9th Meeting of the Standing Committee
19th Meeting of the Advisory Committee

Heraklion, Greece, 7 – 10 April 2014

Report of the Intersessional Working Group 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 table on monitoring studies done in Europe	Anna Nele Herdina (c) Marie-Jo Dubourg-Savage Laurent Biraschi Christine Harbusch
Mitigation and compensation measures	Luisa Rodrigues (c) Lothar Bach 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
Impact of mortality rate on populations	Christian Voigt (c) Lothar Bach Luisa Rodrigues Christine Harbusch
Deterrents	Lothar Bach (c) Luisa Rodrigues Dino Scaravelli
Maximum foraging distances of species and Detectability coefficients to compare activity indices	Marie-Jo Dubourg-Savage (c) Eeva-Maria Kyheröinen
Collect national guidelines (including information on feathering/stopping WTs)	Andrzej Kepel (c) Branko Mićevski
Use of dogs *vs* humans during carcass searches	Dina Kovač (c) Jan Collins

Comparing measurement of activity at ground level and rotor height	Lothar Bach (c) Marie-Jo Dubourg-Savage Jan Collins
Small Wind Turbines	Kirsty Park (c) Lothar Bach Jan Collins
Offshore windfarms	Lothar Bach (c)
Update of guidelines	Marie-Jo Dubourg-Savage Luisa Rodrigues Lothar Bach Andrzej Kepel Branko Mićevski Christine Harbusch Kirsty Park Jeroen Minderman Branko Karapandža Jasja Dekker Jan Collins Thierry Kervyn Dina Kovač Petra Bach Katherine Walsh / Jean Matthews (review)

The IWG thanks Petra Bach for her help in the preparation of the text on “Estimation of mortality rate taking into consideration predation, efficiency and controlled area; choice of best estimator for Europe”, and Joana Bernardino and Rita Bastos for their comments on the same subject.

Results

Results are presented by sub-group.

Update/reorganizing of the list of references

Annex 1 includes new references and is an addendum to the list of references which had been presented in AC18 (*Doc.EUROBATS.AC18.6*).

Compilation of data on bat mortality per country

The following table updates the data per species and per country regarding bat fatalities found both accidentally and during post-construction monitoring studies from 2003 to the end of December 2013. It reflects by no means the real extent of bat mortality at wind turbines as it is based only on reported fatalities.

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

Reported bat fatalities in Europe (2003-2013) - State 27/03/2014

Species	AT	BE	CH	CR	CZ	DE	ES	EE	FI	FR	GR	IT	LV	NL	NO	PT	PL	SE	UK	Total
Nyctalus noctula	24				3	716	1			12	10					1	5	1		**773**
Nyctalus lasiopterus							21			6	1					8				**36**
N. leisleri			1		1	108	15			39	58	2				206				**430**
Nyctalus spec.							2									16				**18**
Eptesicus serotinus					7	43	2			14	1			1		0	3			**71**
E. isabellinus							117									1				**118**

E. serotinus / isabellinus							11									16				**27**
E. nilssonii						3		2	6				13		1		1	8		**34**
Vespertilio murinus				5	2	89				6	1		1				3	1		**108**
Myotis myotis						2	2			2										**6**
M. blythii							4													**4**
M. dasycneme						3														**3**
M. daubentonii						5										2				**7**
M. bechsteinii										1										**1**
M. emarginatus							1			1										**2**
M. brandtii						1														**1**
M. mystacinus						2					2									**4**
Myotis spec.						1	3													**4**
Pipistrellus pipistrellus		5			3	431	73			278		1		14		243	1	1		**1050**
P. nathusii	2				2	565				87	34	2	23	7			12	5		**739**
P. pygmaeus						46				121			1			31	1	1	1	**202**
P. pipistrellus / pygmaeus			1				483			24	54					35	1			**598**
P. kuhlii				51			44			81						37				**213**
P.pipistrellus / kuhlii																19				**19**
Pipistrellus spec.				13	2	36	20			85	2		2			85			3	**248**
Hypsugo savii				24		1	44			30	28	10				43				**180**
Barbastella barbastellus						1	1			2										**4**
Plecotus austriacus	1					6														**7**
Plecotus auritus						5														**5**
Tadarida teniotis							23			1						22				**46**
Miniopterus schreibersii							2			4						3				**9**
Rhinolophus ferrumequinum							1													**1**
Rhinolophus mehelyi							1													**1**
Chiroptera spec.		1		46		46	320	1		189	8	1				102	2	30	7	**753**
Total	**27**	**6**	**2**	**139**	**20**	**2110**	**1191**	**3**	**6**	**983**	**199**	**16**	**40**	**22**	**1**	**870**	**29**	**47**	**11**	**5722**

Updating of tables on monitoring studies done in Europe

Annex 2 contains new data of studies done in Europe; this table is an addendum to Table 1 of *EUROBATS Publication Series nº 3,* Annex 3 of *Doc.EUROBATS.AC14.9.Rev1,* Annex 3 of *Doc.EUROBATS.StC4-AC15.22.Rev.1,* Annex 2 of *Doc.EUROBATS.AC17.6* and Annex 2 of *Doc.EUROBATS.AC18.6).*

Mitigation and compensation measures

Current knowledge continues to suggest two measures for reducing the mortality of bats: change of the cut-in speed to higher wind speed values and the use of blade feathering position during low wind speeds (preventing turbines from freewheeling or only spin at very low rpms, generally less than 1 rpm).

Arnett *et al*. (2013) synthesized information from 10 operational mitigation studies in North America, concluding that increasing cut-in speed between 1.5 and 3.0 m/s or feathering blades and slowing rotor speed up to the turbine manufacturer's cut-in speed yields substantial reductions in fatality of bats:

- most studies found at least a 50% reduction in fatalities when turbine cut-in speed was increased by 1.5 m/s above the manufacturer's cut-in speed

- reduction in fatalities reported by one study that implemented a raised cut-in speed for temperatures above 9.5°C
- reduction in fatalities reported by one study that implemented a low-speed idling approach
- up to 72% fewer bats killed reported by one study that implemented feathering turbine blades (pitched 90º and parallel to the wind) at or below the manufacturer's cut-in speed.

Several examples of implementation of increase of cut-in speed, established in Canada, France, Germany, Poland and Portugal were referred in the reports presented to 17th and 18th Meetings of the Advisory Committee (*Doc.EUROBATS.AC17.6* and *Doc.EUROBATS.AC18.6*). In Belgium, the Walloon government recently regulated wind turbines development. This decision also includes a mitigation scheme : between the 1st of April and the 30th of October when air temperature is higher than 8° Celsius (or 10°C in lowlands) and it doesn't rain, blades are stopped under wind speed less than 6m/s (measured at nacelle height) between sunset and dawn; between the 1st of August and the 15th of October, during autumn migration, the thresholds are adapted to wind speed lower than 7m/s (measured at nacelle height) and air temperature higher than 5° Celsius (or 8° C in lowlands). Electricity production is theoretically reduced of only 2 %. (Thierry Kervyn, com. pers.).

The IWG recommends that countries start implementing the increase of cut-in speed and blade feathering. This should be implemented on a site-specific basis according to the groups of species that occur in the area.

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

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

New approaches have been made to improve the effectiveness of fatality estimators. In the USA, Péron *et al*. (2013) used superpopulation capture-and-recapture models (used for population sizes). This approach integrates time and age variation in the parameters and accounts for possible extended carcass persistence with influence in the detection process between search intervals. Bastos *et al*. (2013) also achieved these attributes by producing stochastic dynamic simulations, which consider the non-constancy and inter-dependency of the commonly used parameters, such as search efficiency and carcass persistence, for bias-corrected estimates. Bastos *et al*. (2013) framework can provide algorithms capable of estimating potential real mortality even in the absence of detected carcasses. These approaches have in common that they deal with variation in study designs and environment.

The model of Körner-Nievergelt *et al*. (2013) also allows estimation of fatalities on the basis of extrapolation of sampled data (for example for nights within the search interval). In difference to other approaches, Körner-Nievergelt *et al*. (2013) developed a model that allows skipping the carcass search process, calculating real fatalities only on the basis of wind speed and bat activity. In this context, the study design has to be the same as the study design proposed by Körner-Nievergelt *et al*. (2013) in terms of turbine type, rotor diameter, species composition, activity patterns, wind conditions, bat detector types, recording sensitivity and geographical region.

Bastos R., M. Santos & J.A. Cabral. 2013. A new stochastic dynamic tool to improve the accuracy of mortality estimates for bats killed at wind farms. *Ecological Indicators*, 34:428–440.

Körner-Nievergelt F., R. Brinkmann, I. Niermann I & O. Behr. 2013. Estimating Bat and Bird Mortality Occurring at Wind Energy Turbines from Covariates and Carcass Searches Using Mixture Models. *PLoS ONE*, 8(7):e67997. doi:10.1371/journal.pone.0067997.

Péron G., J.E. Hines, J.D. Nichols, W.L. Kendall, K.A. Peters & D.S. Mizrahi. 2013. Estimation of bird and bat mortality at wind-power farms with superpopulation models. *Journal of Applied Ecology*, 50(4):902-911.

Impact of mortality rate on populations

A likely negative of wind turbine-related fatalities on bat population is often discussed among stake holders of the wildlife *vs* wind energy conflict in Europe. Indeed, the question whether or not wind-turbine related fatalities affect populations seems to be a double-edged sword. On the one hand, this question is of pivotal concern for European conservationists, yet on the other hand population effects are not at the centre of the E.U. legislation according to the habitat directive. A lack of evidence could even be considered as an argument for reducing efforts in implementing mitigation measures.

Currently, there is not a single scientific study that demonstrates an effect of wind turbines on bat populations. This lack of evidence does not necessarily mean that there is not such an effect, but may highlight that such an effect is difficult to proof. In theory, bat populations are particularly susceptible to increased mortality rates, given the low fecundity of bat species and thus recruitment of juveniles in populations (Jones *et al*. 2003). Therefore, even minor increases in mortality risks might have large-scale effects on bat populations. The major difficulty in any demographic study seems to be the lack of required baseline data, e.g. of population sizes, recruitment and dispersal rates in the absence and presence of wind turbines. Even when such demographic parameters have been established for local bat populations over many years, it is difficult to distinguish between effects caused by wind turbines and those triggered by other confounding factors, such as changes in the management of local habitats, losses of daytime roosts, annual climatic fluctuations (e.g. increased winter mortality caused by a sequence of harsh winters), global climate changes among others.

Recently, Giavi *et al*. (2014) suggested that mortality rates of migratory bat species, such as Leisler's bats, are low during migration. These findings were obtained from a capture-recapture study at a stop-over site and were not put in context to likely increased fatality rates of *N. leisleri* at wind turbines, and not in context to population effects. The largest obstacle in the study of population effects is the lack of information about the location of corresponding source populations. Voigt *et al*. (2012) pointed out that wind turbines in Central Europe may have large catchment areas. Information about the connectivity between breeding habitats, stopover and hibernation sites is largely sketchy and mostly limited to the mark-recapture efforts as reviewed by Steffens *et al*. (2004) and Hutterer *et al*. (2005). On a local scale, Roscini *et al*. (2013) combined species distribution models for two species, *Pipistrellus pipistrellus* and *Nyctalus leisleri*, with the spatial distribution of wind turbines in an area of central Italy (Molise region) which is undergoing intense wind farm development. These risk maps helped in identifying vulnerable areas where wind farm construction would be particularly risky for populations of the two species. Yet, this study did not validate if connectivity of wind turbines and local bat populations was effective according to their model, i.e. possibly killed *N. leisleri* could as well come from distant and not from local populations. Santos *et al*. (2013) combined species distribution modelling with mortality data of *Hypsugo savii, Nyctalus leisleri, Pipistrellus kuhlii* and *Pipistrellus pipistrellus* and the ecological conditions at wind farms located in Portugal, and generated predictive models to determine areas of probable mortality and which environmental factors were promoting it. Wind farms sited at humid areas with mild temperatures, closer than 5 km to forested areas and within 600 m of steep slopes showed higher probabilities of mortality. High mortality risk areas also overlapped highly with the potential distribution of *N. leisleri* in Portugal, suggesting that populations of this species may be at high risk due to wind farm fatalities. Moreover, a large extent of the area predicted to be a hotspot for mortality (i.e. areas likely to confer high mortality risk for four species) overlaps with sites highly suitable for wind farm construction. Hedenström & Rydell (2013) showed in another model, based on simple assumptions that the planned increase of wind turbines in Sweden will have a negative effect on Swedish populations of *Nyctalus noctula*, even when the current number of wind turbines remain constant, if no mitigation measures are taken. A study by Voigt *et al*. (2014) on the connectivity between Scandinavian breeding sites of noctule bats (*Nyctalus noctula*) and hibernacula in Germany underpins the difficulty in linking bat fatalities with source populations, i.e. Scandinavian populations of noctule bats may suffer also from the promotion of wind turbine facilities in Germany.

The IWG believes that in the near future the best approach would be the development of studies at regional or local (particularly important for rare species) levels, e.g. the promotion of wind turbine facilities in forested areas may affect in particular non-migratory bat species, e.g. those of the genus *Myotis*, so that population effects may be easier to detect. Any new project should consider the connectivity between wind turbine sites and breeding sites. Also, it is important to consider the cumulative impact of all wind farms in the home range of a population. In case of projects located near national borders, the potential trans-boundary effect should also be considered.

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

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

Hutterer R., T. Ivanova, C. Meyer-Cordes & L. Rodrigues. 2005. Bat migrations in Europe – a review of banding data and literature. *Natursch. Biol. Vielf*., 28.

Jones K.E., A. Purvis & J.L. Gittleman. 2003. Biological correlates of extinction risk in bats. *Am. Natural.*, 161:601–614.

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

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

Steffens R., U. Zöphel & D. Brockmann. 2004. *40th Anniversary Bat Marking Centre Dresden*. Landesamt für Umwelt, Landwirtschaft und Geologie.

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

Voigt C.C., L.S. Lehnert, A.G. Popa-Lisseanu, M. Ciechanowski, P. Estok, F. Gloza-Rausch, T. Görföl, M. Göttsche, C. Harrje, M. Hötzel, T. Teige, R. Wohlgemuth & S. Kramer-Schadt. 2014. The trans-boundary importance of artificial bat hibernacula in managed European forests. *Biodiversity and Conservation*, Doi 10.1007/s10531-014-0620-y.

Deterrents

Acoustic deterrents, as a method to reduce bat fatalities at wind farms, have not yet been proven to be effective for keeping bats away from the risk zone around wind turbine blades (Arnett *et al.* 2013). Besides that, Amorim *et al.* (2012) highlighted hat there is a lack of knowledge about the effect of acoustic deterrents on other wildlife, such as birds and insects. Therefore, although research of deterrents might have potential, those still cannot be considered to mitigate effectively bat fatalities.

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

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

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

The tables included in *Doc.EUROBATS.AC17.6* will be included in the update of the guidelines.

Collect national guidelines

Some new guidelines were published (Zoogdiervereniging & Bureau Waardenburg – Netherland, SECEMU – Spain, regional guidelines for Saarland in Germany). In Germany some regional guidelines changed internet addresses. UK interim guidance for onshore wind was updated.

In Italy and Switzerland national guidelines are under preparation and may be published in 2014.

Parties	EUROBATS guidelines officially recommended	National guidelines exists		
		unofficial	officially recommended	copy provided to IWG WT
Albania	no	no	no	
Belgium	yes (in Wallonie)	no	no	
Bulgaria	no	**YES**	no	**YES** http://www.nmnhs.com/downloads/brcc/bats-en.pdf
Croatia	no		**YES**	**YES** http://www.zastita-prirode.hr/content/download/393/2127/file/Smjernice%20za%20izradu%20studije%20utjecaja%20na%20okoliš%20za%20vjetroelektrane%20-%20šišmiši.pdf
Czech Republic	**YES** (with some local adaptations)	no	no	no (for adaptations)
Denmark	no	no	no	
Estonia	no	no	no	
Finland	**YES**	no	no	(Only general guidance concerning windfarms and planning procedures, section on bats very short, EUROBATS guidelines mentioned) www.tuulivoimaopas.fi/files/38/Tuulivoimarakentamisen_suunnittelu.pdf
France	**YES**	**YES**	**YES**	**YES** **SFEPM presurvey (2010):** http://www.sfepm.org/pdf/chiroptere_document_cadrage_version_finale_signee.pdf **Survey (2012):** http://www.sfepm.org/pdf/Diag-SFEPM-eolien_vFinale.pdf **Monitoring (2013):** http://www.sfepm.org/pdf/SFEPM_suivi_FINAL_08032013.pdf **Official general guidelines (2010) at:** http://www.developpement-durable.gouv.fr/IMG/pdf/guide_eolien_15072010_complet.pdf
Georgia	no	no	no	
Germany	no	**YES** (for several federal states or companies)	no	**YES** **Bayern:** https://www.verkuendung-bayern.de/files/allmbl/2012/01/anhang/2129.1-UG-448-A001_PDFA.pdf **Baden-Württemberg:** https://mvi.baden-wuerttemberg.de/fileadmin/redaktion/m-mvi/intern/dateien/PDF/Windenergieerlass_120509.pdf **Hessen:** http://www.energieland.hessen.de/mm/WKA-Leitfaden.pdf **Nordrhein-Westfalen:** https://www.umwelt.nrw.de/naturschutz/pdf/13_11_12_nrw_leitfaden_arten_habitatschutz.pdf **Saarland:** http://www.saarland.de/dokumente/thema_naturschutz/Leitfaden_Artenschutz_Windenergie_Schlussfassung_19Juni2013.pdf **Schleswig-Holstein:** http://www.umweltdaten.landsh.de/nuis/upool/gesamt/windenergie/windenergie.pdf **Other:** 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.egeeulen.de/files/nlt-rs_170_2014_anlage_01_arbeitshilfe_entwurf.pdf
Hungary	no	no	no	
Ireland	no	**YES**	no	**YES** http://www.batconservationireland.org/pubs/reports/BCIreland%20Wind%20Farm%20Turbine%20Survey%20Guidelines%20Version%202%208.pdf (ver. 2012)
Italy	no	no	no	
Latvia	no	no	no	
Lithuania	**YES**		YES	no
Luxembourg	no	no	no	
Macedonia, FYR	no	no	no	
Malta	no	no	no	
Moldova	no	no	no	
Monaco	no	no	no	
Montenegro	no	no	no	
Netherlands	no	**YES**	no	**YES** http://www.rvo.nl/sites/default/files/2014/02/Protocollen%20vleermuisonderzoek%20bij%20windturbines.pdf
Norway	no	no	no	
Poland	no	**YES**	no	**YES** www.salamandra.org.pl/DO_POBRANIA/Nietoperze/Guidelines_Poland.doc (EN translation of version 2009.2) http://www.ekoefekt.pl/dokumenty/dokument_29.pdf (PL text of the

				project of new guideline – ver. 2011 – still not officially accepted, but commonly used)
Portugal			**YES**	**YES** http://www.icnf.pt/portal/naturaclas/patrinatur/resource/docs/Mam/morc/morc-recom-p-eolic
Romania	no	**YES**	no	**YES** http://www.aplr.ro/index.php?lang=ro&cat=9&page=2
San Marino	no	no	no	
Slovak Republic	no	no	no	
Slovenia	no	no	no	
Sweden	no	no	no	
Ukraine	no	no	no	
United Kingdom		**YES**	**YES** (in certain circumstances the "stand-off" distance recommended in the EUROBATS Guidelines is used instead of the national guidelines)	**YES** **Onshore wind turbines:** http://publications.naturalengland.org.uk/file/6122941666295808 **Single large turbines:** http://publications.naturalengland.org.uk/file/96013 **BCT – surveying:** http://www.bats.org.uk/data/files/Surveying_for_onshore_wind_farms_BCT_Bat_Surveys_Good_Practice_Guidelines_2nd_Ed.pdf **Single Wind Turbines and bats - Cornwall Council:** http://www.cornwall.gov.uk/idoc.ashx?docid=66ca8fc5-609a-4fae-b4da-e76ccd5c5af9&version=-1
Range states				
Algeria	no	no	no	
Andorra	no	no	no	
Armenia	no	no	no	
Austria	no	no	no	
Azerbaijan	no	no	no	
Belarus	no	no	no	
Bosnia and Herzegovina	no	no	no	
Cyprus	no	no	no	
Egypt	no	no	no	
Greece	no	no	no	
Holy See	no	no	no	
Iran	no	no	no	
Iraq	no	no	no	
Israel	no	**YES** (Israel Nature and Parks Authority)	no	no
Jordan	no	no	no	
Kazakhstan	no	no	no	
Kuwait	no	no	no	
Lebanon	no	no	no	
Libya	no	no	no	
Liechtenstein	no	no	no	
Morocco	no	no	no	
Palestinian Authority Territories	no	no	no	
Russian Federation	no	no	no	
Saudi Arabia	no	no	no	
Serbia			**YES** (chapter about wind farms in national EIA guidelines for bats)	**YES** http://www.nhmbeo.rs/upload/images/ove_godine/Promocije2011/bats_and_environmental_impact_assessment_web_lq.pdf
Spain	no	**Yes**	no	**YES** http://www.secemu.org/media/uploads/barbastella_6_num_esp_2013_red.pdf
Switzerland	no	no	no	
Syrian Arab Republic	no	no	no	
Tunisia	no	no	no	
Turkey	no	no	no	

Use of dogs vs humans during carcass searches

Trained search dogs are proved to be more accurate and effective in searching for bat carcasses under wind turbines in comparison to human observers (Arnett *et al*. 2005, Arnett 2006, Paulding *et al*. 2011, Paula *et al*. 2011, Mathews *et al*. 2013). These differences are caused by the differences between the human vision and dog olfactory sense, which can be used in larger area and in higher and denser vegetation (Arnett *et al*. 2005). In a recent study (Mathews *et al*. 2013) a trial was conducted comparing the abilities of search dogs and human observers, where dogs located 73% (46/63) of bats, whereas humans found 20% (12/60). The dogs averaged 40 min to complete a survey, which was <25% of the time taken by humans. Still, carcass decomposition condition and weather conditions such as wind and temperature can play important roles in scenting conditions and affect the search accuracy and efficiency of the working dog (Paula *et al*. 2011). Also there is a caution when conclusions are being made due to possible bad selections and trainings of the dogs as well as handlers (dog-handler teams). To produce consistent results, bat workers are urged to make assessments of the accuracy and efficiency of the dog–handler team at each wind farm location (Mathews *et al*. 2013).

Compilation of data regarding the involvement of dogs in bat mortality monitoring projects was made based on questionnaires filled out by EUROBATS Focal Points. Search dogs have still not been used in most countries in Europe. They are used more often in bat fatality projects in Portugal, UK, Spain and Germany, as well as in some projects in Denmark, Czech Republic and Bulgaria.

In Mainland Portugal, three companies are already using dogs in carcass searches (Bio3, ECOSATIVA and Strix). Between 2007 and 2009 four dogs were trained under a protocol established between ECOSATIVA and the Drugs Detection Speciality of Republican National Guard (GNR). Nowadays this methodology is used as a standard on all bat and bird monitoring projects conducted by ECOSATIVA. At Bio3, dog-handler teams are trained to search and detect bird and bat carcasses in wind farms and power lines by the Canine Special Unit of the Portuguese Police (UEP-PSP). The cooperation protocol between Bio3 and UEP-PSP includes 3 months of intensive dog and handler training, UEP-PSP certification of handlers as wildlife detection dog trainers, weekly training and periodic, science-based assessments to test the capabilities and performance of dogs.

In UK a research project has been undertaken by University of Exeter contracted to Defra (Department for Environment, Food and Rural Affairs) and has included an evaluation of the bat carcass survey methodology. A report has been produced showing the effectiveness of the methodology and a standard protocol will be published when the research project is completed later in 2014. Also, a special company (Wagtail UK Ltd, Conservation dogs) trains wildlife detection dogs, including for bat carcass searching in wind farm monitoring projects. As of yet they have not been used with bat carcass detection dogs on a full project, but are used for explosive search dog worldwide and body detection dogs also for the UK Border Force.

In Spain, dogs are mainly used to look for illegal poisoned baits, but in the last 1-2 years, several companies have started to look for bat carcasses with dogs.

In Bulgaria a dog is used in only one post-construction monitoring project, which will end later this year (2012-2014).

In Croatia the use of dogs has also been recorded but informally and there is still no reported data on the use of this methodology.

In Denmark bat fatalities were occasionally recorded at one commercial wind turbine site by an untrained dog along with human observers. In the ongoing project trained tracker dogs are used to search for bat carcasses. These dogs have been trained and licensed to track larger game species crippled during hunting or wounded in road traffic accidents (Schweiss-dogs). Prior to bat fatality searches the dogs were trained briefly to recognize bat carcasses. The dogs search efficiency is assessed with 'control bat carcasses' in the surveyed habitats to correct the recorded fatality numbers when estimating total fatalities. In Poland one dog was privately trained for that purpose, but never used in any project.

The possibility of using search dogs for bat mortality monitoring projects isn't mentioned in most national guidelines, except in guidelines made by Portugal, Spain and Italy (in preparation) in which it is suggested as an improved but not obligatory method. In UK the national guidelines on survey, monitoring and mitigation (NE TIN 051) are interim pending on the results of the Defra research. It will include a standard protocol for the use of dogs in carcass searches prepared by UK researcher Fiona Mathews with the assistance of a search dog trainer who works for the UK and Irish police services. However, it has not been adopted by any formal licensing authority. The use of search dogs is also not mentioned in guidelines for bat fatality monitoring of other development projects (roads, railroads etc.) or by any legislation. In Croatia, recommendation to use dogs in bat carcass searches is mentioned in some EIA permits.

In most countries in Europe where this method is being used, dogs are trained for this purpose by individuals. Only in Portugal an organized training for dogs and handlers is used, although it is primarily specialized for other search dogs. An official licensing system for dog, handler or a dog-handler team to search for bat carcasses in bat fatality monitoring projects still isn't known for any country in Europe.

The following table includes the data per country (parties and *non-party range states) regarding the use of dogs in bat carcass searches up to February 2014.

Country	Use of dogs in bat carcass searches	Mentioning of this method in National guidelines for bat fatality monitoring projects on wind farms	Organized training specialized for bat carcass searches	Official license for trained dog, handler or dog-handler team for bat carcass search	Comment
Albania	No	No national guidelines	No	No	No wind farms
Belarus *	No	No national guidelines	No	No	-
Belgium	No	No national/regional guidelines	No	No	-
Bulgaria	Informally in 1 current project	No national guidelines	No	No	-
Czech Republic	Informally in some projects	No national guidelines	No, individuals train dog for this purposes without organized and licensed training	No	-
Croatia	Informally in some projects	Not mentioned, only in some eia permits.	No, individuals train dog for this purposes without organized and licensed training	No	-
Denmark	Informally in some projects	No national guidelines	Yes, but it is primarily specialized for other search dogs and it is not officially licensed in training for bat carcass searches - used for one project	No	-
Finland	No	No national guidelines	No	No	-
France	No	Not mentionned in the SFEPM monitoring guidelines nor in the 2010 National guidelines	No	No	In project for the next action plan
Georgia	No	No national guidelines	No	No	-
Germany	In some bat fatality projects	No national gudielines / not mentioned in federal guidelines	No, individuals train dog for this purposes without organized and licensed training	No	-
Greece	No	No national guidelines	No	No	
Hungary	No	No national guidelines	No	No	-
Ireland	No	Not mentioned	No	No	-
Italy	No	Suggested as an improved method but it is not obligatory (in preparation)	No	No	-
Latvia	No	Not mentioned	No	No	-
Lebanon*	No	No national guidelines	No	No	-
Lichtenstein*	No	No national guidelines	No	No	No wind farms
Macedonia	No	No national guidelines	No	No	Currently no operating wind farms
Malta	No	No national guidelines	No	No	-
Netherland	No	No national guidelines	No	No	-
Norway	No	No national guidelines	No	No	

Poland	No	Not mentioned	No, individuals train dog for this purposes without organized and licensed training	No	One dog was privately trained, but never used
Mainland Portugal	In some bat fatality projects (a few companies as a standard method)	Suggested as an improved method but it is not obligatory	Yes, but it is primarily specialized for other search dogs and it is not officially licensed in training for bat carcass searches	No	
Portugal - Autonomous Region of Azores	No	No regional guidelines	No	No	
Portugal - Autonomous Region of Madeira	No	No regional guidelines	No	No	-
Republic of Moldova	No	No national guidelines	No	No	-
Romania	No	No national guidelines	No	No	-
Serbia*	No	Not mentioned, only guidelines for bat concernig eia on wind farms	No	No	No operating wind farms
Slovak Republic	No	No national guidelines	No	No	-
Slovenia	No	No national guidelines	No	No	Only 1 operating wind farm
Spain*	In some bat fatality projects (several companies)	Suggested as an improved method but it is not obligatory	No, individuals train dog for this purposes without organized and licensed training	No	
Sweden	No	No national guidelines	No, individuals train dog for this purposes without organized and licensed training	No	
Switzerland	No	Not mentioned (in preparation)	No	No	
UK	Informally in some projects	Suggested as an improved method with a standard protocol for the use of dogs in carcass searches (in preparation)	No, individuals train dog for this purposes without organized and licensed training	No	
Ukraine	No	No national guidelines	No	No	-

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

Comparing measurement of activity at ground level and rotor height

In a new paper Müller *et al*. (2013) stated that *Pipistrellus* species do not forage only in clearings but also above the canopy of mature forests and so this might increase their collision risk at wind turbines built in forests.

Bach *et al*. (2013) measured bat activity at nacelle height and ground level at 8 turbines in 2 wind farms simultaneously. They found a correlation between those measurements for *Pipistrellus nathusii* and *Nyctalus noctula*, but it changes character during the season: in autumn and spring it was negative and in summer it was positive. It seemed that in spring and autumn bats hunted either high up or lower down, but in July and August bats used the full space to hunt (there may be more bats in open areas due to migration, fledging of young or simply warmer nights with more insects or more tasty insects in the open places). Alves *et al*. (2011) found no strict correlation between activity at ground and at nacelle height.

Limpens *et al*. (2013) showed that for wind farms with a relatively high bat activity, it seems possible to predict the activity at nacelle height by using ground level data but the relation between the two is not necessarily causal. For the studied wind farm with the highest bat activity, activity at nacelle height was reliably predicted by using wind speed alone but not by bat activity at ground level when wind speed was included in the model.

A study presented at the French national meeting in Bourges in 2012 compared bat activity at 5 m and 45 m high on 10 weather masts in 7 French "département" and different landscapes. Bat passes (n= 138448) were recorded during 10 min. every 20 min. from March to November 2011. The results show that 8 species (*Vespertilio murinus*, the three *Nyctalus*, *Tadarida teniotis, Hypsugo savii* and *Pipistrellus nathusii*) spend 80% of the recorded flight time above 25 m., 6 species/ groups (*Myotis sp., Barbastella barbastellus, Myotis nattereri, Rhinolophus ferrumequinum* and *R. hipposideros*) rarely above 25 m., and the others (*Pipistrellus pygmaeus, P. pipistrellus, P. kuhlii, Eptesicus serotinus, Miniopterus schreibersii, Myotis myotis* and *Plecotus sp*. were recorded lower down but spent also quite a high percentage of their flight time above 25 m. (Bas *et al*. 2014).

Alves P., B. Silva & S. Barreiro. 2011. *Estudo de Incidências Ambientais do Parque Eólico do Alto dos Forninhos: Quirópteros*. Plecotus, Lda

Bach P., L. Bach & K. Ekschmitt. 2013. *Bat activity and bat fatalities at different wind farms in northwest Germany*. Talk at the 16th International Bat Research Conference and 43rd Annual Meeting of the North American Society for Bat Research , San Jose, Costa Rica 2013.

Bas Y., A. Haquart, J. Tranchard & H. Lagrange H. 2014. Suivi annuel continu de l'activité des chiroptères sur 10 mâts de mesure : évaluation des facteurs de risque lié à l'éolien. Actes des 14ème Rencontres Nationales Chauves-Souris de la SFEPM, Bourges Mars 2012. *Symbioses* 32:83-87.

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Small Wind Turbines

Small wind turbines (SWT, now defined as < 100kW; Worldwide Energy Association) are now routinely installed in many European countries and the USA and, in spite of the rapid growth in numbers, there has been little study of their impact on wildlife. Consequently, the evidence-base upon which to establish planning guidance is very limited. Research in the UK has examined the evidence for poetssible effects of micro-turbines and the magnitude of impact that they may have upon birds and bats. Available evidence to date indicates that in close proximity to operating SWT (< 18 m hub height / < 15kW) bat activity is substantially reduced, suggesting their use of habitat adjacent to SWT may be affected (Minderman *et al*. 2012), but that mortality rates at many sites may be relatively low (Minderman *et al*. in review). On-going research is currently testing: 1) the effects of hedgerow proximity and turbine operation on bats in southern England; 2) whether surrounding landscape and habitat configuration influences bat responses to turbines (Minderman, Tatchley & Park in prep.).

A series of laboratory studies by Long *et al*. (2009, 2010a, 2010b) showed that ultrasonic echoes returned from moving SWT blades were imperfect, potentially increasing collision risk by lowering detection of moving blades, and providing one possible mechanism for why bats avoid SWTs.

Research on the planning process for SWT in Germany (Reinhard & Günther 2013) and the UK (Park *et al*. 2013) has found that the planning process in both countries varies widely among local authorities, and that better planning guidance should be developed urgently, incorporating all available evidence and identifying further research needs.

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Long C.V., J.A. Flint & P.A. Lepper. 2010b. Wind turbines and bat mortality: Doppler shift profiles and ultrasonic bat-like pulse reflection from moving turbine blades. *Acoust. Soc. Am.* 128:2238-2245.

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Minderman J., E. Fuentes-Montemayor, J.W. Pearce-Higgins, C.J. Pendlebury & K.J. Park. In review. Levels and correlates of bird and bat mortality at small wind turbine sites.

Park K.J., A. Turner & J. Minderman. 2013. Integrating applied ecology and planning policy: the case of micro-turbines and wildlife conservation. *Journal of Applied Ecology* 50: 199–204. doi:10.1111/jpe.12005.

Reinhard H. & A. Günther. 2013. Kleinwindenergieanlagen und Fledermäuse – Gefahrensabschätzung und artenschutzrechtliche Aspekte. *Naturschutz und Landschaftspflege* 45(2):53-59.

Offshore windfarms

Cox *et al.* (2013) conclude that there is a lack of knowledge about bat migration across the North Sea but the presence of oil rigs provides roosts opportunities and therefore might open up migration routes that were not possible previously, due to the distance involved.

Poerink *et al*. (2013) prepared a report about bat activity at a Dutch offshore wind farm. They showed that between 29th of August and 20th of September *Pipistrellus nathusii* occurred regularly at wind turbines 15 km from the coast. *Nyctalus noctula* was recorded only in two nights. In 23 km from the coast bats were recorded in a much lesser extent, but the study period was also much shorter.

The record of one *Pipistrellus pipistrellus* from Britain in The Netherlands in autumn 2013 (Anonymous 2014) showed that there is an exchange between Britain and the European mainland. Due to the fact that offshore wind farms are built and planned between Britain and The Netherlands, Belgium and France it seems important to study bat migration here.

For the German Baltic Sea area a guideline bat survey design for impact assessments at offshore wind farms was conducted in 2013 (Bach *et al*. 2013).

Anonymous. 2014. *Minivleermuis steekt Noordzee over*. http://nos.nl/artikel/600025-minivleermuis-steekt-noordzee-over.html, 20th January 2014.

Bach L., P. Bach, A. Fuß, M. Göttsche, R. Hill, O. Hüppop, H. Matthes, M. Meyer, H. Pommeranz, B. Russow, A. Seebens & A. Beiersdorf. 2013. Verfahrensanweisung zur Untersuchung des Fledermaus-Zuggeschehens im Offshore-Bereich der Ostsee. In: BSH (Hrsg). *Standard Untersuchung der Auswirkungen von Offshore-Windenergieanlagen auf die Meeresumwelt (StUK4)*. Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg: pp. 76-71.

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Update of guidelines

Guidelines are being updated. The authors hope to present a draft version to the 7th Session of the Meeting of Parties, for approval.

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 the same 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 area not sampled.

It is not possible to evaluate the impacts of wind farms without the mortality data; very few countries sent the results of their monitoring programmes. This is essential if we want to assess the cumulative impacts of wind farms on local or regional bat populations. Therefore the IWG 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
(addendum to the list presented in 18AC)

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Anonymous (2014): *Minivleermuis steekt Noordzee over*. - http://nos.nl/artikel/600025-minivleermuis-steekt-noordzee-over.html, 20th January 2014.

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Arnett E.B., Johnson G.D., Erickson W.P., & Hein C.D., 2013. *A synthesis of operational mitigation studies to reduce bat fatalities at wind energy facilities in North America.* Report submitted to The National Renewable Energy Laboratory. Bat Conservation International. Austin, Texas, USA. 32 pp. + annexes

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Annex 2 - New studies done in Europe

(addendum to Table 1 of *EUROBATS Publication Series nº 3* , Annex 3 of *Doc.EUROBATS.AC14.9.Rev1,* Annex 3 of *Doc.EUROBATS.StC4-AC15.22.Rev.1,* Annex 2 of *Doc.EUROBATS.AC17.6, and Annex 2 of Doc.EUROBATS.AC18.6*)

Study (author, year, area)	time	type of turbines	methods	results	Habitat-types
Bach P. & L. Bach (2013a). Wiesmoor, Germany.	30.April to 31.October 2012 (169 nights)	5 WTs, ENERCON E 82, tower 102m, rotor ø 82m.	**Mortality control** every 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 two AnaBat-SD2 per WT (4m and rotor hight)	no bats found. Acoustic monitoring: calls of *Nyctalus noctula, Nyctalus leisleri, Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus, Plecotus sp* . Myotis dasycneme	agricultural area
Bach P. & L. Bach (2013b). Friesland, Germany.	29.June to 15.October 2012 and 30.June to 15. October2013 (215 nights)	5 WTs, Nordex, tower 90m, rotor ø 90m.	**Mortality control** every 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** at two WT with Avisoft Recordersystem	13 dead bats *(10 Pipistrellus nathusii; 3 Nyctalus noctula*) found. Calculation: probably 4,2 dead bats/WT/year. Acoustic monitoring: calls of *Nyctalus noctula, Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus*	agricultural area, pastures
Bach L. & P. Bach (2013c) Friesland II, Germany	1. April-15. May 2013 and 2 WT: 11. July-15. October 2013, 2 WT: 1. August-15. October 2013	4WTs, REPower; tower 98m; rotor ø 104m	**Mortality control** every 3 days under 4 WTs. Search area of 50m radius around the WT (except for areas with dense vegetation). Tests for search efficiency & predation**. Acoustic monitoring** at 4 WT with Anabat SD1	8 dead bats *(6 Pipistrellus nathusii; 2 Nyctalus noctula*) found. Calculation: probably 3,6 dead bats/WT/year. Acoustic monitoring: calls of *Nyctalus noctula, Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus*	agricultural area, pastures
Bach P., L. Bach & F. Sinning (2014). Walsrode, Germany.	15.July to 15.October 2013 (91 nights)	12 WTs, Nordex N-100, tower 100m, rotor ø100m.	**Mortality control** every 3 days under 7 WTs. Search area of 50m radius around the WT (except for areas with dense vegetation). Tests for search efficiency & predation**. Acoustic monitoring at two WT with Avisoft Recordersystem**	21 bats (12 *Pipistrellus nathusii* ; 3 *Pipistrellus pipistrellus* , 1 *Pipistrellus pygmaeus,* 5 *Nyctalus noctula*) . Acoustic monitoring: calls of *Nyctalus noctula, Nyctalus leisleri, Eptesicus serotinus, Pipistrellus pipistrellus, Pipistrellus nathusii, Pipistrellus pygmaeus, Plecotus sp* .	agricultural area
Beucher Y., Kelm V., Albespy F., Geyelin M. , Nazon L.,& Pick D., 2013	2009-2011	13 WTs, Enercon E70 (of 2.3 MW), tower 65m, rotor ø 71m	**Mortality control 2009 (35 visits):**once a week last May fortnight, first week in June and last 2 weeks in September; 2 controls/week from 05/06 to 20/09. **Mortality control 2010 (40 visits):** once a week in May and last week in September; twice a week from 31/05 to 24/09. **Mortality control 2011 (36 visits)**: from 18/05 to 30/09: once per week in May, twice per week in June, July, August and September **Mortality control 2012** : every day under 2 WTs , July-October (EXEN) **Tests** for search efficiency, predation and controlled area(3 years) **Activity monitoring** at nacelle height: 2009-2011	**2009:** 98 fatalities: 2 Hsav, 15 Pkuh, 57 Ppip, 9 Pip sp., 1 Vmur, 7 Nlei, 2 Nlas, 4 Ppyg. **2010:** curtailment at 6.5 m/sec and security lights switched off: 2 fatalities (Ppip) **2011:** curtailment at 5.5 m/sec and security lights switched off: 3 fatalities (2 Ppip, 1 Pkuh) **2012:** curtailment for 2 WTs and different bat detectors in the nacelles (study Brinkmann et al, no information); 4 fatalities (Ppip) under these WTs	forested ridge and pastures; 1075-1090m
Bio3 (2012a) Lousã II, Portugal	April-October 2011	20 WTs (of 2,5 MW)	Weekly searches around all 20 WT (September-October 2009; April-October 2010); Search area: 50m around WT	**Detection:** Barbastella barbastellus (3); Hypsugo savii (2); Myotis escalerai (2); E. serotinus / E. isabellinus (6); N. leisleri / E. serotinus / E. isabellinus (2); N. lasioterus / N. noctula (2); Nyctalus leisleri (1); Pipistrellus kuhlii (4); P. pipistrellus (27); P. pipistrellus / P. pygmaeus (27); P. pygmaeus (4); P. pygmaeus / M. schreibersii (1). **Shelters:** no shelter monitoring **Mortality:** no mortality detected	mean alt. 950m;shrubs; grassland; pine plantations; deciduous forest
Bio3 (2012b) Chão Falcão II, Portugal	February-November 2011	11 WTs (of 2,3 MW)	Weekly searches around all 11 WT; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** E. serotinus / E. isabellinus (2); N. leisleri / E. serotinus / E. isabellinus (56); Nyctalus spp (5); P. pipistrellus (106); P. pygmaeus / M. schreibersii (43); Pipistrellus kuhlii (1); Pipistrellus sp (57); Plecotus austriacus / auritus (5); Rhinolophus hipposideros (6); Tadarida teniotis (24). **Shelters:** 20 bats (undefined species) probably of Rhinolophus ferrumequinum, R. hipposideros, R.mehelyi / R. hipposideros, P. pygmaeus / M.schreibersii, P. pipistrellus / P. pygmaeus and/or N. leisleri / E. serotinus / E. isabelinus **Mortality:** no mortality detected	mean alt: 410m; shrubs; rock outcrop

Study (author, year, area)	time	type of turbines	methods	results	Habitat-types
Bio3 (2012c) Chão Falcão III, Portugal	April-October 2011	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	**Detection:** N.leisleri/E.serotinus/E.isabelinus (26); P.austriacus/P.auritus (11); P.kuhlii (2); P.pipistrellus (30); P.pygmaeus/M.schreibersii (8); Pipistrellus spp. (12); R.mehelyi/R.hipposideros (1). **Shelters:** R. euryale/R. mehelyi (26) R. hipposideros (1), R. ferrumequinum (1); M. schreibersii (1000); M. myotis/M. blythii (40); Myotis myotis (300); more than 20 undefined species probably of R. hipposideros, R. ferrumequinum, R. mehelyi/R. hipposideros, P. pygmaeus/M. schreibersii, N. leisleri/E. serotinus/E. isabelinus **Mortality:** Pipistrellus sp. (1); P. pipistrellus/P. pygmaeus (1); Nyctalus leisleri (1); Pipistrellus pipistrellus (1). **Mortality rate (Jain et al., 2007 / Huso 2010 / Korner-Nievergelt et al. 2011):** 1,7 / 1,0 / 1,2 bats/WT in 2011	mean alt: 450m; shrubs; eucalypt plantation
Bio3 (2012d) Nave, Portugal	January-December 2011	19 WTs (of 2,0 MW)	Weekly searches around all 19 WT; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** E. serotinus / E. isabellinus (2); N. leisleri / E. serotinus / E. isabellinus (1); Plecotus auritus/Plecotus austriacus (1); Pipistrellus kuhlii (7); P. pipistrellus (9); P. pipistrellus / P. pygmaeus (4); P. pygmaeus (1); Tadarida teniotis (5) **Shelters:** no shelter monitoring **Mortality:** Hypsugo savii (2); Pipistrellus khulii (3); Pippistrelus pippistrelus (2); Pippistrelus pippistrelus/Pippistrelus pygmaeus (1); Nyctalus leisleri (1). **Mortality rate (Jain et al., 2007 / Huso 2010 / Korner-Nievergelt et al. 2011):** 0,6 / 0,3 / 1,6 bats/WT in 2011	mean alt: 1000m; shrubs; rock outcrops
Bio3 (2012e) Carreço-Outeiro, Portugal	April-October 2011	6 WTs (of 2,0 MW)	Weekly searches around all 6 WT in May, June, September and October; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** M. myotis / M. blythi (1); Myotis spp. (1); P. pipistrellus (25); P. pipistrellus / P. pygmaeus (6); P. pygmaeus (2); Pipistrellus spp. (1). **Shelters:** no shelter monitoring **Mortality:** Pipistrellus pipistrellus (1); Pipistrellus khulii (1). **Mortality rate (Jain et al., 2007 / Huso 2010 / Korner-Nievergelt et al. 2011):** 33,3 / 8,6 / 6,3 bats/WT in 2011	mean alt: 430m; shrubs; rock outcrops
Bio3 (2012f) Terra Fria, Portugal	March-October 2011	5 WTs (of 2,0 MW) - Contim; 18 WTs (of 2,0 MW) - Facho-Colmeia; 25 WTs (of 2,0 MW) - Montalegre	Weekly searches around 37 WT (Montalegre - 19; Facho-Colmeia - 13; Contim - 5); Search area: 50m around WT; tests for search efficiency & predation	**Detection:** Barbastella barbastellus (6); Hypsugo savii (5); M. myotis / M. blythi (1); Myotis pequeno sp. (3); Myotis sp. (1); E. serotinus / E. isabellinus (26); N. leisleri / E. serotinus / E. isabellinus (2); Nyctalus leisleri (12); Nyctalus sp. (2); Pipistrellus kuhlii (1); Pipistrellus pipistrellus (59); Pipistrellus sp. (7); Plecotus sp. (1); Tadarida teniotis (2). **Shelters:** Pipistrellus sp. (90); Small Myotis (15) **Mortality:** Montalegre - Nyctalus leisleri (3), Pipistrellus pipistrellus (1); Facho-Colmeia - Pipistrellus pipistrellus (2); Contim - no bats mortality detected;. **Mortality rate (Jain et al., 2007 / Huso 2010 / Korner-Nievergelt et al. 2011):** Montalegre - 2 / 2,8 / 1,4 bats/WT in 2011; Facho-Colmeia - 1,6 / 2,3 / 1,2 bats/WT in 2011;	**Contim**: mean alt.: 1150m; shrubs; grassland; rock outcrop; forest; **Facho-Colmeia**: mean alt.: 1200m; shrubs; grassland; forest; **Montalegre**: mean alt.: 1100m; shrubs; grassland; forest; rock outcrop
Bio3 (2013a) Bornes, Portugal	April-October 2011	24 WT (of 2,5 MW)	Weekly searches around all 24 WT; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** Barbastella barbastellus (11); E. serotinus / E. isabellinus (8); Hypsugo savii (7); M. myotis / M. blythi (9); Small Myotis (2); Myotis sp. (1); Nyctalus leisleri (2); Nyctalus sp. (1); Pipistrellus kuhlii (110); P. kulli / P. pipistrellus (41); P. pipistrellus / P. pygmaeus (394); P. pipistrellus / P. pygmaeus / M. schreibersii (62); P. pygmaeus / M. schreibersii (10); Pipistrellus sp. (77); Plecotus sp (4); Tadarida teniotis (17). **Shelters:** Rhinolophus sp., (32); Rhinolophus hipposideros (1) and undefined species (a several number) **Mortality:** Pipistrellus pipistrellus (1); Hypsugo savii (1). **Mortality rate (Jain et al., 2007 / Huso 2010 / Korner-Nievergelt et al. 2011):** 1,18 / 1,19 / 0,79 bats/WT in 2011	mean alt. 1100m; shrubs;rock outcrops; hardwood forest;

Study (author, year, area)	time	type of turbines	methods	results	Habitat-types
Bio3 (2013b) Mosqueiros II, Portugal	July 2011 to June 2012	10 WTs (of 2,0 MW)	Weekly searches around all 10 WT; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** M. myotis/M. blythii (2); M. escalerai (1); M. daubentonii (1); P. pipistrellus (27); P. pygmaeus (1); P. kuhlii (3); Pipistrellus sp. (9); N. leisleri (1); N. leisleri/E. serotinus/E. isabellinus (1); Nyctalus sp. (1); E. serotinus/E. isabellinus (4); P. auritus/P. austriacus (2); T. teniotis (5). **Shelters:** Rhinolophus ferrumequinum (11); R. ferrumequinum/R. euryale/R. mehelyi (17); Rhinolophus hipposideros (4). **Mortality:** Tadarida teniotis (1). **Mortality rate (Huso 2010):** 0,34 bats/WT in 2011	mean alt: 1080m; shrubs; rock outcrops; oak forest
Bio3 (2013c) Lousã II, Portugal	April-October 2012	20 WTs (of 2,5 MW)	**Monitoring Bat Activity:** Presence/absence of bats, identification of the species detected, during 10 minutes of census were done at each sampling transects (N=16), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Monitoring bats shelter:** 9 bats shelters were prospected**. Mortality surveys:** Weekly searches around all 20 WT (September-October 2009; April-October 2010); Search area: 50m around WT	Detection: Barbastella barbastellus (8); E. serotinus / E. isabellinus (9); E. serotinus / E. isabellinus/ N. leisleri (24); M. myotis / M. blythi (1); N. lasiopterus/ N. noctula (1); P. kulli / P. pipistrellus (6); P. pipistrellus / P. pygmaeus (26); P. pipistrellus / P. pygmaeus / M. schreibersii (72); P. pygmaeus / M. schreibersii (12); Pipistrellus kuhlii (25); Pipistrellus pipistrellus (32); Pipistrellus sp. (4); P. austriacus / P. auritus (2); Tadarida teniotis (4). **Shelters:** E. serotinus / E. isabellinus/ N. leisleri (1), Rhinolophus hipposideros (2) and P. pipistrellus / P. pygmaeus / M. schreibersii (1) **Mortality:** no mortality	mean alt. 950m;shrubs; grassland; pine plantations; deciduous forest
Bio3 (2013d) Meroicinha II, Portugal	March 2012 to January 2013	6 WTs	**Monitoring Bat Activity**: Presence/absence of bats, identification of the species detected, during 10 minutes of census were done at each sampling points (N=12), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Monitoring bats shelter**: 27 bat shelters were prospected in each of the following months: February, April to July and December. **Mortality survey**: Weekly searches around all 6 WT (March-october 2012) and monthly in March, October and November of 2012; Search area: 50m around WT	**Detection:** Barbastella barbastellus (1); E. serotinus / E. isabellinus (1); E. serotinus / E. isabellinus/ N. leisleri (8); M. myotis / M. blythi (1); Nyctalus sp. (1); P. pygmaeus / M. schreibersii (1); Tadarida teniotis (23). **Shelters:** M. mystacinus (~18); M. daubentonii (~30); Tadarida teniotis (~70); Small Myotis (~51); M. daubentonii / M. mystacinus (~4); Myotis sp (~6); R. ferrumequinum (~4); Pipistrellus groups (at least 31 individuals) **Mortality:** no mortality	mean alt. 1280m;shrubs; grassland; rock outcrops
Bio3 (2013e) Nave, Portugal	January-December 2012	19 WTs (of 2,0 MW)	**Monitoring Bat Activity**: Presence/absence of bats, identification of the species detected, during 10 minutes of census were done at each sampling point (N=20), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Mortality surveys**:Weekly searches around all 19 WT; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** Barbastella barbastellus (7); E. serotinus / E. isabellinus (16); E. serotinus / E. isabellinus / H. savii (2); N. leisleri / E. serotinus / E. isabellinus (2); Hypsugo savii (2); Small Myotis (4); M. myotis / M. blythii (2); Pipistrellus kuhlii (8); P. kuhlii / P. pipistrellus (3); pipistrellus (68); P. pipistrellus / P. pygmaeus (18); P. pipistrellus / P. pygmaeus/ M. schreibersii (10); P. auritus / P. austriacus (7); Tadarida teniotis (5) **Shelters:** no shelter monitoring **Mortality:** Nyctalus leisleri (1). **Mortality rate (Huso 2010 / Korner-Nievergelt et al. 2011):** 01 / 0,1 bats/WT in 2012	mean alt: 1000m; shrubs; rock outcrops

Study (author, year, area)	time	type of turbines	methods	results	Habitat-types
Bio3 (2013f) Chão Falcão III, Portugal	April-November 2012 and January 2013	9 WTs (of 2,3 MW)	**Monitoring Bat Activity**: Presence/absence of bats, identification of the species detected, during 10 minutes of census were done at each sampling point (N=28), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Monitoring bats shelter**: 28 bats shelters were prospected in each of the following months: May, June and August of 2012 and january of 2013. **Mortality surveys**:Weekly searches around all 9 WT made by man and dog; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** N.leisleri/E.serotinus/E.isabelinus (26); P.austriacus/P.auritus (11); P.kuhlii (2); P.pipistrellus (30); P.pygmaeus/M.schreibersii (8); Pipistrellus spp. (12); R.mehelyi/R.hipposideros (1). **Shelters:** R. hipposideros (6), R. ferrumequinum (several individuals), M. schreibersii (823), R. ferrumequinum (1), Rhinolophus sp. (2), m. myotis / M. blythi (1), Myotis myotis (162), R. mehelyi / R. euryale (1), several individuals of different species and groups such as: R. hipposideros, R. ferrumequinum, R. mehelyi / R. hipposideros, P. pygmaeus / M. schereibersii, N. leisleri / E. serotinus / E. isabelinus, N. lasiopterus / N. noctula **Mortality:** Nyctalus leisleri (2). **Mortality rate (Huso 2010 / Korner-Nievergelt et al. 2011):** 0,5 / 0,6 bats/WT in 2012	mean alt: 450m; shrubs; eucalypt plantation
Bio3 (2013g) Chão Falcão II, Portugal	February-October 2012	11 WTs (of 2,3 MW)	**Monitoring Bat Activity:** Presence/absence of bats, identification of the species detected, during 10 minutes of census were done at each sampling point (N=34), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Monitoring bats shelter:** 10 bats shelters were prospected in each of the following months: June, July, September and October. **Mortality surveys**: Weekly searches around all 11 WT; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** E. serotinus / E. isabellinus (2); Small Myotis (2), N. leisleri / E. serotinus / E. isabellinus (73); Nyctalus spp (4); P. kuhlii / P. pipistrellus (8); P. pipistrellus / P. pygmaeus (76); P. pipistrellus / P. pygameus / M. schreibersii (14), P. pygameus / M. schreibersii (2), Pipistrellus kuhlii (1); Pipistrellus sp (14); Plecotus austriacus / auritus (2); Tadarida teniotis (14). **Shelters:** R. hipposideros (8), undifined species (more than 10 individuals), several individuals of different species and groups such as: R. hipposideros, R. ferrumequinum, R. mehelyi / R. hipposideros, P. pygmaeus / M. schereibersii, N. leisleri / E. serotinus / E. isabelinus, N. lasiopterus / N. noctula **Mortality:** no mortality detected	mean alt: 410m; shrubs; rock outcrop
Bio3 (2013h) Bornes, Portugal	April-October 2012	24 WT (of 2,5 MW)	**Monitoring Bat Activity**: Presence/absence of bats, identification of the species detected, during 10 minutes of census were done at each sampling transects (N=32), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Monitoring Bats Shelter**: 10 bats shelters were prospected. **Mortality surveys**: Weekly searches around all 24 WT; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** Barbastella barbastellus (27); E. serotinus / E. isabellinus (5); Hypsugo savii (4); M. emarginatus / M. bechsteinii (1), M. escalerai (2), M. myotis / M. blythi (4); Myotis sp. (1); N. leisleri / E. serotinus / E. isabelinus (2); Pipistrellus kuhlii (53); P. pipistrellus (286); P. pygmaeus (2); Pipistrellus sp. (165); P. austriacus / P. auritus (7); R. ferrumequinum (2); R. mehelyi / R. hipposideros (1); Tadarida teniotis (8). **Shelters:** R. hipposideros (2); 83 bat passes of R. ferrumequinum, R. euryale, R. euryale / R. mehelyi, M. myotis, R. hipposideros; Rhinolophus sp. (1); 3 or 4 individuals of P. pipistrellus / P. pygameus, R. mehelyi / R. hipposideros, R. ferrumequinum, R. hipposideros, R. euryale / R. mehelyi **Mortality:** Pipistrellus pipistrellus (1); Hypsugo savii (1). **Mortality:** no mortality detected	mean alt. 1100m; shrubs;rock outcrops; hardwood forest;
LEA (2013). Alto do Marco. Portugal.	July 2012 to June 2013	6 WTs (of 2,0 MW)	**Monitoring Bat Activity**: Presence/absence of bats, identification of the species detected, and the existence of feeding activity and social calls were detected. 10 minutes of census were done at each sampling point (N=12), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. **Mortality surveys**: Monthly searches Novembro to Fevereiro and Weekly searches March to october around all 6 WTs.	**Monitoring Bat Activity**:Tadarida teniotis, Rhinolophus ferrumequinum, Pipistrellus pipistrellus, Eptesicus sp., Hypsugo savii/P. kuhlii, P. pipistrellus/P. pygamaeus/Miniopterus schreibersii **Morrtality surveys**: 7 dead bats found during study (3 Pipistrellus pipistrellus; 2 Pipistrellus pygmaeus; 1 Nyctalus lasiopterus; 1 Eptesicus sp.); Mortality rate: 6,64 Bats/WTs/year.	mean alt.: 1250m; shrubs;

Study (author, year, area)	time	type of turbines	methods	results	Habitat-types
Procesl, (2013a). Sabugal, Portugal.	January 2012 - December 2012	48 WTs (of 2,0 MW)	**Mortality control**: Weekly searches (7 searches from June to July 2012; 5 searches from September to October 2012) around na average of 80% of the WTs; Search area: 50m around WT; tests for search efficiency. Predation values based on blibliography.	**Detection:** Rferrumequinum (1); Reuryale (1); Mescalerai (1); Myotis sp. (4); Ppipistrellus (2); Pkuhlii (107); Ppygmaeus / Mschreibersii (14); Pkuhlii / Ppipistrellus (41); Ppipistrellus / Ppygmaeus (52); Pipistrellus sp. (23); Hsavii (3); Nleisleri (16); Nlasiopterus / Nnoctula (3); Nyctalus sp. (4); Eptesicus sp. (8); Plecotus sp. (7); Bbarbastellus (4); Tteniotis (21). **Shelters** (2 in August): Rferrumequinum (710) with offspring; Reuryale/Rmehelyi (500) with offspring; Memarginatus (1). **Mortality:** 6 dead bats - Ppipistrellus (3); Pipistrellus sp. (1); Nleisleri (2); Mortality rate: 21,9 bats/WT in 2012.	Mean altitude: 850 m; schrubs; rock outcrops
Procesl, (2013b). Serra de Alvaiázere, Portugal.	January 2012 - December 2012	7 WTs (of 2,0 MW)	**Mortality control**: Weekly searches around all 7 WTs; Search area: 50m around WT; tests for search efficiency & predation	**Detection:** Mescalerai (1); Myotis sp. (1); Ppipistrellus (4); Pkuhlii (9); Ppygmaeus / Mschreibersii (2); Pkuhlii / Ppipistrellus (1); Ppipistrellus / Ppygmaeus (5); Ppygmaeus (3); Pipistrellus sp. (1); Nleisleri (3); Nlasiopterus / Nnoctula (1); Nyctalus sp. (2); Bbarbastellus (4); Tteniotis (4). **Shelters** (8 in hibernation period): Rferrumequinum (223); Rhipposideros (6); Rhinolophus sp. (50); Mmyotis / Mblythii (32); Mmyotis (10); Mdaubentoni (1); Myotis sp. (2); Mschreibersi (1963); 1 unidentified. **Mortality:** 0 dead bats; Mortality rate: 0.	Mean altitude: 600 m; Schrubs
Procesl, (2013c). Lourinhã II, Portugal.	August 2011 - July 2012	9 WTs (of 2,0 MW)	**Mortality control**: Weekly searches (6 searches from 28 September 2011 to 3 November 2011; 8 searches from 23 May 2012 to 13 July 2012) around all 9 WTs; Search area: 50m around WT; tests for search efficiency. Predation values based on blibliography.	**Detection:** Mmyotis / Mblythii (3); Myotis sp. (2); Ppipistrellus (24); Ppygmaeus / Mschreibersii (2); Ppipistrellus / Ppygmaeus / Mschreibersii (28); Nyctalus sp. (1); Nyctalus sp. / Eptesicus sp. (1); Eserotinus / Eisabellinus (1). **Shelters** (5 confirmed): Rferrumequinum (15); Mmyotis / Mblythii (1); Mschreibersi (120). **Mortality:** 6 dead bats (1 Mschreibersii; 2 Pipistrellus sp.; 3 non identified); 1 in May, 1 in June, 1 in September and 3 in October; **Mortality rate**: 10,91 bats/WT per year (2011/2012).	Mean altitude: 170 m; eucalypt plantation; vine; agriculture

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