ebro River Valley. Lowlands (< 700 m a.s.l.): wine yards, crops, fruit cultivations, and *Populus sp* . plantations. Sistema Ibérico mountain range (up to 2,262 m a.s.l.): forest, pasture, shrubland, croplands, and pine plantations.
Chatton et al. (2011) St Genou (Indre) 2010. France.	3 months	6 Vestas V80	once a week	5 Pipistrellus pipistrellus	cereal fields
Chatton et al. (2011) St Genou (Indre) 2011. France.	6 months	6 Vestas V80	Twice a week	5 Pipistrellus pipistrellus; estimation 2011:45 bats/6WTs/6months (but no correction for predation nor controlled surface)	cereal fields
Frey et al (2013). Timmeler Kampen near Bagband, Germany.	29. March to 1.October 2012 (217 nights) acoustic monitoring. 26 days mortality control.	18 WTs, 3 ENERCON E 82, tower 108m, rotor ø 82m and 15 E66, tower 98m.	**Mortality control** every 3 days (morning, 20 min per WT) under 18 WTs. Search area of 50m radius around the WT (except for areas with dense vegetation). Tests for search efficiency & predation. **Acoustic monitoring** at 3 WTs with two AnaBat-SD1 per WT (4m and rotor hight)	1 dead bat (Pipistrellus *nathusii*) found. Calculation: probably 0.2 dead bats/WT/study period. Acoustic monitoring: calls of Nyctalus noctula, *Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus, Myotis spp* .	agricultural area with few hedges and trees
Georgiakakis P. et al. (2012). East Macedonia and Thrace. Greece.	August 2009 to July 2010 (248 days)	88 WTs in 9 wind parks (towers 44-60m, rotor ø 52-90m).	**Mortality control:** All turbines were visited 5-6 days per week (except 24 December 2009 to 11 March 2010: 20 days only) Search area of 50m radius around the WT, two fieldworkers. The turbine platform was searched from a car moving in a circle. The rest of the plot was checked on foot. Each turbine was visited alternately morning and mid-day to afternoon. When a bat was located, researchers recorded the code of the wind turbine, the distance to the tower base of the nearest turbine (n = 108 carcasses), the exact carcass position using GPS equipment and the date.	181 dead and 2 injured bats. Mean number of fatalities per turbine per year: 2.08. *Nyctalus leisleri* (n = 56 bats, 31%), *Pipistrellus pipistrellus/pygmaeus* (n = 53, 29%), *Pipistrellus nathusii* (n = 35, 19%), *Hypsugo savii* (n = 23; 13%), *Nyctalus noctula* (n = 10; 5%). 1 *Eptesicus serotinus, 1 Nyctalus lasiopterus,* 1 *Vespertilio murinus* . Most killed bats were males (n = 123, 67%); most killed bats were adults (n = 167,91%).The majority of fatalities were observed from May to September.	main habitat types: forests (beech, oak and pine reforestations), sclerophyllous vegetation and alpine meadows. Other habitats: cultivated fields, pastures and rocky slopes.
Gottfried I. et al. (2011). Szczecin Coast, Gdańsk Coast, Chełmsk-Dobrzyń Lakeland, South Wielkopolska Lowland, Sudetes Foothills. Poland.	2007 to 2011	Towers 80m (one tower, Chełmsk-Dobrzyń Lakeland, 45m)	all accessible data form Poland from 2007 to 2011	26 dead bats: 5 *Nyctalus noctula* , 12 *Pipistrellus nathusii* , 1 *Pipistrellus pipistrellus* , 1 *Pipistrellus pygmaeus* , 3 *Eptesicus serotinus* , 3 *Vespertilio murinus* , 1 *Eptesicus nilssonii*	farmland and meadow in five regions in Poland: Szczecin Coast, Gdańsk Coast, Chełmsk-Dobrzyń Lakeland, South Wielkopolska Lowland, Sudetes Foothills
Gottfried T. & I. Gottfried (2012). Sudete Foothills, SW Poland.	May to October 2012	6 WTs: REpower MM92, 2 MW (tower 80m, rotor ø 92.5m)	**Mortality control**: 6 wind turbines. 7 controls, one control per month, check only technical square about 1350m²	27 dead bats: 11 *Nyctalus noctula* , 5 *Nyctalus leisleri* , 4 *Pipistrellus nathusii* , 2 *Pipistrellus pipistrellus* , 2 *Pipistrellus sp* , 2 *Vespertilio murinus* , 1 undetermined. Most of dead bats were find in August and September (93%)	farmland
Guilitte O. (2012). Bièvre, Southern Belgium.	16. to 28. August 2012	7 wind turbines Vestas V90 2MW	**Mortality control**: Punctual search for bat and bird carcasses under wind turbines (search radius : 40 meters)	2 *Pipistrellus pipistrellus* found dead	coniferous forest plantations and arable land
Kervyn T. (2012). Tarcienne, Southern Belgium.	21.August 2012	6 wind turbines Repower MD77	**Mortality control**: Punctual search for bat and bird carcasses under wind turbines	1 unidentified bat found dead	arable land

Korner-Nievergelt et al. (2011), Germany.			Simulation study on a German dataset.	Formula for to determining the detection probability of birds or bats that are killed at wind turbines (based on carcass persistence rate, searcher efficiency and the probability that a killed animal falls into a searched area)	
LEA (2012a). Alto do Marco. Portugal.	July 2011 to June 2012	6 WTs (of 2,0 MW)	**Monitoring Bat Activity**: Presence/absence of bats, identification of the species detected, and the existence of feeding activity and social calls were detected. 10 minutes of census were done at each sampling point (N=12), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Mortality surveys**: Monthly searches Novembro to Fevereiro and Weekly searches March to october around all 6 WTs.	**Monitoring Bat Activity**: Rhinolophus ferrumequinum, Pipistrellus pipistrellus, Pipistrellus pygmaeus, Pipistrellus kuhlii, Hypsugo savii, Barbastella barbastellus, Tadarida teniotis, Eptesicus sp, Plecotus sp. and Nyctalus leisleri /Eptesicus sp. **Mortality surveys**: 8 dead bats found during study (3 Pipistrellus pipistrellus; 2 Nyctalus leisleri; 1 Tadarida teniotis; 1 Hypsugo savii); Mortality rate: 6,35 Bats/WTs/year.	mean alt.: 1250m; shrubs;
LEA (2012b). Negrelo e Guilhado. Portugal.	Mid March to mid October	10 WTs (of 2,0 MW)	**Monitoring Bat Activity:** Presence/absence of bats, identification of the species detected, and the existence of feeding activity and social calls were recorded. 10 minutes of census were done at each sampling point (N=14), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Mortality surveys**: Weekly searches 15 March to 15 october around all 10 WTs.	**Monitoring Bat Activity**: *Pipistrellus pipistrellus, Pipistrellus kuhlii, Hypsugo savii, Barbastella barbastellus, Tadarida teniotis, Myotis sp, Eptesicus sp, Plecotus sp and Pipistrelluspipistrellus/Pipistrellus pygmaeus* . **Mortality surveys**: 2 dead bats found during study (1 *Pipistrellus pipistrellus* ; 1 *Hypsugo savii*); Mortality rate: 0,47 bats/WTs/year.	mean alt.: 1100m; shrubs;
LEA (2012c). Mafômedes. Portugal.	March to October 2011	2 WTs (of 2,0 MW)	**Monitoring Bat Activity:** Presence/absence of bats, identification of the species detected, and the existence of feeding activity and social calls were recorded. 10 minutes of census were done at each sampling point (N=3), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Mortality surveys**: Monthly searches Novembro to Fevereiro and twice per month searches March to october around all 2 WTs	**Monitoring Bat Activity**: *Pipistrellus pipistrellus, Tadarida teniotis, Eptesicus sp, Plecotus sp, Pipistrellus pipistrellus/Pipistrellus pygmaeus, Eptesicus sp/Nyctalus leisleri.* **Mortality surveys**: no mortality detected.	mean alt.: 1100m; shrubs;
LEA (2012d). Penedo Ruivo e Seixinhos. Portugal.	March to October 2011	18 WTs (of 1,8 MW)	**Monitoring Bat Activity**: Presence/absence of bats, identification of the species detected, and the existence of feeding activity and social calls were detected. 10 minutes of census were done at each sampling point (N=22), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Mortality surveys**: Monthly searches November to February and twice per month searches March to October around all 18 WTs.	**Monitoring Bat Activity:** *Rhinolophus hipposideros, Myotis escalerai, Pipistrellus kuhli, Pipistrellus pipistrellus, Hypsugo savii, Nyctalus leisleri, Barbastella barbastellus, Tadarida teniotis, Eptesicus sp, Plecotus sp., Pipistrellus pipistrellus/Pipistrellus pygmaeus, Pipistrellus pipistrellus/Miniopterus schreibersii/Pipistrellus pygmaeus, Nyctalus sp/Eptesicus sp, Nyctalus lasiopterus/Nyctalus noctula/Eptesicus sp* **Mortality surveys**: no mortality detected	mean alt.: 1270m; shrubs;
LEA (2011). Sobrado. Portugal.	March to October 2011	4 WTs (of 2,0 MW)	**Monitoring Bat Activity**: Presence/absence of bats, identification of the species detected, and the existence of feeding activity and social calls were detected. 10 minutes of census were done at each sampling point (N=12), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Mortality surveys**: Weekly searches March to october around all 4 WTs.	Monitoring Bat Activity: *Rhinolophus ferrumequinum, Myotis escalerai, Pipistrellus pipistrellus, Hypsugo savii, Nyctalus leisleri, Tadarida teniotis, Eptesicus sp, Plecotus sp and Nyctalus sp/Eptesicus sp.* Mortality surveys: no mortality detected.	mean alt.: 1280m; shrubs;
Lelong M. (2012) St Genou (Indre) 2012. France.	6 months	6 Vestas V80	Twice a week	2 Pipistrellus pipistrellus ; 1 Eptesicus serotinus, 1 Pipistrellus nathusii; estimation 2012: 64 bats/6WTs/6 months; correction for controler's efficiency, predation, surface	cereal fields

Minderman J. et al. (2012). Central Scotland and northern England, UK.	May to September 2010 (67 nights)	microturbines in central Scotland (N = 7) and northern England (N = 13): 5 building mounted, 15 free standing (tower 6-18m, rotor ø 1.5-13m). 18 3-bladed models, two 2-bladed models.	Bird and bat activity data were collected at each site over four successive days and nights (limited to three days and nights at two, and to two days and nights at one site due to access restrictions), and data collection was repeated once during the season at three of the twenty sites. Activity was compared between experimental treatments: turbines running or braked. **Acoustic monitoring**: Bat activity was automatically recorded using 2 AnaBat SD2 bat detectors (Titley Scientific; one 0-5 m and one 20-25 m from the turbine) during all nights of the observation period at each site (detector failure at 2 sites). Between 19 and 244 hours were sampled per site, during which time turbines were braked between 6 and 102 hours. Weather conditions and landscape features were recorded.	Across all 18 sites, N = 8221 bat passes: 87.6% *Pipistrellus spp.*, 12.4% *Myotis spp* ., *Nyctalus noctula, Plecotus auritus* . Bat activity was lower when turbines were running and this effect depended on WT proximity.	
NOCTULA (2012a). Safra-Coentral (Serra da Lousã). Portugal.	February 2011 to February 2012	Ecotecnia: ECO74	**Monitoring Bat Activity:** Three types of information were recorded: (a) the presence / absence of bats in a particular area, (b) identification of the species detected, (c) the existence of feeding activity (when detecting a series of pulses with a high repetition rate emitted by bats in the terminal phase of an attempt to capture prey). Were done 10 minutes of censuses in each sampling point, with an ultrasonic detector (D240X - Pettersson Elektronik ®) using the method of time expanded with a reproduction speed 10 × lower than the actual. The digital recorder used to store the recordings was the model of the Edirol R-09HR (.Wav format) and a sampling rate of 44.1 kHz. Additionally, was registered the number of bat passages detected during each listening. The analysis of ultrasound was performed using the software BatSound 4.0®, Pettersson Elektronik. The species with difficult vocalizations to distinguish were associated in groups of two or more species. **Monitoring Bats Shelters:** 83 bats shelters were prospected in each of the following months: February, April, and July. **Mortality surveys:**The weekly mortality surveys occurred between March and June 2012 in all the turbines of the wind farm and have been made by observers who performed concentric circles with radius of 60 meters, measured from the base of the turbine. When the observer found dead bats, the following data were registered: a) species, b) sex c) GPS point, d) the distance to the nearest turbine, e) presence of trauma, f) presence or evidence of predation h) digital photograph i) weather conditions.	**Detection:** *P. pipistrellus/ P. pygmaeus; Myotis myotis/blythii; Pipistrellus kuhlii; P. pipistrellus; E. serotinus/isabellinus; N leisleri/E. serotinus/isabellinus; Tadarida teniotis;* small *Myotis* spp.; Nyctalus spp. **Shelters:** *R. hipposideros* (8); *P. auritus/austriacus* (9 and 3 youngs); *R. euryale* (34 and 6 youngs); *Hypsugo savii* (1); *R. ferrumequinum* (1). **Mortality surveys:** 0.	Mixed deciduous forest and pine; pine forest; tall bushes and deciduous forest; pine forest and low bushes.
NOCTULA (2012b). Sobrado (Serra de Montemuro). Portugal.	March to June 2012	Repower: MM82evo	**Monitoring Bat Activity:**Three types of information were recorded: (a) the presence / absence of bats in a particular area, (b) identification of the species detected, (c) the existence of feeding activity (when detecting a series of pulses with a high repetition rate emitted by bats in the terminal phase of an attempt to capture prey). Were done 10 minutes of censuses in each sampling point, with an ultrasonic detector (D240X - Pettersson Elektronik ®) using the method of time expanded with a reproduction speed 10 × lower than the actual. The digital recorder used to store the recordings was the model of the Edirol R-09HR (.Wav format) and a sampling rate of 44.1 kHz. Additionally, was registered the number of bat passages detected during each listening. The analysis of ultrasound was performed using the software BatSound 4.0 ®, Pettersson Elektronik. The species with difficult vocalizations to distinguish were associated in groups of two or more species. **Mortality surveys**:The weekly mortality surveys occurred between March and June 2012 in all the turbines of the wind farm and have been made by observers who performed concentric circles with radius of 60 meters, measured from the base of the turbine. When the observer found dead bats, the following data were registered: a) species, b) sex c) GPS point, d) the distance to the nearest turbine, e) presence of trauma, f) presence or evidence of predation h) digital photograph i) weather conditions.	**Detection:** *P. pipistrellus/ P. pygmaeus* (2 passes); *Pipistrellus* sp. (*P. pipistrellus/P. pygmaeus*) **Mortality surveys:** 0.	Low bushes; rocky outcrops.

NOCTULA (2013). Testos II (Serra de Montemuro). Portugal.	September 2011 to August 2012	ENERCON: E-82	**Monitoring Bats Activity:** Three types of information were recorded: (a) the presence / absence of bats in a particular area, (b) identification of the species detected, (c) the existence of feeding activity (when detecting a series of pulses with a high repetition rate emitted by bats in the terminal phase of an attempt to capture prey). Were done 10 minutes of censuses in each sampling point, with an ultrasonic detector (D240X - Pettersson Elektronik ®) using the method of time expanded with a reproduction speed 10 × lower than the actual. The digital recorder used to store the recordings was the model of the Edirol R-09HR (.Wav format) and a sampling rate of 44.1 kHz. Additionally, was registered the number of bat passages detected during each listening. The analysis of ultrasound was performed using the software BatSound 4.0 ®, Pettersson Elektronik. The species with difficult vocalizations to distinguish were associated in groups of two or more species. **Monitoring Bats Shelters:** 34 bats shelters were prospected in each of the following months: February, April, and July. **Mortality surveys:** The weekly mortality surveys occurred in September and October 2011 and between March and August 2012 in all the turbines of the wind farm and have been made by observers who performed concentric circles with radius of 60 meters, measured from the base of the turbine. When the observer found dead bats, the following data were registered: a) species, b) sex c) GPS point, d) the distance to the nearest turbine, e) presence of trauma, f) presence or evidence of predation h) digital photograph i) weather conditions.	**Detection:** *Barbastella barbastellus* (1 pass); *P. pipistrellus* / *P. pygmaeus* (42 passes); *Myotis myotis/blythii* (1 pass); *Pipistrellus kuhlii* (15pass); P. *pipistrellus* (41 passes); *E. serotinus/isabellinus; N leisleri/E. serotinus/isabellinus* (54 passes); *Tadarida teniotis* (32 passes); small *Myotis* spp. (3 passes); R. *ferrumequinum* (1 passes). **Shelters:** *R. hipposideros* (1); *P. auritus/austriacus* (2); *Myotis daubentonii* (85); *Pipistrellus* sp. (1); *Myotis escalerai* (1). **Mortality:** *Tadarida teniotis* (1); *N. leisleri* (1)	Pine forest; tall bushes and pine forest; low bushes.
Otoul J. (2013). Southern Belgium.	April 2013 to October 2013	6 to 8 WT; study not yet started	**Mortality control**: Systematic search for bat and bird carcasses under wind turbines (search radius 50 m.); ESTIMATION OF MORTALITY RATE CALCULATED TAKING INTO CONSIDERATION PREDATION, EFFICIENCY AND CONTROLLED AREA	study not yet started	study not yet started
Park K. et al. (2013). UK.		microturbines	policy review	recommendations for research	
Procesl, (2012a). Serra de Alvaiázere, Portugal.	January 2011 - December 2011	7 WTs (of 2,0 MW)	**Mortality control**: Weekly searches around all 7 WTs; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** Rferrumequinum (8); Rmehelyi / Rhipposideros (3); Mescalerai (2); Mmyotis / Mblythii (2); Myotis sp. (5); Ppipistrellus (14); Pkuhlii (30); Ppygmaeus / Mschreibersii (5); Pkuhlii / Ppipistrellus (4); Ppipistrellus / Ppygmaeus / Mschreibersii (7); Nleisleri (8); Nlasiopterus / Nnoctula (5); Nyctalus sp. (2); Nyctalus sp. / Eptesicus sp. (10); Eserotinus / Eisabellinus (1); Bbarbastellus (1); Plecotus sp. (1); Tteniotis (6). **Shelters** (15 in hibernation period): Rferrumequinum (112); Rhipposideros (3); Rhinolophus sp. (13); Mmyotis / Mblythii (19); Mmyotis (9); Mblythii (2); Mdaubentoni (1); Mschreibersi (2500). **Mortality:** 12 dead bats (3 Nleisleri; 1 Tteniotis; 1 Ppygmaeus; 1 Pkuhlii; 1 Mschreibersii; 2 Pipistrellus sp.; 3 non identified); 2 in April, 3 in May, 3 in August, 3 in September and 1 in November; Mortality rate: not available.	Mean altitude: 600 m; Schrubs
Procesl. (2012b). Serra de Aire. Portugal.	January 2011 to December 2011	11 WTs (of 2,0 MW)	**Mortality control**: Monthly searches around all 11 WTs; Search area: 50m around WT; tests for search efficiency; Predation estimated on regional tests	**Detection**: Rferrumequinum (1); Rhipposideros (1); Rmehelyi / Reuryale (1); Myotis sp. (1); Ppipistrellus (31); Pkuhlii (16); Pkuhlii / Ppipistrellus (1); Ppipistrellus / Ppygmaeus / Mschreibersii (9); Ppygmaeus / Mschreibersii (6); Pipistrellus sp. (1); Nleisleri (2); Nlasiopterus / Nnoctula (2); Nyctalus sp. (1); Nyctalus sp. / Eptesicus sp. (1); Eserotinus / Eisabellinus (4); ; Plecotus sp. (2). **Shelters** (5 in hibernation period): Rferrumequinum (18); Rhipposideros (2); Rhinolophus sp. (26); Mmyotis (300); Mblythii (3); Mschreibersi (100). **Mortality**: 3 dead bats (1 Nleisleri; 2 Pipistrellus sp.); 2 in April, 1 in September; Mortality rate: 11,3 bat/WT/year	Mean altitude: 300 m; Schrubs, olive culture, airfield
Report unavailable (2010) Loire Atlantique 1, France.	4 months	5, type unknown	controls once a week	48 dead bats mainly pipistrelles spec - 51,1 bats/WT/year (Winkelmann)	unknown
Report unavailable (2011) Loire Atlantique 1, France.	7 months	5, type unknown	controls once a week	15 dead bats mainly pipistrelles spec - 8,3 bats/WT/yr (Winkelmann)	unknown
Report unavailable (2010) Loire Atlantique 2, France.	4 months	3 ,type unknown	controls once a week	28 dead bats, mainly pipistrelles spec - 54,1 bats/WT/yr (Winkelmann)	unknown
Report unavailable (2011) Loire Atlantique 2, France.	7 months	3, type unknown	controls once a week	25 dead bats, mainly pipistrelles spec. - 23,9 bats/WT/yr (Winkelmann)	unknown

Report unavailable (2011) Morbihan 1, France.		6, type unknown	controls once a week	13 dead bats, mainly pipistrelle bats - 9,87 bats/WT/yr (Winkelmann)	unknown
Report unavailable (2012) Morbihan 1, France.	8 weeks	6, type unknown	controls once a week	0 fatality	unknown
2008 Rochereau (Vienne). France.	15 weeks	4 x Ecotecnia 80-1.6	controls once a week	1 dead bat - 0,65 bat/WT/year (Winkelmann)	
2009 Rochereau (Vienne). France.	33 weeks	4 x Ecotecnia 80-1.6	controls once a week	4 dead bats - 3,12 bats/WT/year (Winkelmann)	
2010 Rochereau (Vienne). France.	33 weeks	4 x Ecotecnia 80-1.6	controls once a week	1 dead bat - 0, 22 bats/WT/ year (Winkelmann)	
Santos H. et al. (2013). Portugal.	2003 to 2011		This study combines species distribution modelling with mortality data and the ecological conditions at wind farms located in Portugal. Predictive models were generated to determine areas of probable mortality and which environmental factors were promoting it. Mortality data for four bat species, *Hypsugo savii, Nyctalus leisleri* , *Pipistrellus kuhlii* and *Pipistrellus pipistrellus* , were used. These experienced the highest levels of fatalities at wind farms in Portugal, comprising 290 of the 466 fatalities recorded from 2003 to 2011. The mortality risk models showed robust performances. Wind farms sited at humid areas with mild temperatures, closer than 5 km to forested areas and within 600 m of steep slopes showed higher probabilities of mortality. High mortality risk areas also overlapped highly with the potential distribution of *N. leisleri* in Portugal, suggesting that populations of this species may be at high risk due to wind farm fatalities. Moreover, a large extent of the area predicted to be a hotspot for mortality (i.e. areas likely to confer high mortality risk for four species) overlaps with sites highly suitable for wind farm construction.		
Viseur S. (2012). Dour, Southern Belgium.	2009 to 2010	11 wind turbines Enercon E82/2000 and 3 wind turbines Enercon E82/2300	**Mortality control:** Punctual search for bat and bird carcasses under wind turbines	3 *Pipistrellus pipistrellus* found dead	arable land and pastures

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