

17th Meeting of the Advisory Committee

Dublin, Ireland, 15 – 17 May 2012

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 Mičevski
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 Mičevski 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
<i>Nyctalus noctula</i>	3			3	567	1		12	10				1		1		598
<i>Nyctalus lasiopterus</i>						21		3	1				5				30
<i>Nyctalus leisleri</i>		1		1	73	15		30	58				152				330
<i>Nyctalus spec.</i>						2							16				18
<i>Eptesicus serotinus</i>				7	36	2		12	1		1						59
<i>Eptesicus isabellinus</i>						117							1				118
<i>E. serotinus / isabellinus</i>						11							13				24
<i>Eptesicus nilssonii</i>					2		2					1		1	8		14
<i>Vespertilio murinus</i>				2	62				1					2	1		68
<i>Myotis myotis</i>					2	2		1									5
<i>M. blythii</i>						4											4
<i>M. dasycneme</i>					2												2
<i>M. daubentonii</i>					4								2				6
<i>M. bechsteini</i>								1									1
<i>M. emarginatus</i>						1		1									2
<i>M. brandtii</i>					1												1
<i>M. mystacinus</i>					2				1								3
<i>Myotis spec.</i>						3											3
<i>Pipistrellus pipistrellus</i>				3	311	73		220		1	15		200	1	1		825
<i>P. nathusii</i>	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
<i>P. pygmaeus</i>					40			67					24	1	1	1	134
<i>P. pipistrellus /pygmaeus</i>		1				483		22	54				28	1			589
<i>P. kuhlii</i>			4			44		77					26				151
<i>P.pipistrellus / kuhlii</i>													16				16
<i>Pipistrellus spec.</i>				2	20	20		69					67			3	181
<i>Hypsugo savii</i>			3		1	44		28	26	8			35				145
<i>Barbastella barbastellus</i>						1		2									3
<i>Plecotus austriacus</i>	1				6												7
<i>Plecotus auritus</i>					4												4
<i>Tadarida teniotis</i>						23		1					11				35
<i>Miniopterus schreibersi</i>						2		3					1				6
<i>Rhinolophus ferrumequinum</i>						1											1
<i>Rhinolophus mehelyi</i>						1											1
<i>Chiroptera spec.</i>					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 n° 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,*

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- 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 Betriebsalgorithmen 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.
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- Governo de Portugal (2011) *Decisão de Incidências Ambientais do Parque Eólico do Alto dos Fominhos*.
- 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.
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- 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 Facility 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 Betriebsalgorithmen für Windenergieanlagen. In: Brinkmann, R., Behr, O., Niermann, I. & Reich, M. (ed.): *Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von*

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- 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>.
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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.

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
<i>Nyctalus noctula</i>	26	10 to a few hundred meters	1, 7, 30, 65	Yes, no
<i>Nyctalus leisleri</i>	17	above canopy, >25m, >40-50m (foraging & direct flight)	5, 6, 30, 32, 42, 45, 64,65, 68	Yes, no
<i>Nyctalus lasiopterus</i>	90	1300m (telescope & radar)	2, 3, 4, 30	Yes
<i>Pipistrellus nathusii</i>	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
<i>Pipistrellus pygmaeus</i>	1,7 (mean radius)	up to the rotor, occasionally >25m, >40-50m in direct flight	20, 30, 64, 65, 68	Yes, no
<i>Pipistrellus pipistrellus</i>	5,1	up to the rotor, >25m, >40-50m in direct flight	21, 61, 65, 68	No; chemiluminescent tags, no
<i>Pipistrellus kuhlii</i>	no information	1-10; up to a few hundreds, >25m	30, 64, 65	Yes, no
<i>Hypsugo savii</i>	?	>100	33, 37, 64, 65	No, no
<i>Eptesicus serotinus</i>	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
<i>Eptesicus isabellinus</i>	?	?	?	?

<i>Eptesicus nilssonii</i>	30	> 50 (foraging & direct flight)	51, 52, 64, 65, 68	Yes, no
<i>Vespertilio murinus</i>	6,2 ♀; 20,5 ♂	20-40, above canopy (foraging) & >40-50m (direct flight)	48, 49, 64, 65, 68	Yes, no
<i>Myotis myotis</i>	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
<i>Myotis blythii</i>	26	1-15	22, 23, 24, 25, 26, 30	Yes
<i>Myotis punicus</i>	15	< 2m (foraging), probably 100m commuting from ridge to ridge	69, 70	Yes
<i>Myotis emarginatus</i>	12,5	no information	17, 18, 30, 33, 36, 38, 39	Yes
<i>Myotis bechsteinii</i>	2,5	1-5 and in the canopy, sometimes above canopy (direct flight)	12, 30, 31, 38, 39, 68	Yes, no
<i>Myotis dasycneme</i>	34	2-5 (up to the rotor)	53, 63, 66	Yes
<i>Myotis daubentonii</i>	10 ♀; >15 ♂	1-5, forages up to canopy & sometimes above in direct flight	57, 58, 68	Yes
<i>Myotis brandtii</i>	10	up to the canopy (foraging) & sometimes above in direct flight	49, 54, 55, 68	?
<i>Myotis mystacinus</i>	2,8	up to 15m in the canopy, up to canopy (foraging) & sometimes above in direct flight	55, 56, 68	Yes, no
<i>Plecotus auritus</i>	2,2-3,3	up to the canopy and above (foraging and direct flight)	59, 68	Yes, no
<i>Plecotus austriacus</i>	regularly up to 7 km	exceptionally >25m, up to the canopy and above (foraging and direct flight)	60, 64, 67, 68	Yes, no
<i>Barbastella barbastellus</i>	10	above canopy, >25m, canopy and above (foraging and direct flight)	11, 12, 30, 34, 35, 64, 68	Yes, no
<i>Miniopterus schreibersii</i>	40	2-5 (foraging) and open sky (transit), >25m	8, 30, 41, 40, 64	Yes, no
<i>Tadarida teniotis</i>	>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				Underwood			
Intensity levels of calls	Species	Distance of detection (m)	Detectability coefficient	Intensity levels of calls	Species	Distance of detection (m)	Detectability coefficient
Low	<i>R. hipposideros</i>	5	5.00	Low	<i>R. hipposideros</i>	5	5.00
	<i>R. ferr./eur./meh.</i>	10	2.50		<i>Plecotus spp.</i>	5	5.00
	<i>M. emarginatus</i>	10	2.50		<i>M. emarginatus</i>	8	3.10
	<i>M. alcaethoe</i>	10	2.50		<i>M. nattereri</i>	8	3.10
	<i>M. mystacinus</i>	10	2.50		<i>R. ferr./eur./meh.</i>	10	2.50
	<i>M. brandtii</i>	10	2.50		<i>M. alcaethoe</i>	10	2.50
	<i>M. daubentonii</i>	15	1.70		<i>M. mystacinus</i>	10	2.50
	<i>M. nattereri</i>	15	1.70		<i>M. brandtii</i>	10	2.50
	<i>M. bechsteinii</i>	15	1.70		<i>M. daubentonii</i>	10	2.50
	<i>B. barbastellus</i>	15	1.70		<i>M. bechsteinii</i>	10	2.50
Medium	<i>M. oxygnathus</i>	20	1.20	<i>B. barbastellus</i>	15	1.70	
	<i>M. myotis</i>	20	1.20	<i>M. oxygnathus</i>	15	1.70	
	<i>P. pygmaeus</i>	25	1.00	<i>M. myotis</i>	15	1.70	
	<i>P. pipistrellus</i>	30	0.83	Medium	<i>P. pygmaeus</i>	20	1.20
	<i>P. kuhlii</i>	30	0.83		<i>M. schreibersii</i>	20	1.20
	<i>P. nathusii</i>	30	0.83		<i>P. pipistrellus</i>	25	1.00

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

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 behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Arnett, B.E. 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., 2011. The effectiveness of search dogs compared with human in searching difficult terrain at turbine sites for bat fatalities. Conference on Wind energy and Wildlife impacts, 2-5 May 2011, Trondheim, Norway, NINA Report 693, presentation abstract p. 40.

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

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

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).