Doc.EUROBATS.AC20.5

20th Meeting of the Advisory Committee

Budva, Montenegro, 23 – 25 March 2015

Report of the IWG on Wind Turbines and Bat Populations

Members

Luisa Rodrigues (Portugal) (coordinator), Marie-Jo Dubourg-Savage (SFEPM, France), Lothar Bach (Germany), Branko Karapandža (Serbia), Andrzej Kepel (Poland), Thierry Kervyn (Belgium), Christine Harbusch (NABU, Germany), Jasja Dekker (BatLife Europe, The Netherlands), Branko Micevski (FYR Macedonia), Dina Kovač (Croatia), Petra Bach (Germany), Jan Collins (BCT, United Kingdom), Kirsty Park (Stirling University, United Kingdom), Anna Nele Herdina (Austria), Christian Voigt (Leibniz Institute for Zoo and Wildlife Research, Germany), Dino Scaravelli (San Marino), Johanna Hurst (Freiburger Institut, Germany), Eeva-Maria Kyheröinen (Finland) , Herman Limpens (Dutch Mammal Society, The Netherlands), Jean Matthews (United Kingdom), Panagiotis Georgiakakis (Greece), Daniela Hamidović (Croatia), Katherine Walsh (United Kingdom), Laurent Biraschi (Luxembourg), Laurent Schley (Luxembourg), Per Ole Syvertsen (Norway), Pascal Moeschler (Switzerland), Joana Bernardino (Bio3, Portugal), Rita Bastos (CITAB/UTAD, Portugal), Fiona Mathews (United Kingdom), Robert Raynor (United Kingdom)

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) Christine Harbusch Laurent Biraschi Marie-Jo Dubourg-Savage
Mitigation and compensation measures	Joana Bernardino (c) Branko Karapandža Dino Scaravelli Lothar Bach Luisa Rodrigues Thierry Kervyn
Estimation of mortality rate taking into consideration predation, efficiency and controlled area; choose of best estimator for Europe	Lothar Bach (c) Dino Scaravelli Jasja Dekker Joana Bernardino Petra Bach Rita Bastos
Impact of mortality rate on populations	Christian Voigt (c)

	Christine Harbusch Jasja Dekker Lothar Bach Rita Bastos
Deterrents	Lothar Bach (c) Branko Karapandža Dino Scaravelli Luisa Rodrigues
Maximum foraging distances of species and Detectability coefficients to compare activity indices	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	Dina Kovač (c) Fiona Mathews Jan Collins Joana Bernardino Petra Bach
Comparing measurement of activity at ground level and rotor height	Lothar Bach (c) Jan Collins Johanna Hurst Marie-Jo Dubourg-Savage Petra Bach Thierry Kervyn
Small Wind Turbines	Kirsty Park (c) Jan Collins Lothar Bach
Offshore windfarms	Lothar Bach (c)
Wind farms and forests	Christian Voigt (c) Andrzej Kepel Branko Karapandža Christine Harbusch Fiona Mathews Lothar Bach

The IWG thanks Laurent Tillon, who helped preparing the draft text on "Wind farms and forests" and Tobias Dürr for his collaboration regarding data on bat mortality.

Some members of the IWG, in collaboration with other colleagues, prepared updated guidelines on wind farms and bats (Rodrigues L., L. Bach, M.-J. Dubourg-Savage, B. Karapandža, D. Kovač, T. Kervyn, J. Dekker, A. Kepel, P. Bach, J. Collins, C. Harbusch, K. Park, B. Micevski & J. Minderman. in press. Guidelines for consideration of bats in wind farms projects – revision 2014. EUROBATS Publications Series). The document was approved in the 7th Session of the Meeting of Parties and is being printed.

Results

Results are presented by sub-group.

Update/reorganizing of the list of references

Annex 1 includes new references and is an addendum to the list of references which had been presented in AC19 (*Doc.EUROBATS.StC9-AC19.Doc.12).*

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 the end of December 2014. It reflects by no means the real extent of bat mortality at wind turbines as it is based only on reported fatalities to EUROBATS IWG members.

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

Bat mortality in Europe (2003-2014) - State 06/03/2015

Species	**AT**	**BE**	**CH**	**CR**	**CZ**	**DE**	**ES**	**EE**	**FI**	**FR**	**GR**	**IT**	**LV**	**NL**	**NO**	**PT**	**PL**	**SE**	**UK**	**Total**
Nyctalus noctula	46				3	836	1			15	10					1	16	1		**929**
Nyctalus lasiopterus							21			6	1					8				**36**
N. leisleri			1		1	124	15			53	58	2				219	5			**478**
Nyctalus spp							2									16				**18**
Eptesicus serotinus	1				7	43	2			16	1			1		0	3			**74**
E. isabellinus							117									1				**118**
E. serotinus / isabellinus							11									16				**27**
E. nilssonii	1					3		2	6				13		1		1	8		**35**
Vespertilio murinus	2			7	2	103				8	1		1				8	1		**133**
Myotis myotis						2	2			2										**6**
M. blythii							4													**4**
M. dasycneme						3														**3**
M. daubentonii						7										2				**9**
M. bechsteinii										1										**1**
M. emarginatus							1			1										**2**
M. brandtii						1														**1**
M. mystacinus						2					1									**3**
Myotis spp						1	3													**4**
Pipistrellus pipistrellus	2	10		2	3	486	73			359		1		15		249	3	1		**1204**
P. nathusii	13	3		3	2	661				129	35	2	23	8			16	5		**900**
P. pygmaeus	4					54				123			1			33	1	1	1	**218**
P. pipistrellus / pygmaeus	1		1				483			25	54					36	1			**601**
P. kuhlii				66			44			90						40				**240**
P.pipistrellus / kuhlii																19				**19**
Pipistrellus spp	8			37	2	49	20			113	1		2			89	2		3	**326**
Hypsugo savii	1			57		1	50			31	26	12				46				**224**
Barbastella barbastellus						1	1			3										**5**
Plecotus austriacus	1					6														**7**
Plecotus auritus						6														**6**
Tadarida teniotis				2			23			1						22				**48**
Miniopterus schreibersii							2			4						3				**9**
Rhinolophus ferrumequinum							1													**1**
Rhinolophus mehelyi							1													**1**
Chiroptera	1	1		14		48	320	1		201	6	1				105	3	30	8	**739**
Total	**81**	**14**	**2**	**188**	**20**	**2437**	**1197**	**3**	**6**	**1181**	**194**	**18**	**40**	**24**	**1**	**905**	**59**	**47**	**12**	**6429**

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

Updating of tables on monitoring studies done in Europe

Annex 2 contains new data of studies done in Europe; this table is an addendum 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,* Annex 2 of *Doc.EUROBATS.AC17.6,* Annex 2 of *Doc.EUROBATS.AC18.6* and Annex 2 *of Doc.EUROBATS.StC9-AC19.12.*

Mitigation and compensation measures

According to current knowledge the increase of wind turbines cut-in speed and feathering turbine blades continues to be the most effective way to mitigate bat fatality at wind energy facilities. In some cases the implementation of such measures have been enhanced by the development of site-specific algorithms that adjust turbines operation based on bat activity, temperature, wind speed, season, and/or time of day (e.g. Brinkmann *et al.* 2011). As mentioned in previous reports, in North America the increase of the cut-in speed (between 1.5 and 3.0 m/s above the manufacturer's cut-in speed) or feathering blades in 10 wind farms reduced in most cases the fatality rate at least 50% (Arnett *et al.* 2013).

Hale & Bennett (2014) recently reported similar results for a wind facility in north-central Texas. Between 2011 and 2013, two curtailment strategies were tested: 1) variable cut-in speed (ranging from 3.0-6.5 m/s depending on wind direction) and 2) regular (cut-in speed 5.0 m/s). Overall bat mortality was 56-82% lower at curtailed turbines compared to controls (manufacturer's cut-in speed 3.0 m/s), yet there was no difference between the two curtailment strategies. The analysis of the financial costs of both two strategies is still undergoing.

In European countries like Belgium, France, Germany, Poland and Portugal the adoption of curtailment strategies is also becoming a reality and it is recommended by the IWG. However, Voigt *et al.* (2015) highlights that some bats (in particular migratory species like *Nyctalus noctula* and *Pipistrellus nathusii*) may still be active at wind speeds higher than 7 m/s and therefore the current practice of cut-in speeds may selectively affect those type of species. Thus, the effectiveness of this type of mitigation measures and its dependency on, for example, geographical location, habitat structure, wind turbine type and species characteristics, still needs to be tested on a larger scale.

Regarding the last step of the mitigation hierarchy, recently 2 peer-reviewed articles have been published about compensation measures for bats in the context of European wind farms, a subject rarely addressed in past scientific publications. Peste *et al.* (2015) conducted a review on conservation measures for bats that may be applied and assessed to compensate/offset residual impacts of wind farms on bat populations, in particularly sedentary or non-migrant species. The majority of the proposed measures focuses especially on the enhancement of habitat heterogeneity at local and landscape scales (e.g. maintenance of native forests; management of production forest to promote the increase of roosts and foraging areas). However, the study also strongly underlines that offsets or compensatory measures should always be seen as a “last resort”. It should only take place after the implementation of the necessary avoidance and minimization measures and follow the 10 principles of the Business and Biodiversity Offsets Programme (BBOP, 2009).

In the second study published, Millon *et al.* (2015) conducted bat activity surveys at farming landscapes in northeast France, during the reproductive and migration season. The surveys were conducted at impacted sites (crops with wind turbines), sites without compensation measures (crops) and a set of sites with potential compensation measures (crops with fallows, hedgerows, bushes and/or grass strips). The results demonstrated that the main groups of species studied (*Pipistrellus* sp., *Eptesicus-Nyctalus* sp. and *Plecotus-Myotis* sp.) responded differently to the different potential compensation measures and that responses were season-dependent. The authors were able to identify that fallows and hedgerows, especially in spring and early summer, could bring about gains and therefore be used to achieve the no-net-loss at wind energy facilities or other offset frameworks. They also showed that bat activity was lower in crops with wind turbines than in crops without wind turbines, indicating negative impact of wind turbines on bat activity. However they also acknowledge some study limitations and point out further research questions.

Arnett E.B., G.D. Johnson, W.P. Erickson & C.D. Hein. 2013. *A synthesis of operational mitigation studies to reduce bat fatalities at wind energy facilities in North America*. A report submitted to the National Renewable Energy Laboratory. Bat Conservation International. Austin, Texas, USA.

BBOP. 2009. The relationship between biodiversity offsets and impact assessment: a BBOP Resource Paper. Washington, D.C.: Business and Biodiversity Offsets Programme.

Brinkmann, R., O. Behr, I. Niermann, M. Reich (editors). 2011. *Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von Fledermäusen an onshore-Windenergieanlagen*. Schriftenreihe Institut für Umweltplanung. Cuvillier Verlag, Göttingen.

Hale, A. & V. Bennett. 2014. *Investigating the benefits of fine-tuning curtailment strategies at operational wind facilities*. *In* Wind Wildlife Research Meeting X: presentation abstracts. Broomfield, Colorado (USA). December 2-5, 2014.

Millon L., J-F Julien, R. Julliard & C. Kerbiriou 2015. Bat activity in intensively farmed landscapes with wind turbines and offset measures. *Ecological Engineering*. 75: 250-257.

Peste, F., A. Paula, L.P. da Silva, J. Bernardino, P. Pereira, M. Mascarenhas, H. Costa, J. Vieira, C. Bastos, C. Fonseca & M.J. Ramos Pereira. 2015. How to mitigate impacts of wind farms on bats? A review of potential conservation measures in the European context. *Environmental Impact Assessment Review*, 51:10-22.

Voigt, C.C., L.S. Lehnert, G. Petersons, F. Adorf & L. Bach. 2015. Wildlife and renewable energy: German politics cross migratory bats. *European Journal of Wildlife Research*. DOI 10.1007/s10344-015-0903-y.

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

In 2014 (and 2015) a new R-package was released by Korner-Nievergelt and co-authors (2015) that allows the estimation of bat mortality. A tutorial is available. This R-package requires basic knowledge of the R Language. Users who are unfamiliar with R are advised to check out www.kollisionsopfersuche.uni-hannover.de (in German) or www.wildlifefatalityestimator.com of Bio3 / ISPA (now fully developed and also including tutorials).

Huso *et al.* (2014) published an article focussing on the aspect that carcasses might not be found under wind turbines. This can happen because the number of actual fatalities is small or the probability to find a bat is below 1. Thus the article suggests an approach that uses Bayes' theorem to calculate the probability of the actual number of fatalities is below a predicted limit, and that can be used even when zero carcasses are observed during searches. This upper bound of the fatality estimate is however strongly affected by the detection probability (and its uncertainty), especially if it is lower than 0.45.

In another article, Huso & Dalthorp (2014) focused again their research on carcass detection rates, in particular on the proportion of carcasses that is expected to fall outside the areas searched. The authors tested 5 estimators differing in assumptions about the relationship of carcass density to distance from the turbine. They concluded that the naïve estimator (which simply divides the observed fatality by the fraction of the area searched) overestimated the total fatality, by a large margin. Therefore, estimates that do not account for distance effects are likely to be biased.

The recent research focus lies also on the basic aspects of the problem like carcass removal and search efficiency, and the variables affecting their bias-adjustment factors (Peters *et al*. 2014).

Huso, M.M.P. & D. Dalthorp. 2014. Accounting for unsearched Areas in Estimating wind turbine-caused fatality. *The Journal of Wildlife Management*, 78(2): 347–358.

Huso M.M.P., D.H. Dalthorp, D.A. Dail & L.J. Madsen. 2014. Estimating wind-turbine caused bird and bat fatality when zero carcasses are observed. *Ecological Applications*. DOI: 10.1890/14-0764.1.

Korner-Nievergelt, F., Behr, O., Brinkmann, R., Etterson, M. A., Huso, M. M., Dalthorp, D. & I. Niermann. 2015. Mortality estimation from carcass searches using the R-package carcass-a tutorial. *Wildlife Biology*, 21(1): 30-43.

Peters, K. A., D.S. Mizrahi & M.C. Allen. 2014. "Empirical Evidence for Factors Affecting Searcher Efficiency and Scavenging Rates at a Coastal, Terrestrial Wind-Power Facility." *Journal of Fish and Wildlife Management* 5.2: 330-339.

Impact of mortality rate on populations

A likely negative of wind turbine-related fatalities on bat population is often discussed among stake holders of the wildlife-wind energy conflict in Europe. In theory, bat populations are particularly susceptible to increased mortality rates, given the low fecundity of bat species and thus recruitment of juveniles in populations (Jones *et al*. 2003). Therefore, even minor increases in mortality risks might have large-scale effects on bat populations. The major difficulty in any demographic study seems to be the lack of required baseline data, e.g. of population sizes, recruitment and dispersal rates in the absence and presence of wind turbines. Even when such demographic parameters have been established for local bat populations over many years, it is difficult to distinguish between effects caused by wind turbines and those triggered by other confounding factors, such as changes in the management of local habitats, losses of daytime roosts, annual climatic fluctuations (e.g. increased winter mortality caused by a sequence of harsh winters), global climate changes among others). We are not aware of any recent (2014-2015) paper dealing with population-effects of wind turbines. Yet, several review papers about the conflict between renewable energy and wildlife, namely bats, were published (Köppel *et al*. 2014, Tabassum-Abbasi *et al*. 2014, Dai *et al*. 2015, Voigt *et al*. 2015) highlighting a discrepancy between the lack of empirical data and a high and urgent need for synthesis.

Giavi *et al*. (2014) suggested that natural mortality rates of migratory bat species, such as *N. leisleri*, are low during migration. Further, two papers call for attention regarding the connectivity of the site of bat fatalities and the likely origin of bats, particularly migratory bats (Voigt *et al*. 2012, Lehnert *et al*. 2014). Lehnert and colleagues pointed out that about 70% of killed *N. noctula* in Eastern Germany were of local origin and 30% of distant origin, e.g. Baltic countries, Belarus and Russia. In the group of migratory individuals, they observed more females than males, and in the group of local individuals they found more juveniles than adults (Lehnert *et al*. 2014). The higher percentage of females from distant places that were killed at German wind turbines highlights the potential large negative effect of the so-called German "Energiewende" on bat population in Northeastern Europe (Voigt *et al*. 2015). Using a spatial modelling approach, Roscini *et al*. (2013, 2014) combined species distribution models for bats with the spatial distribution of wind turbines at an Italian site that undergoes intense wind farm development. In the most recent approach, the authors modelled the incidence of each wind farm o bat flight corridors by overlaying existing and planned turbine locations on potential commuting corridors (Roscioni *et al*. 2014). Identifying risk areas using modelling may help in future to point out areas where wind farm construction is particularly risky for bats. A similar modelling approach was followed by Santos *et al*. (2013) for *Hypsugo savii*, *Nyctalus leisleri*, *Pipistrellus kuhlii* and *Pipistrellus pipistrellus* in order to generate predictive models to determine areas of probable mortality. Hedenström & Rydell (2013) showed in another model, based on simple assumptions that the planned increase of wind turbines in Sweden will have a negative effect on Swedish populations of *Nyctalus noctula*, even when the current number of wind turbines remains constant, if no mitigation measures are taken. Chauvenet *et al*. (2014) used capture-mark-recapture to describe demographic rates for *Eptesicus serotinus* at two sites in England and investigated the transition rates between three stages: juveniles, immatures, and breeders. Using an individual-based population dynamics model, they investigated the expected trajectories for both populations. They demonstrate the presence and scale of temporal variation in this species' demography and show how site-specific variation in demographic rates can produce divergent population trajectories (Chauvenet *et al*. 2014). In conclusion, site or population specific difference in demographic parameters may question the validity of extrapolating patterns observed in local studies to a broader spatial scale.

The IWG is convinced that the development of studies at regional or local (particularly important for rare species) levels is vital, e.g. the promotion of wind turbine facilities in forested areas may affect in particular non-migratory bat species, e.g. those of the genus *Myotis*, so that population effects may be easier to detect. Bat surveys for impact assessment of wind farm projects should take into account the connectivity between wind turbine sites and breeding sites. Also, it is important to take into account the cumulative impact of all wind farms in the home range of a population. Note that such a home range in migrating species may be the area from the UK to the Baltic states or from Russia to Greece.

Chauvenet, ALM, Hutson, A.M., Smith, G.C., Aegerter, J.N. (2014) Demographic variation in the UK serotine bat: filling gaps in knowledge for management.

Dai, K.S., Bergot, A., Liang, C., Xiang, W.N., Huang, Z.H. (2015) Environmental issues associated with wind energy – A review. Renewable energy 75: 911-921.

Giavi, S., Moretti, M., Bontadina, F., Zambelli, N,. Schaub, M., (2014) Seasonal surival probability suggest low migration mortality in migrating bats. PlosONE 9: e85628.

Hedenström 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.

Jones KE, Purvis A, Gittleman JL (2003) Biological correlates of extinction risk in bats. Am Natural 161: 601–614

Köppel, J., Dahmen, M., Helfrich, J., Schuster, E., Bulling, L. (2014) Cautious but committed: moveing toward adaptive planning and operation strategies for renewable enregy’s wildlife implications. Environmental Management 54: 744-755.

Roscini F, Russo D, Di Febbraro M, Frate L, Carranza ML, Loy A (2013) Regional-scale modeling of the cumulative impact of wind farms on bats. Biodivers Conserv. doi 10.1007/s10531-013-0515-3

Roscioni, F., Rebelo, H., Russo, D., Carranza, M.L., DiFebbraro, M., Loy, A. (2014) A modelling approach to infer the effects of wind farms on landscape connectivity for bats. Landscape ecology 29: 891-903.

Santos H., L. Rodrigues, G. Jones & H. Rebelo. 2013. Using species distribution modelling to predict bat fatality risk at wind farms. Biological Conservation, 157:178-186.

Tabassum-Abbasi, P., M., Abbasi, T. Abbasi, S.A. (2014) wind energy: Increasing deployment, rising environmental concerns. Renwable and sustainable energy reviews. 31: 270-288.

Voigt C.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.

Voigt, C.C., Lehnert, L.S., G. Petersons, F. Adorf, L. Bach (2015) Bat fatalities at wind turbines: German politics cross migratory bats. European Journal of Wildlife Research. In press

Deterrents

Acoustic deterrents, as a method to reduce bat fatalities at wind farms, have not been proven to be effective for keeping bats away from the risk zone around wind turbine blades (Arnett *et al.* 2013). However, different approaches are still used and tested (e.g. BCI 2013, Johnson *et al.* 2012), especially in US, where nature legislation is not as strict as in the EU. Specific analyses are still not available about the modulation of the ultrasound in the field for this deterrent effect and also on possible cross effect on other wildlife.

Arnett E., C.D. Hein, M.R. Schirmacher, M.P Huso & J.M. Szewczak. 2013. Evaluating the effectiveness of an ultrasonic acoustic deterrent for reducing bat fatalities at wind turbines. *PLOS ONE*, 8(9): 10.1371/annotation/a81f59cb-0f82-4c84-a743-895acb4b2794. doi: 10.1371/annotation/a81f59cb-0f82-4c84-a743-895acb4b2794

BCI & The National Renewable Energy Laboratory (2013): Proceedings from the August 26th, 2013 Ultrasonic Acoustic Deterrent Workshop: 15pp. http://www.batsandwind.org/pdf/Deterrent%20Workshop%20Proceedings_Final.pdf

Johnson J. B., Ford W. M., Rodrigue J. L., Edwards J. W. 2012. Effects of acoustic deterrents on foraging bats. Res. Note NRS-129. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 pp

Maximum foraging distances of species and Detectability coefficients to compare activity indices

The table on "maximum foraging distances of species" (included in *Doc.EUROBATS.AC17.6*; http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/AC17_Doc_6_IWG_wind_turbines_inc%20Annex%20I-II.pdf) is still valid in the absence of new information.

Detectability coefficients determined by Michel Barataud are:

Open space			
Intensity level of calls	**Species**	**Distance of detection (m)**	**Detectability coefficient**
very low to low	*Rhinolophus hipposideros*	5	5,00
	Rhinolophus ferr/eur/meh.	10	2,50
	Myotis emarginatus	10	2,50
	Myotis alcathoe	10	2,50
	Myotis mystacinus	10	2,50
	Myotis brandtii	10	2,50
	Myotis daubentonii	15	1,67
	Myotis nattereri	15	1,67
	Myotis bechsteinii	15	1,67
	Barbastella barbastellus	15	1,67
medium	*Myotis oxygnathus*	20	1,25
	Myotis myotis	20	1,25
	Pipistrellus pygmaeus	25	1,00
	Pipistrellus pipistrellus	30	0,83
	Pipistrellus kuhlii	30	0,83
	Pipistrellus nathusii	30	0,83
	Miniopterus schreibersii	30	0,83
high	*Hypsugo savii*	40	0,63
	Eptesicus serotinus	40	0,63
	Plecotus spp	40	0,63
very high	*Eptesicus nilssonii*	50	0,50
	Eptesicus isabellinus	50	0,50
	Vespertilio murinus	50	0,50
	Nyctalus leisleri	80	0,31
	Nyctalus noctula	100	0,25
	Tadarida teniotis	150	0,17
	Nyctalus lasiopterus	150	0,17

Open and semi-open space			
Intensity level of calls	**Species**	**Distance of detection (m)**	**Detectability coefficient**
very low to low	*Rhinolophus hipposideros*	5	5,00
	Rhinolophus ferr/eur/meh.	10	2,50
	Myotis emarginatus	10	2,50
	Myotis alcathoe	10	2,50
	Myotis mystacinus	10	2,50
	Myotis brandtii	10	2,50
	Myotis daubentonii	15	1,67
	Myotis nattereri	15	1,67
	Myotis bechsteinii	15	1,67
	Barbastella barbastellus	15	1,67
medium	*Myotis oxygnathus*	20	1,25
	Myotis myotis	20	1,25
	Plecotus spp	20	1,25
	Pipistrellus pygmaeus	25	1,00
	Pipistrellus pipistrellus	25	1,00
	Pipistrellus kuhlii	25	1,00
	Pipistrellus nathusii	25	1,00
	Miniopterus schreibersii	30	0,83
high	*Hypsugo savii*	40	0,63
	Eptesicus serotinus	40	0,63
very high	*Eptesicus nilssonii*	50	0,50
	Eptesicus isabellinus	50	0,50
	Vespertilio murinus	50	0,50
	Nyctalus leisleri	80	0,31
	Nyctalus noctula	100	0,25
	Tadarida teniotis	150	0,17
	Nyctalus lasiopterus	150	0,17

Clutter (underwood)			
Intensity level of calls	**Species**	**Distance of detection (m)**	**Detectability coefficient**
very low to low	*Rhinolophus hipposideros*	5	5,00
	Plecotus spp	5	5,00
	Myotis emarginatus	8	3,13
	Myotis nattereri	8	3,13
	Rhinolophus ferr/eur/meh.	10	2,50
	Myotis alcathoe	10	2,50
	Myotis mystacinus	10	2,50
	Myotis brandtii	10	2,50
	Myotis daubentonii	10	2,50
	Myotis bechsteinii	10	2,50
	Barbastella barbastellus	15	1,67
	Myotis oxygnathus	15	1,67
	Myotis myotis	15	1,67
medium	*Pipistrellus pygmaeus*	25	1,00
	Miniopterus schreibersii	25	1,00
	Pipistrellus pipistrellus	25	1,00
	Pipistrellus kuhlii	25	1,00
	Pipistrellus nathusii	25	1,00
high	*Hypsugo savii*	30	0,83

	Eptesicus serotinus	30	0,83
very high	*Eptesicus nilssonii*	50	0,50
	Eptesicus isabellinus	50	0,50
	Vespertilio murinus	50	0,50
	Nyctalus leisleri	80	0,31
	Nyctalus noctula	100	0,25
	Tadarida teniotis	150	0,17
	Nyctalus lasiopterus	150	0,17

However, Dietz & Kiefer (2014) mention that the distances should be reduced to 1/2 or 1/3 if an automatic detector has been used.

Dietz, C. & A. Kiefer (2014) Die Fledermäuse Europas, Kennen, Bestimmen, Schützen, 400 pages; Kosmos Verlag, Stuttgart. ISBN 978-3-440-11560-2.

Collect national guidelines

No new information was received, so information on National guidelines may be found in *Doc.EUROBATS.StC9-AC19.12* (http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/Doc_StC9_AC19_12_ReportIWG_WindTurbines%20incl_Annexes.pdf).

Use of dogs vs humans during carcass searches

Trained search dogs are proved to be more accurate and effective in searching for bat carcasses under wind turbines in comparison to human observers (Arnett *et al*. 2005, Arnett 2006, Paula *et al*. 2011, Paulding *et al*. 2011, Mathews *et al*. 2013). These differences are caused by the differences between the human vision and dog olfactory sense, which can be used in larger area and in higher and denser vegetation (Arnett *et al*. 2005). Still, carcass decomposition condition and weather conditions such as wind and temperature can play important roles in scenting conditions and affect the search accuracy and efficiency of the working dog (Paula *et al*. 2011). Also there is a caution when conclusions are being made due to possible bad selections and trainings of the dogs as well as handlers (dog-handler teams). To produce consistent results, bat workers are urged to make assessments of the accuracy and efficiency of the dog–handler team at each wind farm location (Mathews *et al*. 2013). Compilation of data regarding the involvement of dogs in bat mortality monitoring projects based on questionnaires filled out by EUROBATS Focal Points was presented to 19th Meeting of the Advisory Committee (*Doc.EUROBATS.StC9-AC19.12*), but no recent published studies on use of dogs vs humans during carcass searches were found since the last report.

Arnett E.B., technical editor. 2005. *Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality, search protocols, patterns of fatality,* *and behavioural interactions with wind turbines*. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Arnett E.B. 2006. A preliminary evaluation on the use of dogs to recover bat fatalities at wind energy facilities. *Wildlife Society Bulletin*, 34(5):1140-1145.

Mathews F., M. Swindells, R. Goodhead, T.A. August, P. Hardman, D.M. Linton & D.J. Hosken. 2013. Effectiveness of search dogs compared with human observers in locating bat carcasses at wind-turbine sites: A blinded randomized trial. *Wildlife Society Bulletin*, 37: 34–40. doi: 10.1002/wsb.256

Paula J., M.C. Leal, M.J. Silva, R. Mascarenhas, H. Costa & M. Mascarenhas. 2011. Dogs as a tool to improve bird-strike mortality estimates at wind farms. *Journal for Nature Conservation*, 19: 202–208.

Paulding E., J. Nowakowski & W. Grainger. 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

The group did not find new information on this topic, so information included in *Doc.EUROBATS.StC9-AC19.12* (http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/Doc_StC9_AC19_12_ReportIWG_WindTurbines%20incl_Annexes.pdf) is still valid.

Small Wind Turbines

It was not possible to update this item.

Offshore windfarms

Rydell *et al*. (2014) described bat regularly migration around the Baltic Sea and German North Sea coast where it is likely that bats from several take off points need to cross the sea.
Skiba (2011) observed *Pipistrellus nathusii* and *Vespertilio murinus* leaving the island Rømø (Denmark) towards the Sea in westerly and south-westerly directions in autumn. He suggested about 5000 bats crossing the German Bight (Skiba 2007), about 1100 leaving from south-western Jütland in Denmark (Skiba 2011).
Lagerveld *et al*. (in press) did the first bat survey at two off-shore wind farms in the Southern North Sea (15 and 23 km from the coastline). They got more than 200 bat contacts, 98% *P. nathusii* and 2% *Nyctalus noctula*. Also recently British studies could show that there are regularly observations of *P. nathusii* during spring and autumn migration period in the south-western North Sea between UK and The Netherlands (BSG Ecology 2014a). That also corresponds with activity patterns of *P. nathusii* along the southern English coastline (BSG Ecology 2013) and a Dutch recovery of a *P. nathusii* banded in UK (Hargreaves 2014). Studies on stable hydrogen isotopes of hair samples *P. nathusii* caught in southern UK showed that at least 40% of the bats must have moved a substantial distance (BSG Ecology 2014b). In combination with the distribution of *P. nathusii* in UK the authors come to the conclusion that the bats probably come from North or Eastern Europe.

Wilson *et al*. (2010) already suggested that migrating bats might be attracted to offshore or coastal wind turbines and will actively investigate it. They suggest that coastal wind turbines might cause bat fatalities due to roost attraction, food attraction, acoustic attraction, echolocation leisure, disorientation (adapted from Kunz *et al*. 2007).

Pelletier *et al*. (2013) give a good overview about offshore observations of bats, mainly in America and describes a large coastal and offshore survey along the northeastern and mid-Atlantic coastal state regions of the US. It turned out that they had more bat calls per 10-nights offshore than inland, but the highest numbers they collected at coastal sites.

Sjollema *et al*. (2014) survey bat activity offshore along the Mid-Atlantic coast (USA) in 2009 and 2010 and found bats in a maximum distance of 21.9 km away from the coast (mean distance: 8.4km, N0 166 records). They found a negative correlation between bat activity and mean nightly wind, but not with mean nightly air temperature and barometric pressure.

Already Allison *et al*. (2008) recognized that bats might have problems with offshore wind turbines. In that paper, they confirm that bats are known to cross large open waters while migrating but that the estimation of the risk of offshore wind turbines is not possible yet due to a lack of data on bat activity offshore. The application of this technique to offshore risk assessment remains to be developed

Allison, T.D., E. Jedry & S. Perkins (2008): Avian Issues for offshore wind development. – J. Marine Technology Society 42(2): 28-38.

BSG Ecology (2013): Kent Bat Migration Research; Baseline Report. – 28 pp. http://www.bsg-ecology.com/index.php/kent-bat-migration-research-report-2013/

BSG Ecology (2014a): North Sea Ferries Bat Migration Research Report. – 20 pp. http://www.bsg-ecology.com/index.php/north-sea-ferries-bat-research-2014/

BSG Ecology (2014b): Stable Isotope Analysis of Nathusis´ Pipistrelle fur samples. – 18 pp. http://www.bsg-ecology.com/index.php/stable-isotope-analysis-evidence-nathusius-pipistrelle-migration/

Hargreaves, D. (2014): 60 for 60 weekly Blogs; Nathusius´Pipistrelle and BCT survey. The Mammal Society. - http://www.mammal.org.uk/60for60_weekly_blogs/nathusius-pipistrelles

Kunz, T.H., Arnett, E.B., Erickson, W.P., Hoar, A.R., Johnson, G.D., Larkin, R.P., Strickand, M.D., Thresher, R.W. & M.D. Tuttle (2007): Ecological impacts of wind development on bats: Questions, research needs, and hypotheses. - Front Ecol. Environ. 5: 315–324.

Lagerveld, S., B. Jonge Poerink, H. Verdaat & R. Haselager (2014): Bat Activity in Dutch offshore wind farms in autumn 2012. - Lutra 57(2): 61-69.

Pelletier, S.K., K. Omland, K.S. Watrous, T.S. Peterson. 2013. Information Synthesis on the Potential for Bat Interactions with Offshore Wind Facilities – Final Report. U.S. Dept of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2013-01163. 119 pp.

Rydell, J., L. Bach, P. Bach, L. Guia-Diaz, J. Furmankiewicz, N. Hagner-Wahlsten, E.-M. Kyheröinen, T. Lilley, M. Masing, M.M. Meyer, G. Petersons, J. Šuba, V. Vasko, V.S Vintulis & A. Hedenström (2014): Phenology of migratory bat activity across the Baltic Sea and the south-eastern North Sea. - Acta Chiropterologica 16(1): 139-147.

Sjollema, A.L., J.E. Gates, R.H. Hilderbrand & J. Sherwell (2014): Offshore activity of bats along the Mid-Atlantic Coast. – Northeastern Naturalist 21(2): 154-163.

Skiba, R. (2007): Die Fledermäuse im Bereich der Deutschen Nordsee unter Berücksichtigung der Gefährdungen durch Windenergieanlagen. – Nyctalus (N.F.)12(2-3): 199-220.

Skiba, R. (2011): Fledermäuse in Südwest-Jütland und deren Gefährdung an Offshore-Windenergieanlagen bei Herbstwanderungen über die Nordsee. – Nyctalus (16 (1-2): 33-44.

Wilson, J.C., M. Elliott, N.D. Cutts, L. Mander, V. Mendão, R. Perez-Dominguez & A. Phelps (2010): Coastal and offshore wind Energy generation: is it environmental benign? – Energies 3: 1383-1422.

Wind farms and forests

Many recent studies have shown that European forests are refuges for bats. Forest habitats supply roosts and foraging grounds for most bat species. Bat activity occurs at higher levels in forests than in open areas, increasing the potential detrimental effect on bat populations. When wind farms are constructed within woodlands, the impacts may include the following:

(i) loss of roosts when trees are felled to make way for turbines and related infrustructure,

(ii) loss of foraging habitat due to tree felling

(iii) disturbance effects from the operational turbines and roads

(iv) potential collision with turbine blades

Roosts

Several studies show that tree-dwelling bats preferentially choose high cavities in trees for roosting (Russo *et al*. 2004; Ruczyński & Bogdanowicz 2005; Tillon & Aulagnier 2014). These may be difficult to detect from ground-level, and acoustic detectors may need to be elevated if they are to be used to assist emergence counts. There is also evidence that the roosting ranges of adjacent social groups of woodland bats do not overlap (August *et al*. 2014). Therefore when roosting sites are lost through felling, it may be difficult for the colony to relocate.

Foraging areas

Nocturnal insect activity is usually higher in forests than in open areas, both because of an increased insect diversity and because air temperature remains higher in forest at night (Karlsson 2000).

Commuting and migratory behaviour

Some bat species have high flight, and can fly above the canopy during their commuting flights and migration. This is especially the case of *Nyctalus noctula* and *Nyctalus leisleri*. Several other species fly high during commuting, even if their foraging behaviour occurs at low levels. This is for instance the case of the ground-gleaning *M. myotis* which has already been observed commuting at a speed of 50 km/h (Arlettaz 1996) and above 32 meters (Sertius-Biotope 2014). Forests stands often reach more than 30 meters above the ground level. When the lowest point of blade movement is 50 meters or lower, the safe space above the canopy is dangerously restricted for these commuting bats, even if the direct surroundings of the turbine have been clear-cut.

Detectability and forest strata

Bat activity is high in the top part of the trees (Rieger & Nagel 2007; Collins & Jones 2009; Müller *et al*. 2012, 2013; Plank *et al*. 2012) and above the canopy (Bach *et al*. 2012; Müller *et al*. 2013). In France, Fauvel & Bécu (2007) and then Barataud & Giosa (2012) demonstrated that although it is possible to detect bats in forest from the ground, the species diversity identified at ground level may be different from that recorded at the canopy. A recent study in France (Tillon pers. com.) showed that certain species which are typically forest bats, and especially gleaning ones such as *Plecotus auritus* and *Myotis bechsteinii*, are detected from the ground but the recorded activity is lower than their actual abundance. Even *Pipistrellus* and *Nyctalus* species foraging above the canopy are usually not detectable from ground (Bach *et al*. 2012; Müller *et al*. 2013). Therefore the absence of ultrasonic evidence or very few contacts on the ground do not necessarily mean that the looked for species is absent or that it occurs rarely and activity recorded from the ground does not reflect its actual abundance in the forest.

In the UK, a recent study has investigated the number of repeated surveys required only to detect woodland species occupancy using walked transect surveys (Scott & Altringham 2014). To provide a 95% probability of species detection, 2 surveys were required for *Myotis brandtii/mystacinus* and *Barbastella barbastellus*, 4 for *Rhinolophus hipposideros*, 5 for *Myotis nattereri*, 9 for *P. auritus*, though the authors point out that surveys can be stopped as soon as occupancy is detected. *Myotis alcathoe* and *M. bechsteinii* have not been detected during the study, but it is suggested based on their call characteristics, that 2-3 surveys for *M. alcathoe* and 4-6 for *M. bechsteinii* would be required.

Furthermore, it´s difficult to definitely identify these species based on acoustic records due to very similar call characteristics

The results of the studies above indicate two main conclusions:

- Bat activity is distributed according to the stratification of the forest habitat with some species keeping to the undergrowth, others foraging within the canopy and understory (mainly *Plecotus* and *Myotis* species), and others foraging above the trees, sometimes quite high (*Nyctalus, Eptesicus, B. barbastellus, Miniopterus schreibersii* and some *Pipistrellus*);
- Not every bat species in the forest can be detected from the ground, particularly true forest species with very high conservation values and species foraging above the canopy. Their activity can very rarely be accurately assessed from the ground even by increasing the number of recording points and sites within the forest (Tillon pers. com).

Since traditional acoustic survey from the ground shows a very low detection rate for some species, additional methods such as acoustic surveys at height and non-acoustic methods (e.g. mist-netting, trapping, radio-tracking) should be utilised for impact assessment studies in forests, especially for wind farm projects ; examples may be found in Hayes (2000), Duchamp *et al*. (2006), Gorresen *et al*. (2008), Bach *et al*. (2012), Barataud (2012), Skalak *et al*. (2012) and Britzke *et al*. (2013). Also, acoustic surveys and any other methods used should take into account the species-specific behaviour and surveys should be carried out on the ground as well as in the canopy and above the canopy. The thermal/infrared recording of bats around the nacelle should also be considered, as suggested by Mathews *et al*. (2015) since there were situations were bats were not recorded with ultrasound detectors placed in the nacelle although their activity might be recorded via cameras.

Post construction attractiveness of wind farms in forest for bats

Bats may be attracted towards wind turbines after their constructions in forests for two reasons.

First, the construction usually implies to increase the proportion of forest edges within the forest, because of road enlargement for trucks or clear-cutting at the WT location. These openings within the forests increase the sunlight on the ground. This boosts vegetation and insect activity in the close vicinity of wind turbines.

Secondly, wind turbines may resemble tall trees, and therefore be attractive to bats as roosting or mating sites (Cryan *et al.* 2014).

For all these reasons, a precautionary approach is adopted by an increasing number of European countries (Germany, Belgium, France, Sweden) when wind turbines are planned in forests.

Some countries or regions allow WT projects only in biologically depleted forests (intensive spruce plantations for instance), but refuse them in forests harbouring high biodiversity (broad-leaved forests, ancient forests,...).

Recording bat activity above the canopy or at the lowest blade level has become a standard in an increasing number of EIA related to WT projects in forests.

Fragments, edges and hedges

Even small forest fragments and hedges in otherwise open agricultural landscape have large positive impact on local bat activity and diversity (e.g. Brandt *et al*. 2007; Řehák *et al*. 2010; Kelm *et al*. 2014), but also on bat diversity on regional scale (Mehr *et al*. 2011). Therefore, bat surveys for impact assessment of wind farm projects should especially consider forest fragments and hedges and, if needed, to employ same methods as recommended for wind farms in forests.

Also, Kelm *et al*. (2014) studied bat activity in relation to distance to hedgerows in an agricultural landscape. They found that activity of all bat species was concentrated near the hedges and decreasing with distance, at species-specific and season-specific intensities and rates. For most of the species (except for only *Nyctalus noctula* during summer) activity is significantly lower at 200 m distance from hedges, which strongly supports threshold distance of wind turbines from forest edges, hedges and other habitat elements specifically important for bats set up by EUROBATS Guidelines.

Arlettaz, R. "Feeding behaviour and foraging strategy of free-living mouse-eared bats, *Myotis myotis* and *Myotis blythii*." *Animal behaviour* 51.1 (1996): 1-11.

August, T. A., M. A. Nunn, A. G. Fensome, D. M. Linton, and F. Mathews. 2014. Sympatric Woodland Myotis Bats Form Tight-Knit Social Groups with Exclusive Roost Home Ranges. PLoS One 9:e112225.

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.

Barataud, M. 2012. Ecologie acoustique des Chiroptères d’Europe: Identification des espèces, étude de leurs habitats et comportements de chasse. Biotope, Mèze & Muséum national d’histoire naturelle, Paris.

Barataud, M. & S. Giosa. 2012. Biodiversité Des Chiroptères et Gestions Forestières En Limousin. Limoges. LT-BAR25.pdf.

Brandt, G., Blows, L., Linton, D., Paling, N. & Prescott, C. 2007. Habitat associations of British bat species on lowland farmland within the Upper Thames catchment area. Habitat Associations of British bats. Centre for Wildlife Assessment & Conservation E-Journal 1: 10-19.

Britzke, E.R., E.H. Gillam & K.L. Murray. 2013. “Current State of Understanding of Ultrasonic Detectors for the Study of Bat Ecology.” Acta Theriologica 58 (2): 109–17.

Collins, J. & G. Jones. 2009. “Differences in Bat Activity in Relation to Bat Detector Height: Implications for Bat Surveys at Proposed Windfarm Sites.” Acta Chiropterologica 11 (2): 343–50.

Cryan, P. M., Gorresen, P. M., Hein, C. D., Schirmacher, M. R., Diehl, R. H., Huso, M. M., ... & Dalton, D. C. (2014). Behavior of bats at wind turbines. Proceedings of the National Academy of Sciences, 111(42), 15126-15131.

Duchamp, J.E., M. Yates, R-M Muzika & R.K. Swihart. 2006. “Estimating Probabilities of Detection for Bat Echolocation Calls: An Application of the Double-Observer Method.” Wildlife Society Bulletin 34 (2): 408–12. doi:10.2193/0091-7648(2006)34[408:EPODFB]2.0.CO;2.

Fauvel, B. & D. Bécu. 2005. Développement d’une méthodologie pour mesurer l’activité des chauves-souris : Diverses applications et définition d’un protocole pour le suivi des Réserves de l’ONF. In Les Mammifères Forestiers, Actes Du XXVIIIème Colloque Francophone de Mammalogie de La SFEPM, edited by L. Tillon, 18:63–70.

Gorresen, P.M., A.C. Miles, C.M. Todd, F.J. Bonaccorso & T.J. Weller. 2008. Assessing Bat Detectability and Occupancy with Multiple Automated Echolocation Detectors. Journal of Mammalogy 89 (1): 11–17.

Hayes, J.P. 2000. Assumptions and Practical Considerations in the Design and Interpretation of Echolocation-Monitoring Studies. Acta Chiropterologica 2 (2): 225–36.

Karlsson, I. M. (2000). Nocturnal air temperature variations between forest and open areas. Journal of applied meteorology, 39(6), 851-862.

Kelm D.H., Lenski J., Kelm V., Toelch U. & Dziock F. (2014) Seasonal bat activity in relation to distance hedgerows in an agricultural landscape in central Europe and implications for wind energy development. Acta Chiropterologica 16(1): 65-73. doi:103161/150811014X683273.

Mathews, Fiona, Richardson, Suzanne and Hosken, David (2015): A nationwide assessment of the impacts of wind turbines on bats - What have we learnt so far? In: Köppel, Johann & Schuster, Eva: Book of Abstracts. Conference on Wind energy and Wildlife impacts (CWW 2015), March 10-12, 2015. Berlin, Germany, p. 46.

Mehr M., R. Brandl, T. Hothorn, F. Dziock, B. Förster, J. Müller, 2011. Land use is more important than climate for species richness and composition of bat assemblages on a regional scale. Mammalian Biology - Zeitschrift für Säugetierkunde, 76 (4): 451-460.

Müller J., R. Brandl, J. Buchner, H. Pretzsch, S. Seifert, C. Strätz, M. Veith, B. Fenton. 2013. From ground to above canopy — Bat activity in mature forests is driven by vegetation density and height, Forest Ecology and Management 306: 179-184

Müller, J., M. Mehr, C. Bässler, M.B. Fenton, T. Hothorn, H. Pretzsch, H.-J. Klemmt & R. Brandl. 2012. Aggregative Response in Bats: Prey Abundance versus Habitat. Oecologia 169: 673–84.

Plank, M., K. Fiedler & G. Reiter. 2012. Use of Forest Strata by Bats in Temperate Forests. Journal of Zoology 286: 154–62.

Řehák, Z., Ž. Horáčková, J. Zukal & T. Bartonička 2010. Importance of forest fragments in agricultural landscape to bats. 15 International Bat research conference, Prague, 23-27 august 2010. Programme, Abstract. List of Participants: 262

Rieger, I. & P. Nagel. 2007. "Vertical Stratification of Bat Activity in a Deciduous Forest." In The Canopy of a Temperate Floodplain Forest - Results from Five Years of Research at the Leipzig Canopy Crane, edited by M. Unterseher, W. Morawetz, S. Klotz, and E. Arndt, The Leipzig Canopy Crane Project, 141–49. Leipzig (Germany): Universität Leipzig.

Scott C, Altringham J. 2014. WC1015 Developing effective methods for the systematic surveillance of bats in woodland habitats in the UK. Report,University ofLeeds, 62pp.

Skalak, S.L., R.E. Sherwin & R.M. Brigham. 2012. Sampling Period, Size and Duration Influence Measures of Bat Species Richness from Acoustic Surveys. Methods in Ecology and Evolution 3: 490–502.

Tillon, L. & S. Aulagnier. 2014. Tree cavities used as bat roosts in a European temperate lowland sub-atlantic forest. Acta Chiropterologica 16 (2): 359–68. doi:10.3161/150811014X687314.

Ruczyński, I., and W. Bogdanowicz. 2005. Roost cavity selection by Nyctalus noctula and N. leisleri (Vespertilionidae, Chiroptera) in Białowieża primeval forest, Eastern Poland. Journal of Mammalogy 86:921-930.

Russo, D., L. Cistrone, G. Jones, and S. Mazzoleni. 2004. Roost selection by barbastelle bats (Barbastella barbastellus, Chiroptera: Vespertilionidae) in beech woodlands of central Italy: consequences for conservation. Biological Conservation 117:73-81.

Sertius-Biotope (2014) – Projet éolien de Trois-Ponts – Etude de l'activité des chauves-souris en altitude. Décembre 2014. 34 pp.

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 and this is why we advise for a 3-year mortality monitoring to get a better idea of the impact and to avoid biases unrelated to the wind farm. Furthermore monitoring of mortality rarely follows the same method. Monitoring schedule, time interval between controls and estimator for mortality rate differ from one wind farm to the other and make comparisons impossible. Tests for predation and searcher's efficiency are not always performed, not to mention the correction for the % of area not sampled.

It is not possible to evaluate the impacts of wind farms without mortality data; yet very few governments sent the results of their 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 urges the Eurobats range states again 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

(addendum to the list presented at the AC 19)

Aminoff , S., N. Hagner-Wahlsten, E.-M.Kyheröinen, A. Lindén, J. Brommer, A. Brutemark & M. Fred (2014): Methods for studying post –construction effects of wind power on bats in central europe cannot be directly applied in southern Finland. Book of abstracts, XIIIth European Bat Research Symposium, 1-5 September 2014, Šibenik, Croatia: 25.

Bach P. & L. Bach (2014): Monitoring der Fledermausaktivität im Windpark Ammersche Länder, Endbericht 2014. - unveröff. Gutachten i.A. Planungsbüro Diekmann & Mosebach: 47Seiten.

Bach, L. & P. Bach (2014): Monitoring der Fledermausaktivität im Windpark Spolsen Gondelmonitoring und Schlagsuche - Zwischenbericht 2014 – unveröff. Gutachten i.A. Planungsbüro Diekmann & Mosebach: 31 Seiten.

Bach L., P. Bach & W. Dormann (2014): Fachbeitrag Fledermäuse zum Windparkstandort Schütting. – Gondelmonitoring und Schlagsuche - unveröff. Gutachten i.A. FPJ Windpark Schütting Netz und Wege GmbH & Co. KG: 32 Seiten.

Baerwald E. & R. Barclay (2014) Applying Research to Conservation - Science-based strategies can save bats at wind farms. *Bats* 32: 2-4.

Bennett, V.J. & A.M. Hale (2014): Red aviation lights on wind turbines do not increase bat–turbine collisions. *Animal Conservation* 17:354-358. doi: 10.1111/ acv.12102

Bernardino, J. (2011) Wind & Biodiversity project: finding the best integrated solution. Seminário "Wind & Biodiversity". 15 de Novembro de 2011, Aveiro, Portugal.

Bernardino, J., Zina, H., Costa, H., Fonseca, C., Ramos Pereira, M. J., Vieira, J., Bastos, C., Mascarenhas, M. (2012) Dinámica espacio-temporal y registro de mortalidad de aves y murciélagos en parques eólicos Portugueses: una revisión. I Congreso Ibérico de Energía Eólica y Conservación de la Fauna. 12-14 January, 2012. Jerez de la Frontera, Spain

Bernardino, J.; Zina, H.; Passos, I.; Costa,H.; Ramos Pereira, M. J.; Fonseca, C.; Mascarenhas, M. (2012) Bird and bat mortality at Portuguese wind farms. Proceedings of the 32nd Annual Meeting of International Association for Impact Assessment. 27 May - 1 June 2012. Porto, Portugal.

Bernardino, J.; Bispo, R.; Mascarenhas, M. & Costa, H. (2012) Are we properly assessing bird and bat mortality at onshore wind farms? In Proceedings of the 32nd Annual Meeting of International Association for Impact Assessment. 27 May- 1 June 2012. Porto, Portugal.

Bernardino, J., Bispo, R. Costa, H. & Mascarenhas, M. (2013) Bird and bat fatality estimation: current approaches and new insights. Conference on Wind power and Environmental Impacts. 5-7 February, 2013. Stockholm, Sweden.

Bernardino, J., Bispo, R., Paula, J., Costa, H. & Mascarenhas, M. (2014) Os desafios da estimação da mortalidade de aves e morcegos em parques eólicos: avanços recentes e novas diretrizes. 5º Congresso Nacional de Avaliação de Impacte. 20 e 21 de Março de 2014. Viseu, Portugal.

Bernardino, J., Paula, A., Marques, A. T., Peste, F., Ramos Pereira, M.J., Fonseca, C., Mascarenhas, M. & Costa, H. (2014) Estratégias e tecnologias de minimização de impactes dos parques eólicos nas aves e morcegos: qual a verdadeira relação de custo/benefício? Livro de atas do 5º Congresso Nacional de Avaliação de Impacte. 20 e 21 de Março de 2014. Viseu.

Bernardino, J., Paula, A., Marques, A. T., Peste, F., Ramos Pereira, M.J., Fonseca, C., Mascarenhas, M. & Costa, H. (2014) Estratégias e tecnologias de minimização de impactes dos parques eólicos nas aves e morcegos: qual a verdadeira relação de custo/benefício? 5º Congresso Nacional de Avaliação de Impacte. 20 e 21 de Março de 2014. Viseu, Portugal.

BFL (2014): Fledermausmonitoring im Windpark Kirchberg 2012-2013 (Rhein-Hunsrück-Kreis) - Endbericht 2013-2014. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014): Fledermausmonitoring im Windpark Gau-Bickelheim 2013 (Landkreis Alzey-Worms) - Zwischenbericht 2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014): Fledermausmonitoring im Windpark Riegenroth 2013 (Rhein-Hunsrück-Kreis) - Zwischenbericht 2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014): Fledermausmonitoring im Windpark Hangen-Weisheim 2013 (Landkreis Alzey-Worms) - Zwischenbericht 2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014): Fledermausmonitoring im Windpark Laubach 2013 (Rhein-Hunsrück-Kreis) - Zwischenbericht 2012. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014): Fledermausmonitoring im Windpark Hochstätten 2012-2013 (Landkreis Bad Kreuznach) - Endbericht 2012-2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014): Fledermausmonitoring im Windpark Schopfloch 2012-2013 (Landkreis Freudenstadt) - Endbericht 2012-2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

Bio3 (2014) Monitorização da comunidade de quirópteros no Parque Eólico de Três Marcos. Relatório I (Fase Anterior à Construção – Ano 2012/2013), 70pp.

Bio3 (2014). Monitorização das comunidades de aves e quirópteros no Parque Eólico do Malhanito. Relatório 3 (Fase de exploração –2012/2013). 178pp.

Bio3 (2014). Monitorização das comunidades de aves e quirópteros no Parque Eólico da Terra Fria - Relatório final de Montalegre. 207pp.

Bispo, R., Bernardino, J. & Marques, T. (2011) Estratégia de verificação de cadáveres de aves em testes de remoção nos estudos de monitorização de parques eólicos. XIX Congresso da Sociedade Portuguesa de Estatística. 28 de Setembro a 1 de Outubro de 2011. Nazaré, Portugal.

Bispo, R. Marques, T.A. & Bernardino, J. (2012) Detetabilidade de cadáveres de aves em parques eólicos sob densidades não uniformes. XX Congresso da Sociedade Portuguesa de Estatística. 26 a 29 de Setembro de 2012. Porto, Portugal.

Bispo, R., Bernardino, J., Paula, J., Marques, T.A., Costa, H. & Mascarenhas, M. (2015) Enhancing the study design of carcass removal trials for bats and birds at wind farms. Conference on Wind energy and Wildlife impacts. 10-12 March, 2015. Berlin, Germany.

Bispo, R., Marques, A.T., Soares, M., Costa, M., Mascarenhas, M. & Bernardino, J. (2015) Using bird fatality explanatory variables and conservation status to identify primary target species. Conference on Wind energy and Wildlife impacts. 10-12 March, 2015. Berlin, Germany.

Brünig, W. & J. Rutschke - PINK (2014): Schlagopferkartierung an zwei Windkraftanlagen in Westerholz, Abschlussbericht. 8pp.

Conduché, N., T. Daumal, C. Louvet, S. Tourte & F. Spinelli-Dhuicq (2012): Suivis des impacts sur les chiroptères du parc éolien de “La Picoterie”, commune de Charly-sur-Marne (02). Ecothème pour La Compagnie du Vent, 43 pp.

Correia R., Faneca C., Vieira J.M.N., Bastos C., Mascarenhas M., Costa H., Bernardino J., Fonseca C., Ramos Pereira M.J. (2013). Bat Monitoring System for Wind Farms. Proceedings off the 12th Conference on Programmable Devices and Embedded Systems. Velke Karlovice, Czech Republic.

Correia R., Faneca C., Albuquerque D., Vieira J., Bastos C., Fonseca C. & Ramos Pereira M.J. (2014) Low cost acoustic design of a bat test room. *Bioacoustics* 24(1): 81-87.

Correia R., Vieira J., Faneca C., Albuquerque D., Bastos C., Costa H., Bernardino J., Mascarenhas M., Ramos Pereira M.J., Fonseca C. &. Inácio O. (2014) Caracterization of the ultrasonic acoustic field of a wind turbine In Proceedings of the TechniAcoustica 2014, 29-31 October 2014, Murcia, Spain, Pg 1420-1428.

Correia, R., Faneca, C., Albuquerque, D., Vieira, J., Bastos, C., Fonseca, C. & Ramos Pereira, M.J.. (2014) Low-cost acoustic design of a bat test room. Bioacoustics. 24(1): 81-87.

Cryan, PM, PM Gorresen, CD. Hein, MR Schirmacher, RH Diehl, MM Huso, DTS Hayman, PD Fricker, FJ Bonaccorso, DH Johnson, K Heist & DC Dalton (2014) Behavior of bats at wind turbines. PNAS. doi: 10.1073/pnas.1406672111.

Dai, K.S., Bergot, A., Liang, C., Xiang, W.N., Huang, Z.H. (2015) Environmental issues associated with wind energy – A review. Renewable energy 75: 911-921.

Ecosativa. 2014. Monitorização de avifauna, quirópteros, flora e vegetação do Parque Eólico do Toutiço e respectivas linhas eléctricas e Parque Eólico de Vale Grande. Fase de exploração. Relatório final.

Faneca, C., Correira, R., Vieira, J., Bastos, C., Fonseca, C., Ramos Pereira, M.J., Mascarenhas, M., Costa, H. & Bernardino, J. (2012) 3D reconstruction of bat trajectories from stereo vision. Proceedings of the 18th Portuguese Conference on Pattern Recognition. 26 October 2012. Coimbra, Portugal.

Fonseca, C., Mascarenhas, M., Costa, H., Bernardino, J., Vieira, J., Bastos, C. & Ramos Pereira, M. J. (2013) Wind & Biodiversity Solutions for Reducing the Impacts of Wind Farms on Bats and Birds. 16th International Bat Research Conference and 43rd North-American Symposium on Bat Research, 1-15 2013, San José, Costa Rica

Frey, K., L. Bach & P. Bach (2014): Monitoring der Fledermausaktivität im Windpark Krögershamm, Zwischenbericht 2014 – unveröff. Gutachten i.A. Planungsbüro Diekmann & Mosebach: 35 Seiten.

Hurst J., Schauer-Weisshahn H., Dietz M., Höhne E., Biedermann M., Schorcht W., Karst I. & Biedermann R., 2014. When are bats active in high altitude above the forest canopy ? Activity data from wind masts allows prediction of times with high collision risks. Book of abstracts, XIIIth European Bat Research Symposium, 1-5 September 2014, Šibenik, Croatia.

Huso M.M.P. & Dalthorp D. (2014) Accounting for Unsearched Aread in Estimating Wind Turbine-Caused Fatality. *J. Wildl. Man*. 78(2) : 347-358. doi : 10.1002/jwmg.663.

Johnson, Joshua B ; Ford, W. Mark ; Rodrigue, Jane I. ; Edwards, John W. (2012) Effects of acoustic deterrents on foraging bats. Res. Note NRS-129. Newtown Square, PA : U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p.

Kelm D.H., Lenski J., Kelm V., Toelch U. & Dziock F. (2014) Seasonal bat activity in relation to distance hedgerows in an agricultural landscape in central Europe and implications for wind energy development. *Acta Chiropterologica* 16(1) : 65-73 . doi :103161/150811014X683273.

Köppel, J., Dahmen, M., Helfrich, J., Schuster, E., Bulling, L. (2014) Cautious but committed: moveing toward adaptive planning and operation strategies for renewable enregy's wildlife implications. Environmental Management 54: 744-755.

Krättli H., Brossard C., Moeschler P. & Bontadina F. (2014) Integration of Bat Conservation Concerns in the Development of Wind Energy Projects in Switzerland. Poster XIIIth European Bat Research Symposium, 1-5 September 2014, Šibenik, Croatia.

LEA. 2015 – Relatório de Monitorização da Atividade e Mortalidade de Quirópteros no Parque Eólico do Alto do Marco. Relatório Final (Ano 3 - Fase de exploração –Ano adicional) elaborado para a empresa Parque Eólico de Gevancas. Laboratório de Ecologia Aplicada da Universidade de Trás-os-Montes e Alto Douro. Vila Real. 51 pp.+ Anexos

Lehnert L.S., Kramer-Schadt S., Schönborn S., Lindecke O., Niermann I., Voigt C.C. (2014) Wind Farm Facilities in Germany Kill Noctule Bats from Near and Far. PLoS ONE 9(8): e103106. doi : 10.1371/journal.pone.0103106.

Marques, A.T, Batalha, H., Rodrigues, S., Costa, H., Ramos Pereira, M.J., Fonseca, C., Mascarenhas, M. & Bernardino, J. (2014) Understanding bird collisions at wind farms: An updated review on the causes and possible mitigation strategies. Biological Conservation, 179: 40-52.

Marques, A.T., Rosa, I., Palminha, G., Paixão, R., Bernardino, J., Costa, H., Mascarenhas, M. (2014) Caraterização da atividade da avifauna associada à sementeira do arroz, através de um sistema de radar. VIII Congresso de Ornitologia da SPEA. 1 a 4 de Março de 2014. Almada, Portugal.

Marques, A.T., Batalha, H., Rodrigues, S., Costa, H., Ramos Pereira, M.J., Fonseca, C., Mascarenhas, M. & Bernardino, J. (2015) Unraveling the causes of bird mortality with wind turbines: what do we know so far? Conference on Wind energy and Wildlife impacts. 10-12 March, 2015. Berlin, Germany.

Marques. A.T., Rosa, I., Palminha, G., Mascarenhas, M., Costa, H., Fonseca, C. & Bernardino, J. (2015) From gigantic databases to targets of interest: using machine learning techniques to filter radar databases. Conference on Wind energy and Wildlife impacts. 10-12 March, 2015. Berlin, Germany.

Mascarenhas, M., Costa, H., Bernardino, J., Vieira, J., Bastos, C., Ramos Pereira, M. J. & Fonseca, C. (2012) Wind & Biodiversity R&D project: integrated solutions for managing biodiversity in Wind Farms. NWCC Wind Wildlife Research Meeting IX. 27-30 November, 2012. Denver, USA.

Mascarenhas, M., Costa, H., Bernardino, J., Vieira, J., Bastos, C., Ramos Pereira, M.J. & Fonseca, C. (2012) The Wind & Biodiversity project. 32ª Conferência anual da Associação Internacional para a Avaliação de Impacte. 27 de Maio a 1 de Junho de 2012. Porto, Portugal.

Mascarenhas, M., Costa, H., Bernardino, J., Vieira, J., Bastos, C., Ramos Pereira, M. J., Fonseca, C. (2012) Proyecto Wind & Biodiversity: Soluciones integradas para la gestión de la biodiversidad en Parques Eólicos. I Congreso Ibérico de Energía Eólica y Conservación de la Fauna. 12-14 January, 2012. Jerez de la Frontera, Spain.

Mesquita, S. (2012) Avoiding and minimizing impact: the beginning of the "Wind & Biodiversity" project. Workshop “Wind Power and Biodiversity: Tools to measure, avoid and compensate impacts”. 29 de Junho de 2012. Lisboa, Portugal

Millon L., Julien J.-F., Julliard R & Kerbiriou C. (2015) Bat activity in intensively farmed landscapes with wind turbines and offset measures. Ecological Engineering 75 (2015) 250-257.

Minderman J., Fuentes-Montemayor E., Pearce-Higgins J. W., Pendlebury C. J. & Park K. J. (2014) Estimates and correlates of bird and bat mortality at small wind turbine sites. Biodiversity and Conservation.

NOCTULA (2013) Monitorização da atividade e mortalidade de aves e quirópteros na área do parque eólico da Tocha (fase de exploração (ano I) – 2012/2013). NOCTULA – Modelação e Ambiente. Viseu. 68 pp.

NOCTULA (2013) - Relatório intercalar de monitorização de avifauna e quirópteros do Parque Eólico ENERFER I (Fase de exploração - Ano I – Julho 2013). Noctula – Modelação e Ambiente. Viseu. 54 pp.

NOCTULA (2013) - Relatório intercalar de monitorização de avifauna e quirópteros do Parque Eólico ENERFER I (Fase de exploração - Ano I – Setembro 2013). Noctula – Modelação e Ambiente. Viseu. 44 pp.

NOCTULA (2014) Monitorização da atividade e mortalidade de aves e quirópteros na área do parque eólico da Tocha (fase de exploração (ano II) – 2013/2014). NOCTULA – Modelação e Ambiente. Viseu. 68 pp.

NOCTULA. 2014. Relatório final de monitorização dos sistemas ecológicos. Parque Eólico de Coentral-Safra (Fase de exploração (ano III) – 2012/2013). Noctula – Modelação e Ambiente. Viseu.

NOCTULA (2014) - Relatório intercalar de monitorização de avifauna e quirópteros do Parque Eólico ENERFER I (Fase de exploração - Ano I – Março 2014). Noctula – Modelação e Ambiente. Viseu. 35 pp.

NOCTULA (2014) - Relatório intercalar de monitorização de avifauna e quirópteros do Parque Eólico ENERFER I (Fase de exploração - Ano I – Maio 2014). Noctula – Modelação e Ambiente. Viseu. 41 pp.

NOCTULA (2014) - Relatório intercalar de monitorização de avifauna e quirópteros do Parque Eólico ENERFER I (Fase de exploração - Ano I – Julho 2014). Noctula – Modelação e Ambiente. Viseu. 45 pp.

NOCTULA (2014) - Relatório intercalar de monitorização de avifauna e quirópteros do Parque Eólico ENERFER I (Fase de exploração - Ano I – Setembro 2014). Noctula – Modelação e Ambiente. Viseu. 42 pp.

Oikon Ltd. (2014): Prac´ enje stradavanja populacija šišmiša tijekom korištenja VE Jelinak (Bat mortality monitoring during operation of Wind farm Jelinak).

Paula, J., Pereira, P., Bernardino, J., Costa, H. & Mascarenhas, M.. (2012) "Catch you scavenger!", camera trapping of carcass removal by scavengers at two Portuguese wind farms. NWCC Wind Wildlife Research Meeting IX. 27-30 November, 2012. Denver, USA.

Paula, J., Pereira, P., Bernardino, J., Costa, H. & Mascarenhas, M.. (2013) Surprised scavenger. Conference on Wind power and Environmental impacts. 5-7 February, 2013. Stockholm, Sweden.

Pereira, M.J., Fonseca, C. & Inácio, O. (2014) Characterization of the ultrasonic acoustic field of a wind turbine. TecniAcoustica 2014. 29-31 October, 2014. Múrcia, Spain.

Peste F., Paula A., Silva L., Bernardino J., Pereira P., Mascarenhas M., Costa H., Vieira J., Bastos C., Fonseca C. & Ramos Pereira M.J. (2015) How to mitigate impacts of wind turbines on bats. A review of potential conservation measures in the European context. *Environmental Impact Assessment Review,* 51: 10-22

Peste, F.; Paula, A.; Silva, L.; Bernardino, J.; Pereira, P.; Mascarenhas, M.; Costa, H.; Vieira, J.; Bastos, C.; Fonseca, C. & Ramos Pereira, M.J. (2015) How to mitigate impacts of wind farms on bats? A review of potential conservation measures in the European context. Environmental Impact Assessment Review. 51:10-22.

PROCESL. 2014. Parque Eólico da Raia (Sub-Parques de Benespera, Pousafoles e S. Cornélio) – Monitorização de Quirópteros. Relatório 5 (3º ano da fase de exploração - 2013).

Ramos Pereira, M.J. (2011) Bats and wind power compensatory measures: a question of habitat management. Seminário "Wind & Biodiversity". 15 de Novembro de 2011, Aveiro, Portugal.

Ramos Pereira, M.J., Peste, F., Paula, A., Pereira, P., Bernardino, J., Vieira, J. Bastos, C., Mascarenhas, M., Costa, H. & Fonseca, C. (2015) Management of coniferous forests for bats affected by wind farms: Challenges and opportunities for mitigation strategies. Conference on Wind energy and Wildlife impacts. 10-12 March 2015. Berlin, Germany

Roemer C., Devos S. & Bas Y. (2014) Assessment of bat mortality risks around human activities using unattended recordings for flight path reconstruction : An affordable method for bat behavioural conservation studies. Book of abstracts, XIIIth European Bat Research Symposium, 1-5 September 2014, Šibenik, Croatia.

Tabassum-Abbasi, P., M., Abbasi, T. Abbasi, S.A. (2014) wind energy: Increasing deployment, rising environmental concerns. Renwable and sustainable energy reviews. 31: 270-288.

Traxler A., Wegleitner S., Jaklitsch H., Darolová A. & Melcher A. (2013) Untersuchungen zum Kollisionsrisiko von Vögeln und Fledermäusen an Windenergieanlagen auf der Parndorfer Platte 2007-2009. Endbericht. *Survey on bird and bat mortality on wind turbines on the Parndorfer Platte 2007-2009. Final report*. BIOME.

Vieira, J., Bastos, C., Correia, R. (2011) Bats and wind power compensatory measures: a question of habitat management. Seminário "Wind & Biodiversity". 15 de Novembro de 2011, Aveiro, Portugal.

Voigt C.C., Lehnert L. S., Petersons G., Adorf F. & Bach L. (2015) Wildlife and renewable energy : German politics cross migratory bats. *Eur J Wildl Res.* DOI 10 1 007/s10344-015-0903-y

Annex 2 - New studies done in Europe

(addendum 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,* Annex 2 of *Doc.EUROBATS.AC17.6, Annex 2 of Doc.EUROBATS.AC18.6 and Annex 2 of Doc.EUROBATS.StC9-AC19.12*)

Study (author, year, area)	**Time**	**Habitat types**	**Data on WTs**	**Methods**	**Results**
Aminoff et al. (2014), Finland	May - October 2014	Gravel, schrub, dense bushes	15 WTs	MM: searches every 3 weeks, in autumn migration period on two consecutive days. SAR 50 m or 30 m (for small turbines), divided into sectors. SET to categorize habitats.	2 dead bats (Enil), no MR calculated.
Bach & Bach (2014a), Ammerland, Niedersachsen, Germany	2013 - 2014	pastures, crops, shrubland	5 WTs: Repower 3.4M (tower: 97m,rotor ø: 104m)	MM: SAR 50 m, divided into 5 categories (visibility), every 3rd day (45 days/year). SET, test for carcass removal rate.	14 dead bats: 7 Pnat, 5 Nnoc, 2 Ppip. Calculated MR: 4,7 bats/WT/year (Brinkmann et al. 2006)
Bach & Bach (2014b), Friesland, Niedersachsen, Germany	June - October 2014	pastures, crops, shrubland	2 WTs: Vestas V112 (tower: 94m, rotor ø:112m)	MM: SAR 60 m, divided into 5 categories (visibility), every 3rd day (51 days). SET, test for carcass removal rate.	8 dead bats: 6 Pnat, 1 Eser, 1Nlei. Calculated MR: 5/WT
Bach et al. (2014), Wesermarsch, Niedersachsen, Germany	August - Septembe r 2014	pastures, crops, shrubland	3 WTs	MM: SAR 50 m, divided into 5 categories (visibility), every 3rd day (20 days). SET, test for carcass removal rate.	7 dead bats: 5 Pnat, 1 Ppip, 1 P. sp. Calculated MR: 4/WT
BFL (2014a), Kirchberg (Rhein-Hunsrück-Kreis), Germany	2012 - 2013	Mountain forest	6 WTs: Enercon E 82 (tower: 135m, rotor ø: 82m)	MM: SAR 50 m., daily - over a period of ten days per month with SET: correction for searched area every 2 months. AS with Batcorder.	No dead bats found. WF worked with algorithm (April - October), after the monitoring that algorithm was confirmed
BFL (2014b), Gau-Bickelheim (Landkreis Alzey-Worms), Germany	2012 - 2013	Open agricultural area, low altitude	3 WTs: Kenarsys K 100 (tower: 135m, rotor ø: 100m)	MM: SAR 50 m., daily - over a period of ten days per month with SET: correction for searched area every 2 months. AS with Batcorder.	3 dead bats: 2 Pnat, 1 Nlei.
BFL (2014c), Riegenroth (Rhein-Hunsrück-Kreis), Germany	2013	Mountain forest	1 WT: REpower 3.4M104 (tower: 128m, rotor ø: 104m)	MM: SAR 50 m., daily - over a period of ten days per month with SET: correction for searched area every 2 months. AS with Batcorder.	2 dead bats: 2 Pnat.
BFL (2014d), Hangen-Weisheim (Landkreis Alzey-Worms), Germany	2013	Open agricultural area, low altitude	2 WTs: REpower 3.4M104 (tower: 128m, rotor ø: 104m)	MM: SAR 50 m., daily - over a period of ten days per month with SET: correction for searched area every 2 months. AS with Batcorder.	1 dead bat: 1 Pnat.
BFL (2014e), Laubach III (Rhein-Hunsrück-Kreis), Germany	2013	Mountain forest	1 WT: Enercon E 101 (tower: 135m, rotor ø: 101m)	MM: SAR 50 m., daily - over a period of ten days per month with SET: correction for searched area every 2 months. AS with Batcorder.	2 dead bats: 2 Ppip, 1 Nlei.

BFL (2014f), Hochstätten (Landkreis Bad Kreuznach), Germany	2012 - 2013	Mountain forest	1 WT: Vestas V90 (tower: 105m, rotor ø: 90m)	MM: SAR 50 m., daily - over a period of ten days per month with SET: correction for searched area every 2 months. AS with Batcorder.	4 dead bats: 3 Ppip, 1 Vmur.
BFL (2014g), Schopfloch (Landkreis Freudenstadt), Germany	2012 - 2013	Mountain forest	1 WT: Enercon E 82 (tower: 135m, rotor ø: 82m)	MM: SAR 50 m., daily - over a period of ten days per month with SET: correction for searched area every 2 months. AS with Batcorder.	2 dead bats: 2 Ppip.
Bio3 (2014a), Três Marcos, Portugal	May-Oct 2012 and Mar-Apr 2013	Pine forest, shrubs, crops.	19 WTs	AS: monthly (Jun-Oct 2012, Mar-Apr 2013) 10-min survey at each sampling point (n=20). Bat activity was recorded at ground level with D240X, Pettersson Elektronik connected to a digital recorder. Monitoring bat shelters: search of 46 potential bat shelters (Jun, Aug-Oct 2012, Mar-Apr 2013)	AS: Bbarb (16), Hsav (2), Mesc (5), Nlei (18), Pkhu (10), Ppip (71), Ppyg (2), Tten (5), Eser/Eisa (14), Mmyo/ Mbly (7), Ppyg/ Msch (6), Mdau (1), Tten (5), Mdau/Mesc/Mbec/Mmys/Mema (2), Nlei/Eser/Eisa (15), Ppip/Ppyg (9), Ppip/Ppyg/Msch (28). Shelters: Rhip (1)
Bio3 (2014b), Malhanito, Portugal	Dec 2012 - Nov 2013	Cistus shrubs, pine and oak forests, young plantations of oaks and holmoaks	29 WTs	MM: Weekly Mar-Oct 2013 and monthly Dec 2012, Feb and Nov 2013, around all 29 WTs. AS: monthly (Mar-Oct 2013) 10-min survey at each sampling point (n=16). Bat activity was recorded at ground level with D240X, Pettersson Elektronik connected to a digital recorder. Monitoring bat shelters: search of 22 potential bat shelters (Jan, Mar, Jul 2013)	MM: 1 NI bat. MR: (Huso 2010 / Korner-Nievergelt et al. 2011 estimator): 0,2 / 0,2 carcasses/WT. AS: Eser/Eisa (4), Mdau (1), Mmyo/Mbly (1), Nlei/Eser/Eisa (2), Nyc sp (1), Pkuh(18), Ppip(2), Ppyg (1), Pip sp(10), Ple sp(3), NI(1). Shelters: Rhip (2), NI (1)
Bio3 (2014c), Terra Fria-Montalegre, Portugal	Mar2013 - Jan2014	mean alt.: 1100m; shrubs; grassland; forest; rock outcrop	25WTs	MM: weekly around all 25 WTs. SAR 50 m; AS: monthly (Mar-Oct 2013), 10-min survey at each sampling point (n=20). Bat activity was recorded at ground level with D240X, Pettersson Elektronik connected to a digital recorder. Shelters: 2 shelters were monitored (Apr; Jun-Oct 2013).	MM: Nlei (2), Pip sp (2), Hsav (1), P pip/ P pyg (1). MR: (Huso 2010 / Korner-Nievergelt et al. 2011 estimators): 7.7 / 7.6 carcasses/WT. AS: Bbbar (4), Eser/Eisa (43), Mdau/Mesc/Mbec/Mmys/Mema (1), Myo spp(1), Nlei/Eser/Eisa (41), Nlas/Nnoc (2), Nlei(11), Nyc spp (3), Pkuh (2), Ppip (77), Ppip/Ppyg (11), Ppip/Ppyg/Msch (2), Pip spp (14), Ple spp (6), Tten(18), NI (17). Shelters: 76 bat passes of Myo spp, Eser/Eisa, Ppip, Pip spp, Mdau, Ppip/Ppyg, Ppip/Ppyg/Msch, Ppyg, Pkuh/Ppip, Nyc spp and observation of Myo spp (63), Mmys/Mdau (~50)
BIOME (2013), Parndorfer Platte, Burgenland, Austria	2007 - 2009	large agricultural areas with crops, pastures, shrubland; near NATURA 2000 areas and national park	98 WTs in 14 parks: Vestas V80, V90, V52; DeWind D6, D8; Enercon E66, E70, E40; Micon NM; GE 1,5; Wintec WT (tower: 60-113m, rotor ø 44-90m)	MM: SAR 100m, once/month. SET, test for carcass removal rate.	31 dead bats: 11 Pnat, 10 Nnoc, 3 Ppyg, 2 Ppip, 2 Vmur, 1 Hsav, 1 Eser, 1 Enil

Brünig, W. & J. Rutschke - PINK (2014), Gifhorn, Niedersachsen, Germany	June - October 2014	crops, near small forest	2 WTs	MM: SAR 50 m, divided into 3 categories (visibility), twice/week. SET, test for carcass removal rate.	10 dead bats: 7 Nnoc, 2 Pnat, 1 Vmur. Calculated MR: 13/WT
Conduché et al. (2012), Charly s/Marne (02), France	12 controls 04 August - 20 October 2011	Crops. Only small woods at each end of the WT line.	11 WTs	MM: SAR 50 m, 5 m between transects, SET. AS in relation to wind speed, temperature and time after sunset	8 dead bats: 5 Ppip, 3 Nlei. MR for 3 months (Winkelman 1989): 26,16 Nlei and 30,41 Ppip
Frey et al. (2014), Ammerland, Niedersachsen, Germany	2014	Pastures, crops, shrubland	3 WTs	MM: SAR 50 m, divided into 5 categories (visibility), twice/week (56 days). SET, test for carcass removal rate.	9 dead bats: 6 Nnoc, 2 Pnat, 1 Ppip. Calculated MR: 6/WT
LEA (2010a), Mafomedes, Portugal	2009	Ridge NE-SW, range altitude 1075-1110m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and pine stand	2 WTs	MM: Control of 15 among 15 days of all WTs. SAR 60 m.	No dead bats found
LEA (2010b), Penedo Ruivo, Portugal	2009	Ridge SW-NE, range altitude 1120-1220m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and pine stand	10 WTs	MM: Control of 15 among 15 days of all WTs. SAR 60 m.	No dead bats found
LEA (2010b), Seixinhos, Portugal	2009	Ridge NE-SW, range altitude 1197-1260m; totally integrated in an important area for the conservation of the biodiversity; low bushes	8 WTs	MM: Control of 15 among 15 days of all WTs. SAR 60 m.	No dead bats found

Oikon Ltd. (2014), Njivice, Split-Dalmatia County, Croatia	March - October 2013	Dry pastures and shrubs	20 WTs, tower 76.9m; rotor ø 82m.	MM: searches twice/month for 2-3 successive days. Search area: 70 m around WT in the area of maximum visibility (plateaus, roads and slopes) due to the very poor visibility in high grass and shrubs. AS: monthly monitoring of bat activity using BD.	148 dead bats: 35 Hsav, 50 Pkuh, 3 Pnat, 1 Tten, 7 Vmur, 15 N/i, 22 Pspp., 15 Pspp./Hsav

Abbreviations

AS = activity survey
Bbar = Barbastella barbastellus, European barbastelle
BD = bat detector
Eisa = Eptesicus isabellinus, Isabelline Serotine
Enil = Eptesicus nilssonii, Northern bat
Eser = Eptesicus serotinus, Common serotine
Espp. = Eptesicus species
Hsav = Hypsugo savii, Savi's pipistrelle
Mbec = Myotis bechsteinii, Bechstein's bat
Mbly = Myotis blythii, Lesser mouse-eared bat
Mbra = Myotis brandtii, Brandt's bat
Mdas = Myotis dasycneme, Pond bat
Mdau = Myotis daubentonii, Daubenton's bat
Mesc = Myotis escalerae, Escalera's bat
MM = mortality monitoring
Mmyo = Myotis myotis, Greater mouse-eared bat
Mmys = Myotis mystacinus, whiskered bat
Mnat = Myotis nattereri, Natterer's bat
MR = mortality rate
Msch = Miniopterus schreibersii, Schreibers' bat
Mspp. = Myotis species
N/i = species wasn't identified
Nlas = Nyctalus lasiopterus, Greater noctule
Nlei = Nyctalus leisleri, Leisler's bat
Nnoc = Nyctalus noctula, Noctule bat
Nspp. = Nyctalus species
Pkuh = Pipistrellus kuhlii, Kuhl's pipistrelle
Plaur = Plecotus auritus, Brown long-eared bat
Plaus = Plecotus austriacus, Grey long-eared bat
Plspp. = Plecotus species
Pnat = Pipistrellus nathusii, Nathusius' pipistrelle
Ppip = Pipistrellus pipistrellus, Common pipistrelle
Ppyg = Pipistrellus pygmaeus, Soprano pipistrelle
Pspp. = Pipistrellus species
Reur = Rhinolophus euryale, Mediterranean horseshoe bat
Rfer = Rhinolophus ferrumequinum, Greater horseshoe bat
Rhip = Rhinolophus hipposideros, Lesser horseshoe bat
Rmeh = Rhinolophus mehelyi, Mehely's horseshoe bat
SAR = search area's radius around WT
SET = tests for search efficiency & predation
Tten = Tadarida teniotis, European free-tailed bat
WF = wind farm
WT = wind turbine Vmur = Vespertilio murinus, Parti-colored bat

References

Aminoff , S., N. Hagner-Wahlsten, E.-M.Kyheröinen, A. Lindén, J. Brommer, A. Brutemark & M. Fred (2014): Methods for studying post –construction effects of wind power on bats in central europe cannot be directly applied in southern Finland. Book of abstracts, XIIIth European Bat Research Symposium, 1-5 September 2014, Šibenik, Croatia: 25.

Bach P. & L. Bach (2014a): Monitoring der Fledermausaktivität im Windpark Ammersche Länder, Endbericht 2014. - unveröff. Gutachten i.A. Planungsbüro Diekmann & Mosebach: 47pp.

Bach, L. & P. Bach (2014b): Monitoring der Fledermausaktivität im Windpark Spolsen Gondelmonitoring und Schlagsuche - Zwischenbericht 2014 – unveröff. Gutachten i.A. Planungsbüro Diekmann & Mosebach: 31pp.

Bach L., P. Bach & W. Dormann (2014): Fachbeitrag Fledermäuse zum Windparkstandort Schütting. – Gondelmonitoring und Schlagsuche - unveröff. Gutachten i.A. FPJ Windpark Schütting Netz und Wege GmbH & Co. KG: 32pp.

BFL (2014a): Fledermausmonitoring im Windpark Kirchberg 2012-2013 (Rhein-Hunsrück-Kreis) - Endbericht 2013-2014. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014b): Fledermausmonitoring im Windpark Gau-Bickelheim 2013 (Landkreis Alzey-Worms) - Zwischenbericht 2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014c): Fledermausmonitoring im Windpark Riegenroth 2013 (Rhein-Hunsrück-Kreis) - Zwischenbericht 2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014d): Fledermausmonitoring im Windpark Hangen-Weisheim 2013 (Landkreis Alzey-Worms) - Zwischenbericht 2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014e): Fledermausmonitoring im Windpark Laubach 2013 (Rhein-Hunsrück-Kreis) - Zwischenbericht 2012. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014f): Fledermausmonitoring im Windpark Hochstätten 2012-2013 (Landkreis Bad Kreuznach) - Endbericht 2012-2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

BFL (2014g): Fledermausmonitoring im Windpark Schopfloch 2012-2013 (Landkreis Freudenstadt) - Endbericht 2012-2013. - Unveröff. Gutachten im Auftrag der juwi Energieprojekte GmbH. Büro für Faunistik und Landschaftsökologie - Bingen am Rhein.

Bio3 (2014a) Monitorização da comunidade de quirópteros no Parque Eólico de Três Marcos. Relatório I (Fase Anterior à Construção – Ano 2012/2013), 70pp.

Bio3 (2014b). Monitorização das comunidades de aves e quirópteros no Parque Eólico do Malhanito. Relatório 3 (Fase de exploração –2012/2013). 178pp.

Bio3 (2014c). Monitorização das comunidades de aves e quirópteros no Parque Eólico da Terra Fria - Relatório final de Montalegre. 207pp.

BIOME (2013): Untersuchungen zum Kollisionsrisiko von Vögeln und Fledermäusen an Windenergieanlagen auf der Parndorfer Platte/Nordburgenland 2007 - 2009, Endbericht. 98pp.

Brünig, W. & J. Rutschke - PINK (2014): Schlagopferkartierung an zwei Windkraftanlagen in Westerholz, Abschlussbericht. 8pp.

Conduché, N., T. Daumal, C. Louvet, S. Tourte & F. Spinelli-Dhuicq (2012): Suivis des impacts sur les chiroptères du parc éolien de “La Picoterie”, commune de Charly-sur-Marne (02). Ecothème pour La Compagnie du Vent, 43 pp.

Frey, K., L. Bach & P. Bach (2014): Monitoring der Fledermausaktivität im Windpark Krögershamm, Zwischenbericht 2014 – unveröff. Gutachten i.A. Planungsbüro Diekmann & Mosebach: 35 Seiten.

LEA (2010a): Relatório de Monitorização da Actividade e Mortalidade de Quirópteros no Parque Eólico de Mafômedes. Relatório Final (Fase de Exploração) elaborado para a EnergieKontor. Laboratório de Ecologia Aplicada da Universidade de Trás-os-Montes e
Alto Douro. Vila Real, Outubro.

LEA (2010b): Relatório de Monitorização da Actividade e Mortalidade de Quirópteros nos Parques Eólicos de Penedo Ruivo e Seixinhos. Relatório Final (Fase de Exploração – Ano IV) elaborado para a EnergieKontor. Laboratório de Ecologia Aplicada da Universidade de Trás-os-Montes e Alto Douro. Vila Real, Junho de 2010.

Oikon Ltd. (2014): Prac´ enje stradavanja populacija šišmiša tijekom korištenja VE Jelinak (Bat mortality monitoring during operation of Wind farm Jelinak).