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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 Eleftherios Hadjisterkotis
Impact of mortality rate on populations	Martin Celuch (c) Lothar Bach Luisa Rodrigues Christine Harbusch Eleftherios Hadjisterkotis
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
Update of guidelines	Marie-Jo Dubourg-Savage Luisa Rodrigues Lothar Bach Martin Celuch Andrzej Kepel Branko Mićevski Christine Harbusch

Results

Results are presented by sub-group. Additionally, Marie-Jo Dubourg-Savage presented a French analysis of detectability coefficients to compare activity indices.

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 AC16 (*Doc.AC16.8*).

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 December 2011. 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	CH	CR	CZ	DE	ES	EE	FR	GR	IT	NL	NO	PT	PL	SE	UK	Total
Nyctalus noctula	3			3	567	1		12	10				1		1		**598**
Nyctalus lasiopterus						21		3	1				5				**30**
Nyctalus leisleri		1		1	73	15		30	58				152				**330**
Nyctalus spec.						2							16				**18**
Eptesicus serotinus				7	36	2		12	1		1						**59**
Eptesicus isabellinus						117							1				**118**
E. serotinus / isabellinus						11							13				**24**
Eptesicus nilssonii					2		2					1		1	8		**14**
Vespertilio murinus				2	62				1					2	1		**68**
Myotis myotis					2	2		1									**5**
M. blythii						4											**4**
M. dasycneme					2												**2**
M. daubentonii					4								2				**6**
M. bechsteini								1									**1**
M. emarginatus						1		1									**2**
M. brandtii					1												**1**
M. mystacinus					2				1								**3**
Myotis spec.						3											**3**
Pipistrellus pipistrellus				3	311	73		220		1	15		200	1	1		**825**
P. nathusii	1			2	391			74	35		5			8	5		**521**

Species	AT	CH	CR	CZ	DE	ES	EE	FR	GR	IT	NL	NO	PT	PL	SE	UK	Total
P. pygmaeus					40			67					24	1	1	1	**134**
P. pipistrellus /pygmaeus		1				483		22	54				28	1			**589**
P. kuhlii			4			44		77					26				**151**
P.pipistrellus / kuhlii													16				**16**
Pipistrellus spec.				2	20	20		69					67			3	**181**
Hypsugo savii			3		1	44		28	26	8			35				**145**
Barbastella barbastellus						1		2									**3**
Plecotus austriacus	1				6												**7**
Plecotus auritus					4												**4**
Tadarida teniotis						23		1					11				**35**
Miniopterus schreibersi						2		3					1				**6**
Rhinolophus ferrumequinum						1											**1**
Rhinolophus mehelyi						1											**1**
Chiroptera spec.					33	320	1	84	7	1			91	3	30	7	**577**
Total	**5**	**2**	**7**	**20**	**1557**	**1191**	**3**	**707**	**194**	**10**	**21**	**1**	**689**	**17**	**47**	**11**	**4482**

AT: Austria, CH: Switzerland, CR: Croatia, CZ: Czech Rep., D: Germany ES: Spain, EE: Estonia, 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*, and Annex 3 of *Doc.EUROBATS.StC4-AC15.22.Rev.1*.

It was decided to not 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

Current knowledge 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).

Several experiments regarding the increase of cut-in speed show a reduction of the fatalities:

- Germany: raise the rotor start-up speed of 2 turbines to 6.0 m/s; fatalities reduced 65% (Behr & von Helversen 2006),

- Canada: raise the rotor start-up speed of 20 turbines from 4.0 m/s to 7.0 m/s; fatalities reduced (Brown & Hamilton 2006),

- Canada: raise the rotor start-up speed of 15 turbines from 4.0 m/s p to 5.5 m/s; fatalities reduced 60% (Baerwald *et al.* 2009),

- USA: raise the rotor start-up speed of 12 turbines from 3.5 m/s to 5.0 m/s and 6.5 m/s; fatalities reduced about 44–93%; no difference between the two speeds (Arnett *et al.* (2011),

- USA: raise the rotor start-up speed from 3.5 m/s to 5.0 m/s and 6.5 m/s; fatalities reduced 50% at 5.0 m/s and 78% at 6.5 m/s (Good *et al.* 2011),

- Portugal: raise the rotor start-up speed of 6 turbines to 3.3 m/s; fatalities reduced 31.4% (LEA 2010).

Two experiments regarding feathering also demonstrate a reduction of the fatalities:

- Canada: blade feather of 6 turbine; fatalities reduced 57.5% (Baerwald *et al.* 2009),

- USA: blade feather of 16 turbines < 4 m/s during first half of the night (approximately sunset plus 5 hours) and second half of the night (sunrise minus 5 hours); fatalities reduced 72% for first half and 50% for second half (Young *et al.* 2011).

These findings suggest that increasing cut-in speed and blade feathering during the night do mitigate bat fatalities. To avoid excessive production losses, the ideal is that these measures may be applied to particularly vulnerable situations regarding low wind speed and high temperature. The IWG recommends that more experiments should take place and results must be made available.

The increasing of cut-in speed and blade feathering are starting to be implemented by some countries:

- In Canada, 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 several species present a much endangered situation. 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 three years and a first commercial regulation of a wind farm is expected to start next summer in northern France. Two tests have been carried out in two wind farms between control and regulated turbines and showed a mortality decrease of 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 during 2011 and ongoing in 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 rise to a 16°C 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 Germany, an algorithm was developed to stop wind turbines taking into account activity in nacelle height, wind speed, season (particularly related to temperature) and night time (Behr *et al*. 2011a). That algorithm will be tested during the next 2 years. During that project the activity at nacelle height was correlated with the number of fatalities and wind speed (Behr *et al*. 2011b, c, Korner-Nievergelt *et al*. 2011). Beside that project raising the start-up speed of turbines is the most common mitigation measure used in Germany. But there is no national agreement on how to determine it. In Brandenburg e.g. a regional guideline ask for raising the start-up speed to 5m/s if the activity at nacelle height is higher than 300 contacts between mid of July and mid of October (Ministerium für Umwelt, Gesundheit und Verbraucherschutz des Landes Brandenburg 2011). In north-western Germany a start-up speed is worked out site specific taking into account the activity at nacelle height, season, wind speed and temperature. 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. Because the start-up speed is site specific it varies between 8m/s (Bach & Bach 2009) and 6,3m/s (Bach & Niermann 2011).

- In Portugal, a project including 4 turbines located less than 7 km from the most important underground roost known in mainland, occupied all over year by several thousands of bats of several species, was authorized if cut-in speed is increased from 3 m/s to 3.3 m/s (Governo de Portugal 2011).

Arnett E.B., M.M. Huso, M.R. Schirmacher & J.P. Hayes (2011) Altering turbine speed reduces bat mortality at wind-energy facilities. *Frontiers in Ecology and the Environment*, 9:209-214.

Bach L. & P. Bach (2010) *Monitoring der Fledermausaktivität im Windpark Cappel-Neufeld,* *Abschlussbericht*. unpubl. report to WWK: 45 pp.

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

Baerwald E., J. Edworthy, M. Holder & R. Barclay (2009) A large-scale mitigation experiment to reduce bat fatalities at wind energy facilities. *Journal of Wildlife Management* 73(7): 1077-1081.

Behr O. & O. von Helversen (2006) *Gutachten zur Beeinträchtigung im freien Luftraum jagender und ziehender Fledermäuse durch bestehende Windkraftanlagen*. Wirkungskontrolle zum Windpark Roßkopf (Freiburg i. Br.) im Jahre 2005. Unpubl. report for 2005 on behalf of Regiowind GmbH & Co. KG Freiburg.

Behr O., R. Brinkmann, I. Niermann & F. Korner-Nievergelt (2011a) 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.

Behr O., R. Brinkmann, I. Niermann & F. Korner-Nievergelt (2011b) Akustische Erfassung der Fleder-mausaktivität an 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, 177-286, Cuvillier Verlag, Göttingen.

Behr O., R. Brinkmann, I. Niermann & F. Korner-Nievergelt (2011c) Vorhersage der Fledermaus-aktivität an Windenergieanlagen. In: Brinkmann, R., Behr, O., Niermann, I. & Reich, M. (ed.): *Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von Fleder-mäusen an Onshore-Windenergieanlagen*. Umwelt und Raum Bd. 4, 287-322, Cuvillier Verlag, Göttingen.

Brown W.K. & B.L. Hamilton (2006) *Monitoring of Bird and Bat Collisions with Wind Turbines at the Summerview Wind Power Project, Alberta 2005-2006*. Prepared for Vision Quest Windelectric. Calgary, AB.

Good R.E., W. Erickson, A. Merrill, S. Simon, K. Murray, K. Bay & C. Fritchman (2011) *Bat Monitoring Studies at the Fowler Ridge Wind Energy Facility, Benton County, Indiana. April 13-October 15, 2010*. Prepared for the Fowler Ridge Wind Farm.

Governo de Portugal (2011) *Decisão de Incidências Ambientais do Parque Eólico do Alto dos Forninhos*.

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

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).

LEA (2010) *Monitorização dos efeitos da Medida de Minimização de Mortalidade do Parque Eólico do Outeiro. Relatório final.* Laboratório de Ecologia Aplicada da Universidade de Trás-os-Montes e Alto Douro. Vila Real, 78 pp.

Ministerium für Umwelt, Gesundheit und Verbraucherschutz des Landes Brandenburg (2011) *Beachtung naturschutzfachlicher Belange bei der Ausweisung von Windeignungsgebieten und bei der Genehmigung von Windenergieanlagen*.

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

Young D.P.Jr., S. Nomani, W.L. Tidhar & K. Bay (2011) *NedPower Mount Storm Wind Energy Faciligy post-construction avian and bat monitoring, July–October 2010*. Unpublished report prepared for NedPower Mount Storm, LLC, Houston, Texas. Prepared by Western EcoSystems Technology, Inc., Cheyenne, WY, USA.

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

Usually the estimation of bat mortality takes into account how many bats really died at a wind turbine multiplied with the probability that a carcass was overlooked (searchers efficiency), taken away (predation) and/or impossible to be found due to the area structures. This estimator has three disadvantages: (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 these disadvantages into account:

- Huso (2010) developed an estimator which takes into account that the carcasses are not normally distributed. 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 start-up 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.

In France, two recent monitoring studies (Cornut & Vincent 2010; Sané unpublished) 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 (Oikostat and BIO3 estimators were at that time unknown to the authors).

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.

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.

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.

There are only two local modelling studies, for *Nyctalus noctula* (Blohm & Heise 2009) and *Pipistrellus pipistrellus* (Kiefer & Wöhl unpublished). This type of studies has the basic problem of assessing populations on a National level although in some situations rough National estimates may exist, particularly for species included in Natura 2000´s Annex 2. The IWG believes that in the near future the best approach would be the development of studies at local or regional levels.

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.

Blohm & Heise (2009), Windkraftnutzung und Bestandsentwicklung des Abendseglers, *Nyctalus noctula* (Schreber, 1174), in der Uckermark. *Nyctalus* 14, 1-2: 14-26.

Kiefer A. & Wöhl S. (unpublished). Grundlegende Überlegungen zu der Tabelle "Zwergfledermäuse und WEA". Version 1.3 vom 8. Dezember 2010 (Modell for *P. pipistrellus*).

Deterrents

There is little new knowledge about deterrent studies. Arnett *et al*. presented a poster at a conference in Trondheim, where they showed that they managed to reduce the mortality in 2009 and 2010 between 18-62% compared with turbines working without deterrents (Arnett *et al*. 2011). But since the variation value is very high (in some cases the mortality even raised (pers. comm) and the costs of deterrents are enormous, it is still unsuitable as a practical mitigation measure.

Arnett, E.B., M. Baker, C. Hein, M. Schirmacher, M.M.P. Huso & J.M. Szewczak 2011 Effectiveness of deterrents to reduce bat fatalities at wind energy facilities. Conference on Wind Energy and Wildlife Impacts, 2-5 May 2011, Trondheim, Norway, NINA Report 693, presentation abstract p.57.

Table on maximum foraging distances of species

In the framework of the Environmental Impact Assessment of wind farm projects, it is important to know the range of the different species encountered in the vicinity and the height at which they can fly. The following table updates the information for the different bat species which have been killed by wind turbines (**new information in bold**). For most species the information comes from radio tracking studies and the mentioned references are listed below the table.

Species	Max foraging distance (km)	Height of flight (m)	References	Radio-tracking studies
Nyctalus noctula	26	10 to a few hundred meters	1, 7, 30, **65**	Yes, **no**
Nyctalus leisleri	17	above canopy**, >25m, >40-50m (foraging & direct flight)**	5, 6, 30, 32, 42, 45,**64,65, 68**	Yes**, no**
Nyctalus lasiopterus	90	1300m (telescope & radar)	2, 3, 4, 30	Yes
Pipistrellus nathusii	12	1-20 (foraging); 30-50 (migration**), >25m, foraging above canopy & >40-50m in direct flight**	43, 45, 46, 47,30, **64,65, 68**	Yes, **no**
Pipistrellus pygmaeus	1,7 (mean radius)	up to the rotor, **occasionally >25m, >40-50m in direct flight**	20, 30**, 64, 65, 68**	Yes, **no**
Pipistrellus pipistrellus	5,1	up to the rotor**, >25m, >40-50m in direct flight**	21, 61, **65, 68**	No; chemiluminescent tags, **no**
Pipistrellus kuhlii	no information	1-10; up to a few hundreds**, >25m**	30, **64, 65**	Yes, **no**
Hypsugo savii	?	>100	33, 37, **64, 65**	No, **no**
Eptesicus serotinus	12	50 (up to the rotor), **>25m, forages above canopy, >40-50m in direct flight**	13, 14, 15, 16, 30, 62**, 64, 65,68**	Yes, **no**
Eptesicus isabellinus	**?**	**?**	**?**	**?**

Eptesicus nilssonii	30	> 50 **(foraging & direct flight)**	51, 52, **64, 65, 68**	Yes, **no**
Vespertilio murinus	6,2 ♀; 20,5 ♂	20-40**, above canopy (foraging) & >40-50m (direct flight)**	48, 49, **64, 65, 68**	Yes, **no**
Myotis myotis	25	1-15m (direct flight in open sky in transit); **>25m; up to 40 (50)m in direct flight**	26, 27, 28, 29, 30**, 64, 68**	Yes, **no**
Myotis blythii	26	1-15	22, 23, 24, 25, 26, 30	Yes
Myotis punicus	**15**	**< 2m (foraging), probably 100m commuting from ridge to ridge**	**69, 70**	**Yes**
Myotis emarginatus	12,5	no information	17, 18, 30, 33, 36, 38, 39	Yes
Myotis bechsteinii	2,5	1-5 and in the canopy, **sometimes above canopy (direct flight)**	12, 30, 31, 38, 39, **68**	Yes, **no**
Myotis dasycneme	34	2-5 (up to the rotor)	53, 63, 66	Yes
Myotis daubentonii	10 ♀; >15 ♂	1-5**, forages up to canopy & sometimes above in direct flight**	57, 58, **68**	Yes
Myotis brandtii	10	up to the canopy **(foraging) & sometimes above in direct flight**	49, 54, 55, **68**	?
Myotis mystacinus	2,8	up to 15m in the canopy**, up to canopy (foraging) & sometimes above in direct flight**	55, 56, **68**	Yes, **no**
Plecotus auritus	2,2-3,3	up to the canopy **and above (foraging and direct flight)**	59**, 68**	Yes, **no**
Plecotus austriacus	regularly up to 7 km	**exceptionally >25m,** up to the canopy **and above (foraging and direct flight)**	60, **64**, 67, **68**	**Yes**, **no**
Barbastella barbastellus	10	above canopy, **>25m, canopy and above (foraging and direct flight)**	11, 12, 30, 34, 35, **64, 68**	Yes, **no**
Miniopterus schreibersii	40	2-5 (foraging) and open sky (transit), **>25m**	8, 30, 41, 40, **64**	Yes, **no**
Tadarida teniotis	>30 (Portugal), 100 (Switzerland)	10-300	44, 9, 10, 30	Yes

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Detectability coefficients to compare activity indices

Activity indices (usually the number of contacts per time unit) result generally of pre-construction surveys and are required by wind energy promoters to evaluate the risks of their projects. But the number of bat contacts/hour can only be compared between species that have calls of similar intensity. The probability of contacting a species with a low intensity call (e. g. a Lesser horseshoe bat) is smaller than a species with a very high intensity call (e.g. a Noctule bat). Range variations of a signal depend also on many parameters that make comparison even more difficult. To allow comparison, bats have therefore been sorted according to the increasing intensity of their sonar calls (see table below). A detectability coefficient based on the maximum distance of detection has been calculated for 2 different locations of the observer (open vs. woodland). Applying this coefficient to the number of contacts or indices per species will then allow comparing the activity between species or groups of species. For more details see Barataud 2012.

Open space			
Intensity levels of calls	**Species**	**Distance of detection (m)**	**Detectability coefficient**
Low	*R. hipposideros*	5	5.00
	R. ferr./eur./meh.	10	2.50
	M. emarginatus	10	2.50
	M. alcathoe	10	2.50
	M. mystacinus	10	2.50
	M. brandtii	10	2.50
	M. daubentonii	15	1.70
	M. nattereri	15	1.70
	M. bechsteinii	15	1.70
	B. barbastellus	15	1.70
Medium	*M. oxygnathus*	20	1.20
	M. myotis	20	1.20
	P. pygmaeus	25	1.00
	P. pipistrellus	30	0.83
	P. kuhlii	30	0.83
	P. nathusii	30	0.83

Underwood			
Intensity levels of calls	**Species**	**Distance of detection (m)**	**Detectability coefficient**
Low	*R. hipposideros*	5	5.00
	Plecotus spp.	5	5.00
	M. emarginatus	8	3.10
	M. nattereri	8	3.10
	R. ferr./eur./meh.	10	2.50
	M. alcathoe	10	2.50
	M. mystacinus	10	2.50
	M. brandtii	10	2.50
	M. daubentonii	10	2.50
	M. bechsteinii	10	2.50
	B. barbastellus	15	1.70
	M. oxygnathus	15	1.70
	M. myotis	15	1.70
Medium	*P. pygmaeus*	20	1.20
	M. schreibersii	20	1.20
	P. pipistrellus	25	1.00

	M. schreibersii	30	0.83		*P. kuhlii*	25	1.00
					P. nathusii	25	1.00
High	*H. savii*	40	0.71				
	E. serotinus	40	0.71	High	*H. savii*	30	0.83
	*Plecotus spp.**	40	0.71		*E. serotinus*	30	0.83
Very high	*E. nilssonii*	50	0.50	Very high	*E. nilssonii*	50	0.50
	V. murinus	50	0.50		*V. murinus*	50	0.50
	N. leisleri	80	0.31		*N. leisleri*	80	0.31
	N. noctula	100	0.25		*N. noctula*	100	0.25
	T. teniotis	150	0.17		*T. teniotis*	150	0.17
	N. lasiopterus	150	0.17		*N. lasiopterus*	150	0.17

* Note for *Plecotus*: some high intensity calls can be sent during commuting flight in the open (ref. call DVD 3.93)

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Collect national guidelines

The subgroup sent an email to all delegates to update the situation. Next table includes the current information.

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	no	no	no	
France	**YES**	**YES**	**YES**	**YES** http://www.sfepm.org/pdf/Recommandations31052006_parceolien.pdf Official general guidelines 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	no	no	
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** ftp://gis.dipbsf.uninsubria.it/Eolico_biblio/guidelines_portugal.pdf
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://www.snh.gov.uk/docs/C245244.pdf 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
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			**YES** (chapter about bats in national EIA guidelines)	**YES** http://www.ekoplan.gov.rs/en/download-1227/upload-centar/dokumenti/razno/bats_and_environmental_impact_assessment_web_lq.pdf
Spain	no	no	no	
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 (Installations Classées pour la Protection de l'Environnement) rules and regulations. Part of the national guidelines will be modified accordingly.

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).
In USA, dogs found 71% of the bats randomly placed in searcher efficiency trials at first locality and 81% of those at second locality, compared to 42% and 14% for human searches, respectively (Arnett *et al*. 2005). Both the dog-handler team and humans found a high proportion of trial bats within 10 m of the turbine. However, human search efficiency declined as vegetation height and density increased while dog-handler efficiency remained high. The dog-handler team consistently found higher proportions (65-100%) of trial carcasses in high, medium, and low visibility habitats at both sites, and 40-50% in extremely low visibility habitats.

Dogs have proven to be efficient and cost effective also in Australia and their use at wind farms is becoming standard practice (Paulding *et al*. 2011). Experiments shown that trained dogs can search an area of 3 hectares (radius of 100m around a turbine) efficiently in less than 20 minutes and detect all carcasses present. A human surveyor would walk 7.5km to cover the same area will lower success.
In UK, a special company trains dogs for special purposes, including bat carcass searching in wind farm monitoring projects. Also a pilot study with dogs has started in the UK (Mathews 2011).

In Portugal, three companies are already using dogs in carcass searches, and two projects are being carried-out. The biologist-dog project resulted of a protocol established between Bio3 and the Special Operations Group of the Portuguese Public Security Police (PSP) – K9 Unit, to train handlers (biologists) and detection dogs to form dog-handler teams. After training, to assess the use of dogs for bird and bat carcass searches in real field surveys, the following hypotheses were addressed: (1) dogs are more accurate than humans to detect bird and bat carcasses under different vegetation conditions, and (2) carcass decomposition, weather conditions (temperature and wind speed) and distance to the target affects the search accuracy and efficiency of the working dog. Results indicated that dogs are more accurate than humans, independently of vegetation density. Furthermore, carcass decomposition condition, distances to the carcass and weather conditions affect dog's efficiency. Despite significant, the observed effects were reflected in a reduced time scale. Between 2007 and 2009 four dogs were trained under a protocol established between ECOSATIVA and the Drugs Detection Speciality of Republican National Guard (GNR), adapting Arnett's experience published in 2005. The results of the application on 10 wind farms were presented by the end of 2009, and showed significant difference ($p < 0,5$) on detectability, greater the smaller the animal. We found very significant differences ($p < 0,01$) between habitats: forest and tall shrubland were the habitats where the difference of using dogs instead of human observers was bigger. The detectability of dogs is normally above 90%, and never belows 50%. Human observers verify much lower detectability, which can be near to 0% in some habitats, as those referred. In the last 3 years this methodology was applied by this company on more than 20 wind farms, resulting on 90 carcasses found on 14 wind farms. Nowadays this methodology is used as a standard on all bat and bird monitoring projects conducted by ECOSATIVA. Since the beginning of 2011 this methodology is also being applied on two high tension electric lines.

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Update of guidelines

Unfortunately it was not yet possible to start this subject, but the IWG hopes to do it in the near future.

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.

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 AC16 (*Doc.AC16.8*))

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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* and Annex 3 of *Doc.EUROBATS.StC4-AC15.22.Rev.1*)

Study (author, year, area)	time	type of turbines	methods	results	Habitat-types
Traxler A. et al., 2004. Prellenkirchen, Obersdorf, Steinberg/Prinzendorf. NÖ, Austria	Sept. 2003 to Sept. 2004	Wind park Steinberg-Prinzendorf: 9 WTs, Vestas V80; 2.000 kW; tower 100m, rotor ø 80m. Obersdorf: 5WTs, E-66 18.70, 1.800 kW, tower 98m, rotor ø 70m. Prellenkirchen: 8WTs, E-66 18.70, 1.800 kW, tower 98m, rotor ø 70m.	Mortality control every day (morning) under 5 WTs (1 WT Obersdorf, 2 WTs Prellenkirchen, 2 WTs Steinberg). Search area of 100m radius around the WT(vegetation kept short). Observation of (migrating) birds and bats within a circle of 500m diameter around the WT for 15 min. Line transects (car and on foot). Tests for search efficiency & predation.	Steinberg-Prinzendorf: 4 dead bats found (*Pipistrellus nathusii, Plecotus austriacus, 2 Nyctalus noctula).* No flying bats observed. Obersdorf: no dead bats found. Few observations of single bats (*Nyctalus noctula*). Prellenkirchen: 3 dead *Nyctalus noctula* found (outside observation period) and additional 10 dead *Nyctalus noctula* found. Autumn migration of *Nyctalus noctula* was observed on several days (3.14 bats/hour in wind park, 8,73 bats/hour in control area). Bats were observed that did not show avoidance behaviour toward the WTs. Other area - Deutsch Haslau: 1 dead *Nyctalus noctula* found. Calculated collision rate for all 3 parks: 5.33 dead bats per WT per year.	Steinberg-Prinzendorf: Natura 2000 area March-Thaya-Auen 12 km east of wind park. Agricultural area near oak and common hornbeam forest (also Natura 2000 area). Obersdorf: Agricultural area, partly with hedges/ shelter belts and small pine forests. Prellenkirchen: Agricultural area with hills and with the Danube and Hundsheimer Berge to the north. Partly vineyards, near a Natura 2000 area.
Zagmajster M. et al., 2007. Ravne, Pag Island, Southern Kvarner and Trtar Krtolin, Šibenik, Northern Dalmatia. Croatia.	Ravne: 28.4., 01.05., 29.07.2007. Trtar Krtolin: 01.11. 2006.	Ravne: 7WTs, tower 49m, rotor ø 52m. Trtar Krtolin: 14 WTs, tower 50m, rotor ø 48m.	Mortality control in the morning.	6 dead bats found (Ravne: 2 *Hypsugo savii*, 4 *Pipistrellus kuhlii*. Trtar Krtolin:1 *Hypsugo savii).*	Ravne: Middle of the island, alt.:200m. Trtar Krtolin: on a plateau, alt. 400m.
AVES Environnement (L. Allouche), 2011, Mas de Leuze, France	12/07 - 01/10/2011	9 WTs x 800 kW ; tower 50m	Mortality control every 3 days under 8 WTs. Access to 1 impossible. Search area: 40m radius. Tests for search efficiency & predation. No surface correction as 100% except one 95%. 8 WTs regulated (4 at a time with 4 control WTs) with the Chirotech system (7 weeks of regulation, 7 periods)	54 dead bats (only 51 during the control period). For the considered period estimated number of killed bats/WT 82.15 (Erickson's formula) i.e. 4.5 less in 2011 than in 2009, but number of retrieved bats/WT only 1.4 less in 2011. Calculated production loss < 0.15% (Biotope)	grassland, shrubs, 30% cereal crops
GCRA-LPO 26 (J. Cornut), 2010, Le Pouzin, Ardèche, France	05/05 - 20/10/2010	2 WTs x 2300 kW tower 85 m; rotor ø 90m	05/05-20/06 & 21/06-10/08: twice a week, every other day, 11/08-16/09 every 4th day, 17/09-20/10 every 4th day except in October: once a fortnight. Search area: 56m radius. Tests for search efficiency & predation, surface correction	6 fatalities (Hsav 1, Pip sp 1, bat sp. 2, Pkuh 1, Nnoc 1) Estimated mortality/WT/year: 6.79 (Winkelmann 1989) 54,93 (Erickson 2000) 75,99 (Jones 2009) 44,17 (Huso 2010)	River, grassland, shrubs/wood, industrial estate

GCRA-LPO 26 (J. Cornut), 2011, La Répara-Auriples, Drôme, France	05/05-20/10/2010	2 WTs x 2300 kW tower 60 m; rotor ø 71m	05/05-20/06 & 21/06-10/08: twice a week every other day, 11/08-20/10 every other day. Search area: 56m radius. Tests for search efficiency & predation, surface correction	42 fatalities (Ppip 9, Pkuh 8, Pip sp. 7, Hsav 6, Nlei 5, Nnoc 1, Pnat 2, Ppyg 1, Msch 1, Eser 1, bat sp. 1). Estimated mortality/WT/year 130.49 (Winkelmann 1989) 59.68 (Erickson 2000) 86.94 (Jones 2009) 79.17 (Huso 2010)	Mixed forest, agriculture
F. Sané, pers. com., Lou Paou, Lozère, France	2008: 24/04-20/10 2009: 25/08-07/10 2010: 26/07-22/09	7 WTs x 2000 kW tower 80 m; rotor ø 82m	2008: 22 controls (1/8,18 days), 2009: 22 controls (1/2 days) 2010: 27 controls (1/2,19 days) Search area: 60 m radius Tests for efficiency, persistence, visibility classes	2008: 6 bats(Ppip 5, Nlei 1) 2009: 20 bats (Ppip 9, Nlei 4, Hsav 1, bat sp. 6) 2010: no fatality Estimated mortality: no correction for surface as all fatalities within 15m from tower, 5 estimators tested, Huso's formula seems the most accurate: 2008: 5,9-6,4 bats/WT/7,9w 2009: 14 bats/WT/5,4 weeks 2010: 0 bat/WT/8,3 weeks	conifer plantations, Scot pines and birches, pastures in between
ABIES (S. Albouy), 2010, Roquetaillade, Aude, France	15/05-30/09/2009	8 WTs x 660 kW tower 47m; rotor ø 47m 20 WTs x 850 kW tower ? ; rotor ø 52m	15/05-30/09/2009 No tests, no estimation of mortality ??		Open land (pastures (?) with shrubs and scattered trees, some cereal fields
LPO 12, 2008 EXEN & KJM (Y. Beucher), 2011. Castelnau-Pegayrols, Aveyron, France (final report not available)	2008 (LPO12), 2009, 2010	13 WTs x 2500 kW	2008: 09/06-01/07 no protocole, 03/07-19/10 with tests efficiency and disappearance 2009: every 7 days from 22/05 to 3/06 and from 21/09 to 28/09, and every 3,5 days from 3/06 to 18/09 2010: same as 2009	**2008:** 73 bats (49 Ppip, 6 Pkuh, 13 Pipsp, 2 Eser, 1 Nlei, 2 bat sp.) No estimation **2009**: 98 bats (57 Ppip, 15 Pkuh, 7 Nlei, 5 Ppip/Ppyg, 3 Ppip/Ppyg/Hsav, 4 Ppyg, 2 Hsav, 2 Nlas, 1 Pnat, 1 Nlei?, 1 Ppip/Pkuh/Pnat). Estimated mortality: 7,54 bat/WT/4,25 months **2010:** 2 Pip sp. but WTs stopped at low wind speed	Pastures, hay meadows, cultures, along coniferous forest
Albrecht K. & Grünfelder C., 2011. Landkreis Neustadt an der Waldnaab in Bayern (ca. 630 m ü. NN), Germany	16./17.07.2009 and 19./20.08.2009	non	Batcorders registered the bat calls synchronously in three different heights (helium balloon at the height of prospective rotor blades and at 20m, 2m high on a pole)	calls of *Eptesicus nilssonii, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus* and *Myotis mystacinus/brandtii* . Probably also *Vespertilio murinus*	Agricultural area, close to a mixed forest
Bach L. & I. Niermann, 2010 Langwedel, Germany	1.4-31.11 2009 and 1.4.-31.11. 2010	5 WTs (Vestas V90 tower 125m; rotor ø 90m	Mortality control every 2 resp. 3 days under 5 WTs. Search area of 50m radius around the WT (except for areas with dense vegetation). Tests for search efficiency & predation. Acoustic monitoring with one AnaBat-SD1 per WT (at rotor hight)	11 dead bats (7 Nyctalus noctula, 3 Pipistrellus nathusii, 1 Nyctalus leisleri) found. Calculation: probably 2 resp. 4 dead bats/WT/year . Acoustic monitoring: calls of Nyctalus noctula, Nyctalus leisleri, Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus	Agricultural area and mixed forest
Bach L. 2011. Wiesmoor, Germany.	24.05. to 31.10.2011 (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 *(Pipistrellus nathusii,* 2 *Eptesicus serotinu* s) found. Calculation: probably 2 dead bats/WT/year. Acoustic monitoring: calls of *Nyctalus noctula, Nyctalus leisleri, Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus, Plecotus sp* .	Agricultural area.

Bach L., 2011. Timmeler Kampen near Bagband, Germany.	29.03. to 1.10.2011 (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)	2 dead bats *(Myotis dasycneme, Nyctalus noctula*) found. Calculation: probably 0.4 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.
Brinkmann R. et al., 2011. Germany.	July to September 2007 and 2008	72 WTs in 36 wind parks	Mortality control at 30 WTs, acoustic monitoring at rotor height with AnaBat-SD1 and Batcorder, and thermal imaging. Prediction of bat activity (by wind speed, time and month).	100 dead bats (*Pipistrellus nathusii, Nyctalus noctula, Pipistrellus pipistrellus, Nyctalus leisleri*) found during study period, on average 9.5 dead bats per WT (min 0-max 57,5). Estimation: 12 dead bats per WT per year. Bat activity registered by acoustic monitoring corresponds (mostly) to activity seen in thermal imaging.	5 different habitat types in Germany.
Brinkmann R. & Bontadina F., 2006. Ettenheim Mahlberg, Hochschwarzwald, Holzschlägermatte, and Rohrhardsberg. Freiburg, Germany.	03.08. to 28.10.2004 and 02.04. to 16.10.2005	2004: 16 WTs (+16 WTs sporadically). 2005: the 8 WTs with the highest collision rates in 2004.	Mortality control every 5 days (30-50 min per WT). Search area of 50m radius around the WT (except for areas with dense vegetation). Tests for search efficiency & predation.	More dead bats at WTs in forests than at WTs in pastures. 50 dead bats found during study (39 *Pipistrellus pipistrellus* , 8 *Nyctalus leisleri* , 2 *Vespertilio murinus* , 1 *Eptesicus serotinus*).	Some WTs in forests, some on pastures (alt.: 470-1000m)
Hötker H., 2006.	60 publications (1989-2006)	34 wind parks. Tower: 22m to 114m; rotor ø 14m to 80m	"Meta analysis" of 45 studies from 60 publications (Belgium, Germany, Denmark, France, Netherlands, Great Britain, Austria, Spain, USA, Australia)	Calculated mortality rates per turbine per year: between 0 and 103 (Freiamt Schillinger Berg 1, Germany) bats. Median: 6,4 bats. Mean:13,3; standard deviation: 13,3.	Many different habitats.
Seiche K. et al., 2008. Sachsen, Germany.	15th May to 30th September 2006	145 WTs in 26 wind parks	Mortality control twice per week (morning, 30 min per WT). Search area equal to diameter of the rotor + 25% around the WT (except for areas with dense vegetation). Tests for search efficiency & predation. Acoustic and night vision monitoring at 11 WTs (Pettersson D240x and Laar TDM 07C)	114 dead bats found (59 Nyctalus noctula, 24 Pipistrellus nathusii, 15 Pipistrellus pipistrellus, 4 Vespertilio murinus, 4 Eptesicus serotinus, 3 Pipistrellus pygmaeus, 1Myotis myotis, 1Eptesicus nilsonii, 1 Nyctalus leisleri, 2 not identified; 63 % juvenil and 34% adult). More species found with acoustic monitoring.	Some wind parks in agricultural areas at sea level, some on hills (max. alt. 800m)

Ferri V. et al., 2011. Fucino Valley and the Sirente-Velino Natural Regional Park, Abruzzo, Italy.	15th March to 31st October 2009	46 WTs in 2 wind parks. Cerchio-Collarmele: 21WTs, Vestas V80, tower: 78m, rotor ø 80m and Cocullo: 25WTs, Gamesa 850 kW,)	Mortality control every 3 days. Search area: permanent square plots, 120 m per side and centred on the WT (30-60min per WT).	7 dead bats found (6 *Hypsugo savii* , 1*Pipistrellus pipistrellus*)	Scrubland and hemi-cryptophytic pasture patches characterised by *Brachypodium rupestre* . Cerchio-Collarmele: along the southern slopes of the Sirente Massif, alt. 900-1150m. Cocullo: along a mountain ridge, alt. 1200-1600m.
Zieliński P. et al., 2011., Gnieżdżewo gm. Puck, Poland.	15.03.2011 to 15.11.2011	11 WTs	Mortality control, also with trained hunting dog (high gramineous vegetation under most WTs). Search area: 70m radius. Test for search efficiency of the dog.	6 dead bats found during study (3 *Pipistrellus nathusii* , 1*Eptesicus nilssonii* , 1 *Vespertilio murinus* , 1not identified). 17 dead bats found in the years 2007-2011 (8 *Pipistrellus nathusii* , 2 *Vespertilio murinus* , 1*Eptesicus nilssonii* , 1 *Pipistrellus pipistrellus* , 1*Pipistrellus pipistrellus/pygmaeus* , 1 *Pipistrellus pygmaeus* , 3 not identified)	Agricultural area, close to a town.
Procesl/Bio3 (2010), Alto Minho I (sub-windfarms Picos, Alto do Corisco and Santo António), Portugal	April - October 2009	75WTs (of 2 MW)	Monthly searches around 70% of the WT´s; Search area: 50m around WT; tests for search efficiency & predation	9 dead bats (3Ppipistrellus, 1Pkuhli 1Ppygmaeus, 1Eserotinus, 1Nlasiopterus and 2 Pipistrellus sp.): 2 in July, 3 in august and 4 in september). Mortality rate: 2,89bat/WT/7months (Sto António) 1,45bat/WT/7months (Alto do Corisco) and 1,89 bat/WT/7months (Picos)	mean alt. 1200m; shrubs; pine forest; plantations; grassland
Bio3 (2011a) Cabeço Rainha 2, Portugal	March - October 2009	15 WTs (of 2,0 MW)	Weekly searches around all 15 WT; Search area: 50m around WT; tests for search efficiency & predation	4 dead bats (1Nleisleri, 2Eserotinus;1not identified specie): 3 in August and 1 in September; Mortality rate: 0,14 bat/WT/8 months	mean alt. 1100m; shrubs; pine forest
Bio3 (2012) Cabeço Rainha 2, Portugal	March - October 2010	15 WTs (of 2,0 MW)	Weekly searches around all 15 WT; Search area: 50m around WT; tests for search efficiency & predation	2 dead bats (2 not identified species): 1 in August and 1 in September; Mortality rate: 0,21 bat/WT/8 months	mean alt. 1100m; shrubs; pine forest
Bio3 (2011b) Chão Falcão II, Portugal	Mid February-Mid November 2010	11 WTs (of 2,3 MW)	Weekly searches around all 11 WT; Search area: 50m around WT; tests for search efficiency & predation	5 dead bat (1 Ppipistrellus; 2Pkuhli; 1Eptesicus sp.; 1 not identified specie): 1 in August, 3 in September and 1 in November; Mortality rate: 0,52bat/WT/10 months	mean alt: 410m; shrubs; rock outcrop
Bio3 (2011c) Chão Falcão III, Portugal	April-October 2010	9 WTs (of 2,3 MW)	Weekly searches around all 9 WT made by man and dog; Search area: 50m around WT; tests for search efficiency & predation	5 dead bats (3 Nleisleri; 1 Ppygmaeus; 1 not identified species): 1 in July; 1 in August; 2 in September and 1 in October. Mortality rate: 0,64 bat/WT/7 months	mean alt: 450m; shrubs; eucalypt plantation
Bio3 (2011d) Lousã II, Portugal	September 2009-October 2010	20 WTs (of 2,5 MW)	Weekly searches around all 20 WT (September-October 2009; April-October 2010); Search area: 50m around WT	no mortality	mean alt. 950m;shrubs; grassland; pine plantations; deciduous forest
Bio3 (2011e), Serra de Bornes, Portugal	April-October 2010	24 WT (of 2,5 MW)	Weekly searches around all 24 WT; Search area: 50m around WT; tests for search efficiency & predation	4 dead bats (1Ppipistrellus; 1Pkuhli; 1Pipistrellus sp. and 1 Tteniotis): 1 in April, 1 in August, and 2 in September. Mortality rate: 0,25bat/WT/7 months	mean alt. 1100m; shrubs;rock outcrops; hardwood forest;

Bio3 (2010) Serra do Mú, Portugal	January-December 2009	14 WTs (of 2,0 MW)	Monthly searches (Jan-Feb; Nov-Dec) and Weekly searches (Mar-Oct) around 14 WT; Search area: 50m around WT; tests for search efficiency & predation	5 dead bats (2Pkuhli; 2Nleisleri;1Eptesicus sp): 1 in February; 1 in May; 2 in June and 1 in July. Mortality rate: 0.80 bat/WT/year	mean alt.: 530m; cork oak forest
Bio3 (2011f) Serra do Mú, Portugal	January-December 2010	14 WTs (of 2,0 MW)	Monthly searches (Jan-Feb; Nov-Dec) and Weekly searches (Mar-Oct) around 14 WT; Search area: 50m around WT; tests for search efficiency & predation	no mortality	mean alt.: 530m; cork oak forest
Bio3 (2011g) Terra Fria - Contim, Portugal	August - November 2010	5 WTs (of 2,0 MW)	Weekly searches around all 5 WT; Search area: 50m around WT; tests for search efficiency & predation	no mortality	mean alt.: 1150m; shrubs; grassland; rock outcrop; forest
Bio3 (2011h) Terra Fria -Facho-Colmeia, Portugal	April-November 2010	18 WTs (of 2,0 MW)	Weekly searches around 13 WT; Search area: 50m around WT; tests for search efficiency & predation	10 dead bats (2Ppipistrellus/Ppygmaeus; 4 Ppipistrelus; 4Nleisleri): 2 in June; 2 in August; 6 in September. Mortality rate: 0,94 bat/WT/8 months	mean alt.: 1200m; shrubs; grassland; forest
Bio3 (2011i) Terra Fria - Montalegre, Portugal	April-November 2010	25 WTs (of 2,0 MW)	Weekly searches around 19 WT; Search area: 50m around WT; tests for search efficiency & predation	13 dead bats (1 Ppipistrellus; 1Pkuhli; 4 not identified species, 5Nleisleri; 1 Hsavii; 1 Eserotinus): 1 in April; 1 in May; 1 in June; 4 in August; 5 in September and 1 in October. Mortality rate in 2010: 0,92 bat/MW/8 months	mean alt.: 1100m; shrubs; grassland; forest; rock outcrop

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