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Report of the IWG on Wind Turbines and Bat Populations[1]

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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´ behavior in relation to wind farms	Anna Nele Herdina (c) Laurent Biraschi Marie-Jo Dubourg-Savage
Mitigation and compensation measures	Joana Bernardino (c) Branko Karapandža Dino Scaravelli Lothar Bach Luisa Rodrigues Thierry Kervyn
Estimation of mortality rate taking into consideration predation, efficiency and controlled area; choose of best estimator for Europe	Rita Bastos (c) Dino Scaravelli Jasja Dekker Joana Bernardino Petra Bach
Impact of mortality rate on populations	Jasja Dekker (c) Christian Voigt Lothar Bach Rita Bastos Emra Çoraman
Deterrents	Lothar Bach (c) Branko Karapandža Dino Scaravelli Luisa Rodrigues
Maximum foraging distances of species and Detectability coefficients to compare activity indices	Marie-Jo Dubourg-Savage (c) Eeva-Maria Kyheröinen Dina Rnjak Zuhair Amr Christine Harbusch
Collect national guidelines	Andrzej Kepel (c) Branko Mićevski Dina Rnjak Jan Collins
Use of dogs *vs* humans during carcass searches	Dina Rnjak (c) Fiona Mathews Jan Collins Joana Bernardino Petra Bach
Comparing measurement of activity at ground level and rotor height	Lothar Bach (c) Jan Collins Johanna Hurst Marie-Jo Dubourg-Savage Petra Bach Thierry Kervyn
Small Wind Turbines	Kirsty Park (c) Lothar Bach
Offshore wind farms	Lothar Bach (c) Jasja Dekker Herman Limpens
Wind farms and forests	Christine Harbusch (c) Christian Voigt Andrzej Kepel

	Branko Karapandža Fiona Mathews Lothar Bach Thierry Kervyn Johanna Hurst Ruth Petermann
Implementation of mitigation and post-construction monitoring	Daniela Hamidović (c) Branko Micevski Per Ole Syvertsen Jasja Dekker
200m buffer distance to habitats particularly important for bats	Branko Karapandža (c) Noam Leader Mirna Mazija
Sensitivity maps	Noam Leader (c) Mirna Mazija

The IWG thanks Mário Santos (Laboratory of Applied Ecology, University of Trás-os-Montes, Portugal) for comments on "Estimation of mortality rate taking into consideration predation, efficiency and controlled area; choose of best estimator for Europe".

Results

Results are presented by sub-group.

Update/reorganizing of the list of references

Annex 1 includes new references and is an addendum to Annex 1 of Doc.EUROBATS.AC20.5, Annex 1 of Doc.EUROBATS.AC21.8, and chapter 9 of EUROBATS Publication Series nº 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 2016. It reflects by no means the real extent of bat mortality at wind turbines as it is based only on reported fatalities to EUROBATS IWG members and not on the effective mortality that is calculated taking into account different sources of biases such as the survey effort, the removal of carcasses by predators/scavengers, the searcher efficiency and the percentage of the area really searched.

Available data show that up to now at least 28 species have been killed by wind turbines in Europe.

Reported bat mortality in Europe (2003-2016) - State 21/03/2017

Species	AT	BE	CH	CR	CZ	DE	ES	EE	FI	FR	GR	IS	IT	LV	NL	NO	PT	PL	RO	SE	UK	Total
Nyctalus noctula	46				31	1081	1			39	10						1	16	5	1	11	**1242**
Nyctalus lasiopterus							21			6	1						9					**37**
N. leisleri			1	6	3	162	15			72	58		2				262	5				**586**
Nyctalus sp./ *V. murinus*				1			2			1							17					**21**
Eptesicus serotinus	1				11	59	2			25	1				1			3				**103**
E. isabellinus							117										2					**119**
E. serotinus / isabellinus							98										16					**114**

E. nilssonii	1				1	5		2	6					13		1		1		8		**38**
Vespertilio murinus	2			14	6	128				8	1			1				7	7	1		**175**
Myotis myotis						2	2			3												**7**
M. blythii							6			1												**7**
M. dasycneme						3																**3**
M. daubentonii						7											2					**9**
M. bechsteinii										1												**1**
M. emarginatus							1			2												**3**
M. brandtii						2																**2**
M. mystacinus						2					1											**3**
M. nattereri																					1	**1**
Myotis sp						1	3															**4**
Pipistrellus pipistrellus	2	16		6	16	632	211			622			1		15		289	3	3	1	46	**1863**
P. nathusii	13	4		20	7	909				183	35		2	23	8			16	12	5	1	**1238**
P. pygmaeus	4			3	2	113				125				1			38	1	2	1	52	**342**
P. pipistrellus / pygmaeus	1		1				271			49	54						37	1	2			**416**
P. kuhlii				112			44			131		4					45		4			**340**
P.pipistrellus / kuhlii				12							1						19					**32**
Pipistrellus sp	8	2		55	9	76	25			135				2			101	2	4		11	**430**
Hypsugo savii	1			163		1	50			36	26		12				49					**338**
Barbastella barbastellus						1	1			3												**5**
Plecotus austriacus	1					6																**7**
Plecotus auritus						7															1	**8**
Tadarida teniotis				7			23			1							28					**59**
Miniopterus schreibersii							2			5							4					**11**
Rhinolophus ferrumequinum							1					1										**2**
Rhinolophus mehelyi							1															**1**
Rhinolophus sp							1															**1**
Rhinopoma microphyllum												2										**2**
Rousetus aegyptiacus												1										**1**
Taphosus nudiventris												2										**2**
Chiroptera sp	1	11		46	1	72	320	1		192	6		1				113	3		30	9	**806**
Total	**81**	**33**	**2**	**445**	**87**	**3269**	**1218**	**3**	**6**	**1640**	**194**	**10**	**18**	**40**	**24**	**1**	**1032**	**58**	**39**	**47**	**132**	**8379**

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

Updating of tables on monitoring studies done in Europe

Annex 2 contains new data of studies done in Europe; this table is an addendum to Table 1 of EUROBATS Publication Series nº 3, Annex 3 of Doc.EUROBATS.AC14.9.Rev1, Annex 3 of Doc.EUROBATS.StC4-AC15.22.Rev.1, Annex 2 of Doc.EUROBATS.AC17.6, Annex 2 of Doc.EUROBATS.AC18.6, Annex 2 of Doc.EUROBATS.StC9-AC19.12, Annex 1 of EUROBATS Publication Series nº 6, Annex 2 of Doc.EUROBATS.AC20.5 and Annex 2 of Doc.EUROBATS.AC21.8.

Mitigation and compensation measures

In 2016, Gartman *et al.* (2016a, b) published an extend review of international research studies involving mitigation measures for wildlife in the wind energy field, based on over 250 documents ranging from peer-reviewed journal articles and scientific books, to grey literature reports and conference proceedings. The authors concluded that recommended means of avoidance and mitigation through macro- and micro-siting can be effective forms in reducing impacts, but further research is needed. They also concluded that despite deterrence mechanisms (such as ultrasonic devices) appear to be promising, the development of an effective (and internationally applicable) device is still lacking as well as continued monitoring to ensure its efficacy and understand if habituation to the deterrence mechanism occurs. On the other hand, they pointed out how curtailment measures have been particularly useful for bats. The same conclusions have also been highlighted by Arnett & May (2016) which performed also a broad overview of approaches to mitigate impacts on wildlife of onshore wind energy development.

Thus, as mentioned in the EUROBATS Guidelines (Rodrigues *et* al. 2014) and the previous IWG reports, operational mitigation (curtailment) through the increase of wind turbines cut-in speed, feathering turbine blades and/or shutdown on demand, remains the most effective and the only proven way to reduce bat fatality at wind energy facilities. A few years ago the implementation of such measures was based on wind speeds alone (e.g. Arnett *et al*. 2013, Martin *et al.* 2015). Nowadays, as mentioned in the Guidelines, it can be enhanced by site-specific algorithms that adjust turbines operation based on a combination of different environmental parameters (wind speed, temperature, precipitation, time of day, season) and on bat activity itself (when it exceeds pre-determined thresholds), in order to decrease shut-off times and make the adoption of such measures more economically feasible for wind developers.

Step-by-step the adoption of bat-friendly algorithms or systems to inform turbine shutdown on demand at European wind farms is becoming a reality, particularly in Germany. According to Behr *et al.* (2017) the approach of bat acoustic monitoring at the nacelle (using different echolocation detectors, such as Avisoft, Anabat and Batcorder) and turbine specific curtailment has become the standard method to mitigate collision risk of bats at wind turbines in Germany. To help on that, the software-tool ProBat (http://windbat.techfak.fau.de) has been developed, available both in German and English, and that is free of cost. Based on site-specific data on bat activity and wind speed and the methods described in Behr *et al.* (2017), this Microsoft Access based application allows to estimate fatality rates and calculate turbine specific cut-in wind speeds for a bat friendly operation of the turbine. In addition, the software also offers the option to estimate the loss in revenue in curtailed operation.

Other approaches have been proposed to obtained real-time data on bat activity and optimize the operational curtailment of wind turbines, namely *i)* surveillance systems or thermal cameras that detect bats in the rotor swept-zone; or *ii)* a combination of those with acoustic and ultrasound sensors (e.g. ATOM system, Robinson Willmott *et al.* 2015). However these systems still need further improvements and tests to be recommended.

To the best of our knowledge, between 2016 and the beginning of 2017 not much has been published regarding the development, test and implementation of compensation measures for bats on the wind energy context. According to the literature review performed by Arnett & May (2016), offsite habitat-based compensatory measures (such as cave-gating) may provide the best offsets for incidental bat mortality. Nevertheless, empirical evidence demonstrating effectiveness and achievement of no-net-loss for wildlife populations is lacking (Arnett & May, 2016).

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.

Arnett E. & R. May. 2016. Mitigating Wind Energy Impacts on Wildlife: Approaches for Multiple Taxa. *Human-Wildlife Interactions*, 10(1), 28-41.

Behr O., R. Brinkmann, K. Hochradel, J. Mages, F. Korner-Nievergelt, I. Niermann, M.Reich, R. Simon, N. Weber & M. Nagy. 2017. Mitigating Bat Mortality with Turbine-Specific Curtailment Algorithms: A Model Based Approach. *In* Köppel, J. 2017. *Wind Energy and Wildlife Interactions - Presentations from the CWW 2015 Conference*. ISBN: 978-3-319-51272-3 (Online).

Gartman V., L. Bulling, M. Dahmen, G. Geißler & Köppel, J. 2016a. Mitigation Measures for Wildlife in Wind Energy Development, Consolidating the State of Knowledge — Part 1: Planning and Siting, Construction. *Journal of Environmental Assessment Policy and Management,* 18(3): 1650013 (45pp).

Gartman V., L. Bulling, M. Dahmen, G. Geißler & Köppel, J. 2016b. Mitigation Measures for Wildlife in Wind Energy Development, Consolidating the State of Knowledge — Part 2: Operation, Decommissioning. *Journal of Environmental Assessment Policy and Management,* 18(3): 1650014 (31pp).

Martin C., E.B. Arnett & M. Wallace. 2015. *Operational mitigation reduces bat fatalities at the Sheffield wind facility, Vermont*. Conference on Wind Energy and Wildlife Impacts (CWW): Book of Abstracts. Berlin, Germany. March 10-12, 2015.

Robinson Willmott J., G.M. Forcey & L.A. Hooton. 2015. Developing an automated risk management tool to minimize bird and bat mortality at wind facilities. *Ambio* 2015, 44(Suppl. 4): S557–S571.

Rodrigues L., Bach L., Duborg-Savage M.J., Karapandza B., Kovac D., Kervyn T., Dekker J., Kepel A., Bach P., Collins J. & Harbusch C. 2014. *Guidelines for consideration of bats in wind farm projects - Revision 2014*. EUROBATS Publication Series 6.

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

Reyes *et al*. (2016) evaluated how searcher efficiency and proportion of area surveyed affected precision of fatality estimates and probability of detecting rare fatalities. The authors demonstrate that precision of fatality estimates depends strongly on searcher efficiency, and that when searcher efficiency is high, a lesser survey coverage can result in a level of precision that is similar to that achieved when searcher efficiency is low and survey coverage is high. The results indicate that very rare fatalities are likely to go undetected when a low proportion of a site is searched, and that probability of detecting rare fatalities depends greatly on searcher-efficiency rates. The authors also indicate search team and fatality type (feather spots, small carcasses, and large carcasses) as important predictors of searcher-efficiency rates, and demonstrated that dog-handler teams had higher searcher efficiency for all fatality types than human search teams. The authors suggest that detection rates for feather spots are usually less than for either small or large carcasses, and underscore the importance of including feather spots as a separate category in searcher-efficiency trials. The results emphasize the need for managers and agencies to consider study objectives and site characteristics when selecting level of survey coverage, type of search team, and other options to maximize searcher efficiency.

Zimmerling & Francis (2016) analysed available data on bat mortality from post-construction monitoring reports in Canada and derive national and provincial estimates of total bat mortality associated with wind turbines. In order to standardize data collection methodologies used to estimate mortality from carcass searches between different wind farms, the authors used correction factors for scavenger removal, searcher efficiency, proportion of area searched within a 50m radius of turbines, proportion of carcasses expected to fall within a 50m search radius and proportion of carcasses expected during the times of year that surveys took place. The authors discussed the implications of potential biases of the correction factors used on the accuracy of collision mortality estimates, highlighting potential population-level impacts of cumulative turbine-related mortality on some bat species.

Huso *et al*. (2016) reviewed the available methods to estimate the super-population of carcasses at wind power facilities, discussing the role of these estimates in determining appropriate levels of minimization and mitigation of impacts to individual species. The authors discussed the potential to extrapolate these measurements to reflect the cumulative effect of wind farms on individual species. Huso *et al*. (2016) finished by discussing that a generalized and flexible estimator of fatality available to non-statisticians should be developed, fundamental for an assessment of current and projected cumulative level of impact of wind development on bird and bat populations. The authors declared that this estimator would provide important information to scientists as well as policymakers and managers to provide the best information possible on which to base their decisions.

Santos *et al*. (2017) used an Agent Based Model to investigate: a) the influence of the searcher "controlled" variables, i.e., different field monitoring protocols, monitoring periods and periodicities on carcass detection success (number of carcasses found/total mortality) for field trials at onshore wind farms, and b) the accuracy of five widely used mortality estimators, considering eventual changes in the detection success of carcass searches associated with the searcher "controlled" variables. The authors depicted no differences in the success on the detection of carcasses for the different field monitoring protocols tested. On the other hand, the authors showed increasing levels of error for all estimators as monitoring periods and periodicities grow, independently, despite increases in complexity, assumptions and accuracy claimed by estimators' authors. Santos *et al*. (2017) proposed a reduction in the monitoring periods and a shortening in the periodicity of searches in order to reduce bias in the estimations and increase the confidence limits of impact assessments associated with mortality estimates at onshore wind farms.

Huso, M., Dalthorp, D., Miller, T.J., Bruns, D. 2016. Wind energy development: methods to assess bird and bat fatality rates post-construction. *Human–Wildlife Interactions*, 10(1), 62–70.

Reyes, G.A., Rodriguez, M.J., Lindke, K.T., Ayres, K.L., Halterman, M.D., Boroski, B.B., Johnston, D.S. 2016. Searcher Efficiency and Survey Coverage Affect Precision of Fatality Estimates. *The Journal of Wildlife Management*, 80(8),1488–1496. DOI: 10.1002/jwmg.21126

Santos, M., Bastos, R., Ferreira, D., Santos, A., Barros, A., Travassos, P., Carvalho, D., Gomes, C., Vale-Gonçalves, H.M., Braz, L., Morinha, F., Paiva-Cardoso, M.N., Hughes, S.J., Cabral, J.A. 2017. A spatial explicit agent based model approach to evaluate the performance of different monitoring options for mortality estimates in the scope of onshore windfarm impact assessments. *Ecological Indicators*, 73, 254–263. DOI: 10.1016/j.ecolind.2016.09.044

Zimmerling, J.R and Francis, C.M. 2016. Bat Mortality Due to Wind Turbines in Canada. *The Journal of Wildlife Management*, 80(8),1360–1369. DOI: 10.1002/jwmg.21128

Impact of mortality rate on populations

A likely negative of wind turbine-related fatalities on bat population is often discussed among stakeholders of the wildlife-wind energy conflict in Europe. In theory, bat populations are particularly susceptible to increased mortality rates, given the low fecundity of bat species and thus recruitment of juveniles in populations (Jones *et al*. 2003). Therefore, even minor increases in mortality risks might have large-scale effects on bat populations. The major difficulty in any demographic study seems to be the lack of required baseline data, e.g. of population sizes, recruitment and dispersal rates in the absence and presence of wind turbines. Even when such demographic parameters have been established for local bat populations over many years, it is difficult to distinguish between effects caused by wind turbines and those triggered by other confounding factors, such as changes in the management of local habitats, losses of daytime roosts, annual climatic fluctuations (e.g. increased winter mortality caused by a sequence of harsh winters) and global climate changes. The subgroup is not aware of any recent (2015-2016) paper demonstrating specifically an effect of wind turbines on bat populations. Yet, several review papers highlight to various extents the discrepancy between empirical data and the urgent need for synthesis (Köppel *et al*. 2014, Tabassum-Abbasi *et al*. 2014, Dai *et al*. 2015, Schuster *et al*. 2015, Smales 2015, Voigt *et al*. 2015, Arnett *et al*. 2016). Giavi *et al*. (2014) suggested that natural mortality rates of migratory bat species, such as *Nyctalus leisleri*, are low during migration. Two papers highlight the difficulty in connecting individuals bats killed at wind turbines and the likely location of their local populations, particularly for migratory bats (Voigt *et al*. 2012, Lehnert *et al*. 2014). The higher percentage of females from distant places that were killed at German wind turbines suggest a potential large negative effect of the so-called German "Energiewende" on bat population in Northeastern Europe (Voigt *et al*. 2015, Lehnert *et al*. 2014). Using a spatial modelling approach, Roscioni *et al*. (2013, 2014) combined species distribution models for bats with the spatial distribution of wind turbines at an Italian site that undergoes intense wind farm development. They modelled the likely incidence of each wind farm in bat flight corridors by overlaying existing and planned turbine locations on potential commuting corridors (Roscioni *et al*. 2014). A similar modelling approach was followed by Santos *et al*. (2013) for *Hypsugo savii*, *Nyctalus leisleri*, *Pipistrellus kuhlii* and *Pipistrellus pipistrellus* in order to generate predictive models to determine areas of probable mortality. Hedenström & Rydell (2013) showed in another model, based on simple assumptions that the planned increase of wind turbines in Sweden will have a negative effect on Swedish populations of *Nyctalus noctula*, even when the current number of wind turbines remains constant, if no mitigation measures are taken. Ferreira *et al*. (2015) investigated the impact of windmills on bat species using a spatially explicit agent-based model. They found a clear relationship between mortality events and the proximity between roosts and the location of the wind turbines. Chauvenet *et al*. (2014) used capture-mark-recapture to describe demographic rates for *Eptesicus serotinus* at two sites in England, investigating the transition rates between three stages: juveniles, immatures and breeders. Using an individual-based population dynamics model, they investigated the expected trajectories for both populations. They demonstrate the presence and scale of temporal variation in this species' demography and show how site-specific variation in demographic rates can produce divergent population trajectories (Chauvenet *et al*. 2014). Erickson *et al*. (2015) used branching models to study effects of different rates of mortality on a long lived-low fecundity and a short-lived, moderate fecundity bat (and two types of birds: songbirds and eagles). This modelling effort showed that long lived species may seem stable until a threshold of mortality occurs, after which even small increases in mortality will increase the risk of (local) extinction. Frick *et al*. (2017) too, used expert elicitation and population projection models to estimate the effects of wind turbines on populations.

In conclusion, site or population specific differences in demographic parameters may question the validity of extrapolating patterns observed in local studies to a broader spatial scale. Recently, Diffendorfer *et al*. (2015) developed probabilistic, quantitative assessment methods to assess the impact of wind energy development on wildlife populations. Their approach is based on fatality information, population estimates, species range maps, turbine location data, biological characteristics and generic population models. The model generates estimates of the relative risk and quantitative measures of the magnitude of the effect on species' population trends and sizes, yet this model has not been validated for any bat species. The authors concur that this model is based on simplifying assumptions and that consequently the outcome may suffer from spares or unreliable empirical data. Indeed, the authors argue that bat fatality rates are influenced by multiple factors which may complicate any projections of models on the population level (page 16; Diffendorfer *et al*. 2015). Lastly, their model is not designed to implement management strategies regarding the wildlife-friendly development of wind energy, but rather for scientific purposes. More recently, Diffendorfer *et al*. (2017) present a broader methodology to assess population-level effects of wind energy facilities, using ecological knowledge, demographic models and the potential biological removal concept. However, again the authors stress that the data required to make the assessment may be currently lacking or is of insufficient quality for some species.

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

Arnett, E. B., Baerwald, E. F., Mathews, F., Rodrigues, L., Rodríguez-Durán, A., Rydell, J., & Voigt, C. C. (2016). Impacts of wind energy development on bats: a global perspective. In *Bats in the Anthropocene: Conservation of Bats in a Changing World* (pp. 295-323). Springer International Publishing.

Chauvenet, ALM, Hutson, A.M., Smith, G.C., Aegerter, J.N. (2014) Demographic variation in the UK serotine bat: filling gaps in knowledge for management. *Ecology and Evolution*, 4(19): 3820-3829.

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

Diffendorfer, J. E., Beston, J. A., Merrill, M. D., Stanton, J. C., Corum, M. D., Loss, S. R., Thogmartin, W.E., Johnson D.H., Erickson R.A & Heist, K. W. (2015). Preliminary methodology to assess the national and regional impact of US wind energy development on birds and bats.*US Geological Survey Scientific Investigations Report*, *506*.

Diffendorfer, J.E., J.A. Beston, M.D. Merrill, J.C. Stanton, M.D. Corum, S.R. Loss, W.E. Thogmartin, D.H. Johnson, R.A. Erickson & K.W. Heist, 2017. A Method to Assess the Population-Level Consequences of Wind Energy Facilities on Bird and Bat Species. In: Koppel, J. (ed.). Wind Energy and Wildlife Interactions. Presentations from the CWW2015 Conference. Springer International.

Erickson, R. A., E. A. Eager, J. C. Stanton, J. A. Beston, J. E. Diffendorfer, andW. E. Thogmartin. 2015. Assessing local population vulnerability with branching process models: an application to wind energy development. *Ecosphere* 6(12): article 254.

Ferreira, D., Freixo, C., Cabral, J. A., Santos, R., & Santos, M. (2015). Do habitat characteristics determine mortality risk for bats at wind farms? Modelling susceptible species activity patterns and anticipating possible mortality events. *Ecological Informatics*, *28*, 7-18.

Frick, W.F., E.F. Baerwald, J.F. Pollock, R.M.R. Barclay, J.A. Szymanski, T.J.Weller, A.L. Russell S.C. Loeb, R.A. Medellin & L.P. McGuire, 2017. Fatalities at wind turbines may threaten population viability of a migratory bat. *Biological Conservation* 209: 172–177.

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

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

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

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

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Voigt, C.C., Lehnert, L.S., G. Petersons, F. Adorf, L. Bach (2015) Wildlife and renewable energy: German politics cross migratory bats. *European Journal of Wildlife Research*. 61:213-219

Deterrents

The subgroup did not have access to new information since the last report (Doc.EUROBATS.AC21.8).

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

The subgroup did not have access to new information since the last report (Doc.EUROBATS.AC21.8).

Collect national guidelines

In 2016 the EUROBATS Publication Series No 6 "Guidelines for consideration of bats in wind farm projects - Revision 2014" was translated and published in German and French. Therefore it is more accessible in countries which use these languages. In early 2017 translation of the Guidelines into Greek was finished and publication is under preparation.

In Finland, new general guidelines on wind farms planning were published in 2016. The section about bats is very short and general. The EUROBATS guidelines are not mentioned in the text but they are included in the reference list.

In France, in autumn 2015 the Directorate General for Risk Prevention of French Ministry of Ecology, Sustainable Development, Transport and Housing accepted as national guidelines for post-construction environmental monitoring the document produced by the union of wind

farm developers. As this document does not take into account the EUROBATS guidelines, the Société Française pour l'Étude et la Protection des Mammifères published online in 2016 new versions of guidelines for all stages of impact assessment and post-construction monitoring.
In Germany, in three federal states new regional guidelines were published. In Thüringen the new guidelines are specifically on bats. In addition, the Federal Agency has published a book with recommendations concerning bats and wind turbines in forests (Hurst *et al*. 2016). It is unavailable on-line and can be purchased. For references see the chapter "Wind farms and forests" of the report.
In Israel, most of the EUROBATS guidelines (revision 2014) have been translated to Hebrew and the Israel Nature & Parks Authority has made sure that for all new planed wind farms the monitoring scheme instructed by the Ministry of Environment as part of the EIA and surveys required are based on these guidelines.
In mainland Portugal, the national "Guidelines for consideration of bats in monitoring programs of wind turbines projects in mainland" (first version prepared in 2004) were updated with some aspects referred in the EUROBATS Guidelines (revision 2014). A draft proposal was discussed with promoters, companies in charge of monitoring programs, bat experts and environmental authorities. The text was finished in February 2017 and is now waiting for approval by the president of the Institute for the Conservation of Nature and Forests.
The new UK guidance on Bats & wind farms is being drafted at present.
The internet addresses of some national guidelines changed since the previous publication in the Working Group report (2014). Therefore the new list of guidelines is presented below.
All focal points are kindly requested to report to the IWG any new national guidelines or theirs updating.

Countries	EUROBATS guidelines officially recommended	National guidelines exist		
		unofficial	officially recommended	available on-line (year of publication)
Parties				
Albania	no	no	no	
Belgium	yes (in Wallonie)	no	no	
Bulgaria	no	**YES**	no	http://www.nmnhs.com/downloads/brcc/bats-en.pdf (2008)
Croatia	no		**YES**	http://www.zastita-prirode.hr/content/download/393/2127 (2011)
Cyprus	no	no	no	
Czech Republic	**YES** (with some local adaptations)	no	no	no (for adaptations)
Denmark	no	no	no	
Estonia	no	no	no	
Finland	no	no	**YES** (section on bats very short, EUROBATS guidelines just listed in reference list)	http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/79057/OH_5_2016.pdf (2016)
France	**YES** (in some regions)	**YES**	**YES**	**Official general guidelines** http://www.grand-est.developpement-durable.gouv.fr/IMG/pdf/Guide_eolien_cle71dfc4.pdf (2010) http://www.charente-maritime.gouv.fr/content/download/19109/131043/file/12%20Eolien%20

Countries	EUROBATS guidelines officially recommended	National guidelines exist		
		unofficial	officially recommended	available on-line (year of publication)
				St%20F%C3%A9lix%205%20annexe%2013%20Protocole_de_suivi_environnemental.pdf (2015) **SFEPM guidelines** presurvey: http://www.sfepm.org/pdf/20160201_planification_V2.1.pdf (2016) survey: https://www.sfepm.org/pdf/20160213_diagnostic_V2.1.pdf (2016) monitoring: https://www.sfepm.org/pdf/20160213_suivis_V2.1.pdf (2016)
Georgia	no	no	no	
Germany	no	**YES** (for several federal states or companies)	**YES** (for some federal states and a national one on wind turbines in forests)	**Bayern**: https://www.verkuendung-bayern.de/files/allmbl/2012/01/anhang/2129.1-UG-448-A001_PDFA.pdf (2011) **Baden-Wurttemberg**: https://wm.baden-wuerttemberg.de/fileadmin/redaktion/m-mvi/intern/Dateien/PDF/Windenergieerlass_120509.pdf (2012) **Hessen**: http://www.energieland.hessen.de/mm/WKA-Leitfaden.pdf (2012) **Niedersachsen** part 1: http://www.umwelt.niedersachsen.de/download/96713/Planung_und_Genehmigung_von_Windenergieanlagen_an_Land_in_Niedersachsen_und_Hinweise_fuer_die_Zielsetzung_und_Anwendung_Windenergieerlass_Ministerialblatt_vom_24.02.2016_.pdf (2016) part 2: http://www.umwelt.niedersachsen.de/download/96712/Leitfaden_-_Umsetzung_des_Artenschutzes_bei_der_Planung_und_Genehmigung_von_Windenergieanlagen_in_Niedersachsen_Ministerialblatt_vom_24.02.2016_.pdf (2016) **Nordrhein-Westfalen** general: https://www.umwelt.nrw.de/fileadmin/redaktion/PDFs/klima/13_11_12_nrw_leitfaden_arten_habitatschutz.pdf (2013) in forests: https://www.umwelt.nrw.de/fileadmin/redaktion/PDFs/klima/leitfaden_wind_im_wald.pdf (2012) **Saarland**: http://www.saarland.de/dokumente/thema_naturschutz/Leitfaden_Artenschutz_Windenergie_Schlussfassung_19Juni2013.pdf (2013) **Sachsen-Anhalt**: http://www.lee-lsa.de/uploads/media/Leitfaden_Artenschutz_an_WEA_in_ST_07.01.16.pdf (2016) **Schleswig-Holstein**: http://www.umweltdaten.landsh.de/nuis/upool/gesamt/windenergie/windenergie.pdf (2008) **Thüringen**: https://www.thueringen.de/mam/th8/tlug/content/arbeitshilfe_fledermause_und_windkraft_thuringen_20160121.pdf (2015) **Other**: BfN – in forests: http://www.bfn.de/fileadmin/MDB/documents/themen/erneuerbareenergien/bfn_position_wea_ueber_wald.pdf (2011) NLT: http://www.nlt.de/pics/medien/1_1414133175/2014_10_01_Arbeitshilfe_Naturschutz_und_Windenergie__5__Auflage__Stand_Oktober_2014_Arbeitshilfe.pdf (2014)
Hungary	no	no	no	
Ireland	no	**YES**	no	http://www.batconservationireland.org/pubs/reports/BCIreland%20Wind%20Farm%20Turbine%20Survey%20Guidelines%20Version%202%208.pdf (2012)
Israel	**YES**	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	

Countries	EUROBATS guidelines officially recommended	National guidelines exist		
		unofficial	officially recommended	available on-line (year of publication)
Moldova	no	no	no	
Monaco	no	no	no	
Montenegro	no	no	no	
Netherlands	no	**YES**	no	http://www.rvo.nl/onderwerpen/duurzaam-ondernemen/duurzame-energie-opwekken/windenergie-op-land/milieu-en-omgeving/vleermuizen (2013)
Norway	no	no	no	
Poland	no	**YES** (NGOs guidelines 2009 not up-dated, draft official guidelines recommended by NGOs)	no (draft official guidelines still not officially accepted but commonly used)	**Draft of official guideline** http://www.ansee.pl/wp-content/uploads/2015/09/Wytyczne_dotyczace_oceny_oddzialywania_elektrowni_wiatrowych_na_nietoperze.pdf (2013) **NGO guidelines** http://www.salamandra.org.pl/DO_POBRANIA/Nietoperze/Guidelines_Poland.doc (2009.2)
Portugal			**YES**	http://www.icnf.pt/portal/naturaclas/patrinatur/resource/docs/Mam/morc/morc-recom-p-eolic (2008) A draft of new version (2017) is waiting for approval by authority
Romania	no	**YES**	no	http://www.aplr.ro/index.php?lang=ro&cat=9&page=2 (2008)
San Marino	no	no	no	
Slovakia	no	no	no	
Slovenia	no	no	no	
Sweden	no	no	no	
Switzerland	no	no	no	
Ukraine	no	no	no	
United Kingdom	no	**YES**	**YES**	**National guidelines** Natural England's: http://publications.naturalengland.org.uk/file/6122941666295808 (2014) BCT: http://www.bats.org.uk/publications_download.php/1422/Bat_Survey_Guidelines_2nd_edition_wind_farms_chapter_NON_PRINTABLE.pdf (2012) **Regional guidelines** Cornwall – general guidelines: http://www.cornwall.gov.uk/media/3626640/3-Onshore-Wind-V2-June-2013-cover.pdf (2013) Cornwall – single wind turbines: https://www.cornwall.gov.uk/media/3622897/Bat-survey-guidance-for-small-wind-turbine-applications-in-Cornwall-March-2011.pdf (2011) Ceredigion – single wind turbines: https://www.ceredigion.gov.uk/utilities/action/act_download.cfm?mediaid=52666 (2015)
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	
Egypt	no	no	no	
Greece	no	no	no	
Holy See	no	no	no	
Iran	no	no	no	
Iraq	no	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	

Countries	EUROBATS guidelines officially recommended	National guidelines exist		
		unofficial	officially recommended	available on-line (year of publication)
Serbia			**YES** (chapter about wind farms in national EIA guidelines for bats)	http://www.nhmbeo.rs/upload/images/ove_godine/Promocije2011/bats_and_environmental_impact_assessment_web_lq.pdf (2011)
Spain	no	**Yes**	no	http://secemu.org/wp-content/uploads/2016/12/barbastella_6_num_esp_2013_red.pdf (2013)
Syria	no	no	no	
Tunisia	no	no	no	
Turkey	no	no	no	

Hurst, J., Biedermann, M., Dietz, C., Dietz, M., Karst, I., Krannich, E., Petermann, R., Schorcht, W. & R. Brinkmann (2016) Fledermäuse und Windkraft im Wald. Naturschutz und Biologische Vielfalt 153, Bonn - Bad Godesberg: 400 pp.

Use of dogs vs humans during carcass searches

Search dogs are used in a number of fields including police tracking, search and rescue, truffle searches, hunting and cadaver searches (Browne *et al*. 2006). They are proved to be a lot more accurate and effective in searching for bat carcasses under wind turbines at steep and heavily vegetated sites, large search plots and locations where specific threatened or endangered species are the biggest concern (Arnett *et al*. 2005, Arnett 2006, Paulding *et al*. 2011, Paula *et al*. 2011, Mathews *et al*. 2013). The differences between human searchers and search dogs are caused by the differences between human vision and dog olfactory sense, which can be used in larger area and in higher and denser vegetation (Arnett *et al*. 2005).

These conclusions were once again reinforced by Reyes *et al*. (2016). In a set of trials performed at a solar energy facility, searcher-efficiency rates ranged from 86% of large avian carcasses detected by dog-handler teams to 23% of feather spots detected by human teams. Precision of fatality estimates strongly depended on searcher efficiency and very rare fatalities were likely to go undetected when a low proportion of a site was searched, which supports the use of detection dogs to find rare fatalities when survey conditions give them an advantage over 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, Bennett 2014). Reyes *et al*. (2016) stresses the importance of introducing dogs to all parts of the birds (at various stages of decay), as feather spots and partial carcasses may compose a large proportions of detected fatalities at sites where scavenging rates are high or when search intervals are long. It is important to note 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 and maintain the dog's enthusiasm, 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). In 2016 a review of scientific literature regarding the selection of appropriate dogs was published in which olfactory ability is considered critical, but also a range of other characteristics, including biological, psychological, and social traits. Still, no validated selection tools have been published (Beebe *et al*. 2016).

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

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Browne C., K. Stafford & R. Fordham. 2006. The use of scent-detection dogs. *Irish Veterinary Journal*, 59(2): 97-104.

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

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

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

Reyes G., M. Rodriguez, K. Lindke, K. Ayres, M. Halterman, B. Boroski & D. Johnston. 2016. Searcher efficiency and survey coverage affect precision of fatality estimates. *Journal of Wildlife Management*, 80(8): 1488-1496.

Comparing measurement of activity at ground level and rotor height

The EUROBATS Guidelines (Rodrigues *et al*. 2014) identify that large wind turbines have a rotation zone of between 40 and 220m above ground level and therefore consideration should be given to the height at which bat surveys are undertaken. The guidelines go on to recommend that where high structures are available (such as meteorology masts or existing turbines) these are used to erect automated bat detectors within the collision risk zone of the newly proposed turbines in order to establish the bat activity index (and species composition). Recording bat activity at ground level and height simultaneously with the same type of detector allows a comparison and gives insight into the differences in bat activity between two or more heights.

Studies comparing activity levels at ground and at height include the following:

- Various research projects from North America have suggested that, particularly in forested situations, ground level surveying may not provide an accurate picture of bat activity at all heights (Kalcounis *et al*. 1999; Hayes & Gruver 2000).

- Menzel *et al*. (2005) studied the effect of habitat and height on bat activity in the USA and found that activity was significantly higher closer to the ground than at height (30m) in open habitats but bat activity was greater above the canopy (> 30m) than inside or below the canopy in forests. Higher activity levels of open-adapted species were observed above the canopy but activity of clutter-adapted species did not vary with height.
- A study in France (Sattler & Bontadina 2005) used zeppelins to record bat activity at height, finding that no extra bat species were recorded at height in comparison to ground level and feeding buzzes were recorded as high as 90m. *Pipistrellus* species were recorded at 150m; *Eptesicus serotinus* and *Pipistrellus* species were recorded at 90m; and *E. serotinus*, *Pipistrellus* and *Myotis* species were recorded at 30m.
- Arnett *et al*. (2006) carried out acoustic sampling at 1.5m, 22m and 44m above ground level in the USA, concluding that bat species with high frequency echolocation calls were more active at a lower height than bat species with low frequency echolocation calls and vice versa.
- A Scandinavian study relating to offshore wind farms (Ahlen *et al*. 2007) observed *Nyctalus noctula* flying up to 1200m height and observed that most bat migration activity was 0-10m above sea level with larger species flying higher up to 40m.
- Collins & Jones (2009) found, by recording bat activity simultaneously at height (30m) and ground level at seven sites in the UK, that *Nyctalus* and *Eptesicus* species made up a higher proportion of overall bat activity at height in comparison to at ground level and the opposite was true of *Pipistrellus* species. The study found that all species recorded at height had also been recorded at ground level except in a closed canopy woodland situation, where *Nyctalus* and *Eptesicus* species were only recorded above the canopy.
- Behr *et al*. (2011) found that nyctaloids are more frequent at rotor height than at ground level, *Pipistrellus pipistrellus* is less frequent at rotor height than at ground level and the activity levels of *P. nathusii* are similar at all heights.
- Bach *et al*. (2012) studied bat activity inside and above a beech forest. The showed that surveying bats from the ground inside the forest did not reflect the activity above the canopy, both in terms of the species composition and the seasonality. They recommended that bat activity is monitored above the canopy when wind turbines are planned inside the forest.
- In 2013, Bach *et al*. found that there was a link between activity levels measured at ground level and at wind turbine nacelles but this changed throughout the season, with bats flying either at height or close to the ground in spring and autumn but using more of the airspace in the summer.

- A large number of sites all over Europe have hosted automatic recordings of bats within the collision risk zone of turbines, e.g. at the bottom of the blade swept zone of future wind turbines, or at the nacelle of existing wind turbines (e.g. CSD 2013, Sertius-Biotope 2014, Rico 2016).
- A German study (Reers *et al*. 2017) used 193 nacelle height surveys from 130 individual wind turbines to investigate whether bat activity, phenology and species composition differ between open and forested landscapes. There was no significant difference between these variables in these landscapes. The study recommended that bat activity should be recorded additionally at the lowest point of the rotor and also studies into the proximity of bat roosts and the age structure of the forest are needed.
- A German study analysed bat activity data from meteorology masts at proposed wind farms and found that bat activity in forest clearings was greater at ground level than at height (Hurst *et al*. 2014, Hurst *et al*. 2016).
- A recent study by the University of Exeter (Mathews *et al*., 2016) compared bat monitoring data from 138 turbines at ground level (for 1,367 nights) and 105 turbines at height (for 1,258 nights). The study concluded that estimates of activity levels from the ground are positively biased towards *P. pipistrellus* and *P. nathusii* and negatively biased towards *P. pygmaeus* and *N. noctula*. The research showed that ground level monitoring is not able to accurately predict bat activity levels in the collision risk zone for all species and therefore monitoring at height should be carried out.

The main themes that emerge from this work are as follows:

- Surveying from ground level only may not give an accurate assessment of levels of bat activity at height (particularly in forested situations).
- Bat activity has been recorded closer to the ground in open habitats (such as grassland or arable) and at height, above the canopy, in forested situations. However, bats can decrease their flight height also in forest clearings.
- The same species are generally recorded at height as are recorded at ground level, except in forested situations. This emphasises the need to record above the canopy when surveying in forests.
- Bats feed at height.
- Numbers of bat calls and flight heights recorded vary according to the site and the time of year.
- Species composition at height varies from species composition at ground level, with greater proportions of open-adapted species such as nyctaloids at height. However, the pattern of activity of the *Pipistrellus* species and clutter-adapted species is less clear as there is inconsistency in the results of different studies.
- The number of bat calls at height is proportionally higher in August and September than during the other months of the activity season, as a result of an increased activity of

migrating species (mainly *N. noctula*, *N. leisleri* and *P. nathusii* but also resident *P. pipistrellus*).

- However, one study found no significant difference in bat activity, phenology and species composition when comparing activity at the nacelle in open and forested habitats and recommended surveys also from the base of the blade tip in the future.

Therefore, it is recommended that results from bat detector surveys at ground level are used only to predict species composition and phenology at rotor height (e.g. Hurst *et al*. 2015) whereas bat activity indices (quantitative analysis) should only be calculated using recordings of bat activity at height. This is likely to be particularly important in forested situations and where keyholed turbines (sited in a small clearing within woodland or forest) are proposed.

Since bat activity tends to decrease with altitude (measured from the ground in open areas and from the canopy in forested situations, e.g. Hurst *et al*. 2014, Hurst *et al*. 2016), significantly increasing the height of the bottom of the blade swept zone (e.g. from 50m to 70m, using a higher tower but keeping the rotor blade length constant) may be regarded as a complementary mitigation measure, in combination with blade feathering.

Work by Behr *et al*. (2015) on reducing collision risk for bats at onshore wind turbines (using algorithms within the RENEBAT II system) emphasised the potential differences in the area around the nacelle subject to acoustic sampling when using different detectors and even between detectors using different settings; these are important considerations when monitoring bats at height. This work illustrated how detectors could be pre-installed into the nacelle in steel control cabinets. During the study it was found that the distribution of bats in the rotor swept area decreased exponentially with increasing distance from the nacelle, illustrating that bats are indeed attracted to turbines. Jameson & Willis (2016) also found that bats actively visit tall structures in the landscape. This further emphasises the need to record bat activity at height when conducting impact assessments. Due to the new very long rotor blades (70m) and the limited echolocation range of e.g. *Pipistrellus* it is also important to survey bat activity at the bottom of the rotor swept zone. Recent, unpublished studies suggest bat activity may be higher there (Bach L., pers. com.).

Trajectography has recently been made possible using synchronized acoustic or thermographic sensors to record the locations of bats. When applied at existing wind turbines, trajectography shows that bats typically approach turbines on the leeward (downwind) side (Cryan *et al*. 2014, Rico 2016). This suggests that the mast or the nacelle of a wind turbine may be attractive to bats for different reasons. More research needs to be conducted on this topic.

Ahlen I., Bach L., Baagoe H.J. & Petersson J. 2007. *Bats and offshore wind turbines studied in southern Scandinavia*. Swedish Environmental Protection Agency, Stockholm, Sweden, 36 pp.

Arnett E.B., Hayes J.P. & Huso M.P. 2006. *Patterns of pre-construction bat activity at a proposed wind facility in south-central Pennsylvania*. An annual report submitted to the Bats and Wind Energy Co-operative. Bat Conservation International, Austin, Texas, 46 pp.

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Collins J. & Jones G. 2009. Differences in bat activity in relation to bat detector height: implications for bat surveys at proposed windfarm sites. *Acta Chiropterologica*, 11(2): 343-350.

Cryan P.M., Gorresen P.M., Hein C.D., Schirmacher M.R., Diehl R.H., Huso M.M., Hayman D.T., Fricker P.D., Bonaccorso F.J., Johnson D.H. & Heist K., 2014. Behavior of bats at wind turbines. *Proceedings of the National Academy of Sciences*, 111(42): 15126-15131.

CSD. 2013. *Suivi de mortalité des chauves-souris et bat monitoring sur le parc éolien de Perwez*. Rapport final. CSD Ingénieurs Conseils Namur. 94 pp.

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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 possible 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 (< 18m hub height / < 15kW) bat activity is substantially reduced, suggesting their use of habitat adjacent to SWT may be affected (Minderman *et al*. 2012, Tatchley 2015), but that mortality rates at many sites appear to be relatively low (Minderman *et al*. 2015).

Minderman *et al*. (in press) examined the potential for greater impacts on bat foraging activity at sites with multiple turbines, and also at larger scales than previously examined. Based on 34 sites in Scotland (UK) and after accounting for potentially confounding effects (e.g. variation in habitat and weather), they show that: (1) mean *P. pipistrellus* activity is lower at close to SWT (0–100m compared to 200–500m), and (2) the effect on *P. pygmaeus* activity tends to be similar and stronger in multiple SWT sites. The authors concluded that in some cases, adverse effects of SWTs on bat activity may be measurable over longer spatial scales (within 100m) than previously thought. However, combined with earlier findings, it is likely that the bulk of such effects operate within relative close proximity of SWTs (<25m). Moreover, although these effects may be species-specific, with, for example, *P. pygmaeus* potentially more strongly affected by multiple SWT sites, this requires further data.

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Offshore wind farms

Ecocom (2012) studied bats in the Baltic Sea approximately 4-9km east of Öland (Sweden). Nine places (1 windmast and 8 buoys) were studied in an area where offshore wind turbines were planned. All together they recorded 239 bats of at least seven species. The most common one was *Nyctalus noctula* followed by *Pipistrellus pygmaeus, Eptesicus nilssonii*, *Myotis daubentonii, Pipistrellus nathusii*, *Eptesicus serotinus* and *Plecotus auritus.* 13% of the recordings bats were feeding. After building the wind farm, Ecocom (2015) monitored the activity at 3 of the 16 built wind turbines. One microphone of a Avisoft detector was placed 7m above the sea and a second one was placed under the nacelle (height above sea level unknown). Wind turbines were not working in 35 nights during autumn. Most activity was recorded in spring at 7m above the sea: 101 contacts of bats, mainly *P. nathusii* (49) and *P. pygmaeus* (37), and a few *E. nilssonii* (4) and *N. noctula* (1); 10 bats of the genus *Myotis* were also recorded. In the same season, only 3 bats were recorded at nacelle height: 2 *P. nathusii* and 1 *P. pygmaeus*. Less bats were recorded in autumn, but the percentage detected in the two heights was different: at 7m only 5 *P. nathusii* were recorded, while at nacelle height 8 *N. noctula* and 4 *E. nilssonii* were recorded.

In Germany a BfN/BMU project about offshore bat migration (BATMOVE) started in summer 2016. In autumn 2016 bat activity was recorded in the North Sea at Helgoland, at the research platform FINO 1 far outside of the island Borkum and in the German part of the Baltic Sea (Bach *et al*. 2017). The highest bat activity was found in the Baltic Sea, between Gedser and Warnemünde (about 25km out at sea). These data are in line with the findings of Hüppop & Hill (2016) about bat activity at FINO 1 during the last 10 years.

Ecocom. 2012. Studie av fladdermöss vid vindkraftspark Kårehamnsporten före etablering 2012 - inklusive förslag till design av kontrollprogram - unpubl. report to E.On Vind Sverige AB: 16 pp.

Ecocom. 2015. Uppföljande studie av fladdermöss vid Kårehamnporten – En jämförelse mellan förekomst och aktivitet av fladdermöss före respektive efter etablering av vindkraftverk. – unpubl. report to E.On Vind Sverige AB: 14 pp.

Hüppop, O. & R. Hill. 2016. Migration phenology and behaviour of bats at a research platform in the south-eastern North Sea. *Lutra* 59(1-2): 5-22.

Bach, L., P. Bach, H. Pommeranz, R. Hill, C. Voigt, Ma. Göttsche, Mi. Göttsche, H. Matthes & A. Seebens-Hoyer. 2017. Offshore bat migration in the German North and Baltic Sea in autumn 2016. – Poster at the 5th Int. Berlin Bat Meeting (24.- 26.2.2017).

Wind farms and forests

The long-term project on “Investigations to minimize the impacts of wind turbines on bats, particulary in forests”, funded by the German Federal Agency for Nature Conservation, was finished and a book with the results was published (Hurst *et al*. 2016). Investigations specifically into bat activity at height were carried out at several forest sites and additionally in roosting areas of *Barbastella barbastellus*, *Pipistrellus pipistrellus* and *Nyctalus leisleri*, in addition to further investigations into phenology, roost use and spatial habitat use. Furthermore, the book includes meta-analysis of activity data and of maternity roost location data to identify regions with high presence of several bat species. Results and recommendations include: (a) bat species which are relevant to planning should be expected to occur in all forest habitats, (b) a higher potential conflict should be expected in structurally rich landscapes and at low and medium elevation in areas with high activity of a diversity of species, (c) pre- and post-construction monitoring must be carried out, (d) acoustic measurements should be made at nacelle height and also in the area where the lower tips of the rotor blades pass, (e) it was shown that only species which are often casualities of wind turbines were detected to be active at height: *P. pipistrellus*, *P. nathusius* and *Nyctalus* sp, *Eptesicus* sp and *Vespertilio* sp (f) bat activity was highest around the months of July and September and occurred mostly in the first half of the night, (g) bat activity at the ground however was relatively constant across the months, (h) activity decreased considerably with increases in wind speed and reductions in temperature, (i) measurements of bat activity at height (at measuring masts) are necessary to forecast collision risk at certain times at wind farms in forests and to establish site specific shut-down algorithms.

The book also includes a case study on *B. barbastellus* at different sites within Germany, and it was shown that the species is rarely active above 30m or above canopy height, whereas it is regularly active at ground level. From a height of 50m onwards, almost no activity was measured. However, to protect the habitats of this rare species, authors consider that wind farms should not be built in forests with roosts and maternity colonies.

In the case of *N. leisleri*, the book refers an increased risk of collision with wind turbines primarily for females in the proximity of mating areas. Mating areas must therefore be accurately defined in pre-construction surveys.

Authors recommend criteria exempting areas for the construction of wind farms, which include deciduous and mixed old forests, semi-natural coniferous forests with high roost potentials as well as woodland areas within SAC's, and consider that any loss of habitat should be compensated via several measures for the creation of new habitat or through improvement of the quality of existing habitat. Since areas with a high collision risk are not easy to identify, they defend that shut-down times are necessary for all wind farms before results of monitoring are available.

Based on the biology of bats, an increase of risk of mortality almost certainly negatively affects population development, so authors consider that a cautious approach is therefore essential according to the precautionary principles.

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Implementation of mitigation and post-construction monitoring

The IWG on Wind Turbines and Bat Populations has distributed two questionnaires in the past, in 2004 and 2009. An analysis of the responses was presented during the StC4/AC15 in 2010. The main objective of this new questionnaire is to complement the previous ones. Some questions are repeated in order to be able to follow the development of the land-based wind industry on a Pan-European scale.

Nevertheless, considering recent conservation evidence on bat mortality (Voight *et al*. 2012, 2015; Mathews *et al*. 2016, Frick *et al*. 2017), this questionnaire focused on evaluation of best practice and legislation that is implemented under the scope of UNEP/EUROBATS Agreement in order to mitigate high mortality rates across EUROBATS area.

Out of 63 EUROBATS range states, 26 answered questionnaires were submitted to Secretariat. Out of 36 Parties, 19 submitted answers (one Party submitted only for one part of the country (Belgium-Flanders), Denmark submitted 2 answered questionnaires and Portugal submitted questionnaires for mainland and Madeira). Jordan and Algeria reported no operational onshore wind farms in questionnaires. Only data from questionnaires answered were used in subsequent analyses.

Representatives from San Marino, Malta and Armenia reported to Secretariat that they will not submit questionnaires since onshore wind farms are not present in their countries. Regarding Russia, information submitted to the group was that there are only few small wind farms which can be disregarded. Questionnaires from Portugal Azores and Turkey came too late and were not included in the analyses.

Considering the first publication of EUROBATS Guidelines, first wind farms were built only in six range states after 2008, while in 18 range states first onshore wind farms were built prior to 2008 with first wind farm being built in Denmark before 1980.

Germany, Denmark, Poland, Spain and France reported more than 900 onshore wind farms being operational by the end of 2015 (note: Germany probably stated number of wind turbines rather than number of wind farms). Five range states reported in between 100 and 230 wind farms operating by the end of 2015, six range states reported from 10 to 70 wind farms (in addition to Portugal-Madeira), while six countries reported less than 10 wind farms in operation. Moldova, Jordan and Algeria reported no operational wind farms, while Ukraine didn’t provide the answer.

Number of wind farms doesn’t correspond to number of wind turbines per country while minimum-maximum span with median and average number of wind turbines per wind farm provides better overall picture. Morocco and Portugal-mainland reported more than 100 wind turbines as maximum per wind farm, while six range states reported maximums being between 60 and 70 WT/WF (wind turbine per wind farm). Nine range states reported between 12 and 33 WT/WF, while four range states reported 1 to 9 as maximum number of WT/WF. Eleven range states reported minimums of 1 WT/WF. No data on median and average number of

WT/WF was provided by 11 range states. Morocco reported highest median of 22 WT/WF with an average of 49 WT/WF, while Slovenia reported the lowest median and average of 1 WT/WF. Post-construction monitoring of impact on bats is obligatory for new wind farms in 11 range states, while in 13 it is not obligatory and is based on EIA procedure.

Post-construction monitoring was introduced as obligatory in Spain (1986), Portugal-mainland and Portugal-Madeira (2000), Netherlands (2002), Croatia (2004), Morocco (2008), in 2010 in Serbia, Lithuania and Slovakia, and in Moldova (2016). Based on EIA Procedure it can be imposed in Poland after 2008.

Although obligatory monitoring started to be prescribed in different years per different countries, it didn’t apply to all new wind farms after the year obligatory monitoring was introduced in every country. Only six range states reported that it is applied on all new wind farms since the year of introduction, while five range states don’t apply such a rule.

Additionally, obligatory monitoring is applied to all wind farms in six range states disregarding preconstruction assessment threat on bats assessment, while in six range states it is prescribed only for wind farms that are perceived to present a threat to bats based on the preconstruction assessment.

Post-construction monitoring is prescribed probably for almost all wind farms in Portugal and Serbia, and more than 60% wind farms in Croatia. In Lithuania approximately 1/3 of all wind farms and a bit less than 30% of all wind farms in Morocco have post-construction monitoring prescribed. In France, with more than 900 wind farms, it is estimated that 20% wind farms have post-construction monitoring prescribed, while in Spain with more than 1000 wind farms reported, less than 0.5% operates with post-construction monitoring.

In 12 range states there are no law or regulation that prescribes post-construction monitoring, 10 range states have regulations, acts or procedures in which monitoring is prescribed, and in four range states it is reported as unknown.

Post-construction monitoring is done more or less according to EUROBATS Guidelines in eight range-states (France, Croatia, Lithuania, Morocco, Netherland, Portugal-mainland and Portugal-Madeira, Serbia and Spain). In 11 range states it is not done according to the Guidelines (Denmark, Germany, Poland, Belgium-Flanders, Belarus, Latvia, Moldova, Norway, Slovakia, Switzerland and Ukraine) while in five ranges states it is reported as unknown (Ireland, Finland, Georgia, Macedonia and Slovenia).

In 13 range states avoidance or mitigation measures are prescribed: blade feathering in combination with increased cut-in speed (Croatia, France, Serbia and Switzerland), combination of increased cut-in speed and deterrents (Lithuania, Slovakia and Spain), increased cut-in speed only (Denmark, Netherlands, Poland and Portugal-mainland) while Germany reported prescription of shutdown of the wind turbine during specific hours/migration periods or use of turbine-specific curtailments algorithms. Belgium-Flanders and Netherlands reported probably no prescription of avoidance or mitigation measures. In nine range states no mitigation or avoidance is being prescribed (Belarus, Georgia, Ireland, Latvia, Moldova, Morocco, Norway, Slovenia and Ukraine).

Effectiveness of mitigation measures is being monitored at least in seven range states (Morocco-probably, Netherlands-sometimes, Poland, Serbia, Switzerland, Portugal-mainland and Portugal-Madeira, Spain and Croatia). In 16 range states effectiveness of mitigation measures is not being monitored (including ones with most wind farms reported: Denmark, Germany and France) while in Ukraine it is not known.

Implemented mitigation measures are controlled by authorities in 10 range states which includes mostly control on random basis (Croatia, Germany, Lithuania) and in two range states is on annual basis (Netherlands, Portugal-mainland). In 10 range states there is no control reported (including Denmark) while situation is unknown in four range states (Finland, Georgia, Slovenia and Ukraine). Results of monitoring and mitigation monitoring studies are available to public under various conditions at least in five range states (Moldova-probably, Croatia, Netherlands, Poland, Portugal-mainland and Portugal-Madeira, and Serbia). Such studies are not available to public in 14 range states while availability to public in Slovenia is unknown. Bibliographic references to such studies were submitted by six range states (Croatia, Denmark, Germany, Netherlands, Portugal-mainland and Portugal-Madeira, and Spain).

Based on the results, future recommendations regarding post-construction monitoring will be discussed during the 22AC meeting. The full report on the analyses is presented in Annex 3.

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Voigt, C.C., Lehnert, L.S., G. Petersons, F. Adorf, L. Bach. 2015. Wildlife and renewable energy: German politics cross migratory bats. *European Journal of Wildlife Research*, 61:213-219

200m buffer distance to habitats particularly important for bats

Using static detectors Heist (2014) studied bat (and bird) activity for 3 years (2010-2012) at 160 locations across the USA. At specific sub-set of locations he studied effects of landscape features on pass rates and found bat activity levels near the edge of forested river corridors in agricultural settings (in Minnesota) to be higher than those farther from the edge: activity dropped off quickly with distance and it was found to be relatively uniformly low at distances past 200m. He found no such effect of grassland arrays nor of the Great Lakes coastline. Although having limited practical significance for Europe (due to different species composition), it’s interesting to note that spatial patterns of bat activity in relation to particular landscape elements seem to be very similar (Kelm *et al*. 2014, Heim *et al*. 2015) and that therefore Guidelines' recommendation of 200m buffer may have even more universal application.

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Heist, K. 2014. *Assessing Bat and Bird Fatality Risk at Wind Farm Sites using Acoustic Detectors*. Doctoral Dissertation, University of Minnesota.

Kelm, D.H., J. Lenski, V. Kelm, U. Toelch & F. Dziock. 2014. Seasonal Bat Activity in Relation to Distance to Hedgerows in an Agricultural Landscape in Central Europe and Implications for Wind Energy Development. *Acta Chiropterologica*, 16(1): 65-73. doi: http://dx.doi.org/10.3161/150811014X683273.

Sensitivity maps

No significant progress has been made yet. Initial sensitivity mapping has been developed in Israel, although it has still to be reviewed and validated. This will be presented for review by the IWG during the 22AC meeting.

Final remarks

Available results continue to show that mortality is highly variable between different sites and between different wind turbines within one wind farm. Besides that, mortality varies between years and this is why we advise for at least a 3-year mortality monitoring during the operational phase to get a better idea of the impact and to avoid biases unrelated to the wind farm. Furthermore monitoring of mortality rarely follows the same method. Monitoring schedule, time interval between controls and estimator for mortality rate differ from one wind farm to the other and make comparisons impossible. Tests for predation and searcher's efficiency are not always performed, not to mention the correction for the % of area not sampled.

It is not possible to evaluate the impacts of wind farms without mortality data; yet very few 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 urges the EUROBATS range states again to send data on observed mortality (raw data and not aggregated ones in synthesis), 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 Annex 1 of Doc.EUROBATS.AC20.5, Annex 1 of Doc.EUROBATS.AC21.8, and chapter 9 of EUROBATS Publication Series nº 6)

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Behr, O., Brinkmann, R., Korner-Nievergelt, F., Nagy, M., Niermann, I., Reich, M., Simon, R. (Hrsg.) (2015). Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen (RENEBAT II). - Umwelt und Raum Bd. 7, 368 p., Institut für Umweltplanung, Hannover.

Bennett E. (2015). Observations from the Use of Dogs to Undertake Carcass Searches at Wind Facilities in Australia. In Wind and Wildlife, Proceedings from the Conference on Wind Energy and Wildlife Impacts, October 2012, Melbourne, Australia; Springer 2015, p.113-124.

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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,* Annex 2 of *Doc.EUROBATS.AC18.6,* Annex 2 of *Doc.EUROBATS.StC9-AC19.12,* Annex 1 of *EUROBATS Publication Series nº 6,* Annex 2 of *Doc.EUROBATS.AC20.5,* and Annex 2 of *Doc.EUROBATS.AC21.8*)

Study (author, year, area)	**Time**	**Habitat types**	**Data on WTs**	**Methods**	**Results**
Bio3, Prados, 2011, Portugal	March to October 2010	Mainly agricultural areas with some pine plantations, bushes and rocky outcrops with a few oak forests	Pre-construction monitoring	AS: monthly from March to October (10-min survey at each sampling point). Bat activity was recorded at ground level with D240X Pettersson Elektronik connected to a digital recorder. Bat vocalizations were analysed using sound-analysis software.	Roosts: 2Mmyo/Mbly, 24 Rfer, 4 Ppip/Ppyg/Msch, 1 Eser/Eisa, 1 Ppip/Ppyg, 2Rhip, 1 Reur/Rmeh AS: Bbar, Eser/Eisa, Eser/Eisa/Hsav, Hsav, Mdau/Mesc/Mbec/Mmys/Mema, Nlas/Nnoc, Nlei, Nlei/Eser/Eisa, Nyc sp., Paus/Paur, Pkuh, Pkuh/Ppi, Ppip/Ppyg, Ppip/Ppyg/Msch, Ppyg, Ppyg/Msch, Pip sp., Rfer, Tten, NI.
Bio3, Portela do Pereiro, 2015, Portugal	July 2014 to February 2015	Mainly old pastures and bushes with some pine forest and eucalyptus.	4 VESTAS V90 (1.8mW each)	AS: monthly between July and October. Roosts: Monthly visits between July and October 2014 and January, February 2015.	AS: Eser/Eisa, Mesc, Nlei, Nlei/Eser/Eisa, Nyc spp., Pkuh, ppip, Pip spp., Ple spp., Tten. Roosts: 29 Mmyo/Mbly, 585 Msch, 19 Rfer, 1 Rhip, 230 Mmyo, 5 Rhi sp.
Bioinsight, Malhanito, 2016, Portugal	August 2008 to January 2016	Mainly bush and occasionally pine and cork oak forests and cork oak agroforest systems.	29 ENERCOM E-82 WT's (2.3mW each)	MM: Weekly between March and October and monthly between December and February and in November.AS: monthly from March to October (10-min survey at each sampling point). AS: Bat activity was recorded at ground level with D240X Pettersson Elektronik connected to a digital recorder. Bat vocalizations were analysed using sound-analysis software.	5 dead bats: 1 Ppip, 1 Eisa, 1 Ppyg, 1 Pip spp. and 1 NI AS: Nlei, Pkuh, Ppyg/Msch, Ppip, Ppyg, Ppip/Ppyg, Ppip/Ppyg/Msch, Eser/Eisa, Nyc sp., Nlei/Eser/Eisa Roosts: 187Rhip, 18 Mmyo/mbly, 51 Reur/Rmeh, 17 Mbly
Bio3, Prados, 2016, Portugal	January to December 2014	Mainly agricultural areas with some pine plantations, bushes and rocky outcrops with a few oak forests	17 ENERCOM E-82 WT's (2.3mW each)	MM: Weekly between March and October with the use of a man-search dog team. AS: monthly from March to October (10-min survey at each sampling point). AS: see above	10 dead bats: 1 Ppyg, 1 Ppip, 1 Tten, 1 Hsav, 4 Nlei and 2 NI. Roosts: 78 Rfer, 1Ppip/Ppyg, 4 Ppip/Ppyg/Msch, 1 Eser/Eisa, 9 Rhip, 13 Mmyo/Mbly, 3 Reur, 1 Myp spp., 7 Mmyo, 1 Mbly, 4Rmeh/reur AS: Bbar, Eser/Eisa, Eser/Eisa/Hsav, Hsav, Mdau, Mesc, Mmyo/Mbly, Myo spp., Nlas/Nnoc, Nlei, Nlei/Eser/Eisa, Nyc sp., Pkuh,Ppip, Ppyg/Msch, Pip sp.,Plec spp., Reur/Rmeh, Tten, NI.
Bioinsight, Mosqueiros II, 2016, Portugal	March to December 2015	Mainly bushes, some rocky outcrops and oak forests.	10 ENERCOM E-82 (2.0mW each) + 2 ENERCOM E-92 (2.3mW each)	MM: Weekly between March and October.AS: monthly from March to October (10-min survey at each sampling point), for methods see above	MM: 12 dead bats: 5Ppip, 3 Nlei, 1Pkuh, 1 Pkuh/Ppip, 1 Tten, 1 Hsav; Roosts: 18 Rfer/Reur/Rmeh, 37 Mmyo, 99 Rfer, 274 Nlei/Eser/Eisa, 54Eser/Eisa, 310 NI, 2 Nyc spp., 1 Nlas/Nnoc, 11 Rhip, 3 Reur, 6 Ppip, 3 Pip spp., 26 Mmyo/Mbly. AS: Rfer, Rhip, Rmeh/Rhip, Rfer/Rhip/Rmeh/Reur, Mmyo/Mbly, Mesc, Mdau, Mmyo/Mbly/Mesc/Mbech/Mdau, Ppip, Ppyg, Pkuh, Ppip/Ppyg, Ppip/Ppyg/msch, Ppip/Pkuh, Ppyg/Msch, Hsv, Nnlei, Nlas, Nlei/Nlas, Nlas/Nnoc, Nlei/Eser/Eisa, Nyc sp., Eser/Eisa, Eser/Eisa/Hsav, Bbar, Paur/Paus, Tten
Bioinsight, Vale de Estrela, 2016, Portugal	March to December 2015	Mainly bushes and grasslands, with some rocky outcrops and occasional oak forests.	11 ENERCOM E-92 (2.3mW each)	MM: Weekly between March and October.AS: monthly from March to October (10-min survey at each sampling point), for methods see above	MM: 0 dead bats. AS: Bbar, Eser/Eisa, Eser/Eisa/Hsav, Nlei/Eser/Eisa, Nyc spp., Mmyo/Mbly, Myo spp., Pkuh, Ppip, Ppyg, Ppyg/Msch, Pip spp., Paus/Paur, Rfer, Tten. Roosts: 6 Ppip, 37 Rfer, 1 Rhip, 2 Ppip/Msch, 24 Mmyo/Mbly, 5 Myo spp.

Bio3, Alto dos Forninhos, 2016, Portugal	May 2014 to April 2015	Mainly pine forests, some holm oaks, cork oaks and other hardwood trees	4 SENVION MM92 (2.05mW each)	MM: Weekly between March and October and monthly between November and February. AS: monthly from March to October (10-min survey at each sampling point), for methods see above	MM: 1 dead bat, 1 Nlei. AS: Bbar, Eser/Eisa, Eser/Eisa/Hsav, Hsav, Mesc, Mmyo/Mbly, Myo spp, Nlei, Nlei/Eser/Eisa, Pkuh, Ppip, Ppyg/Msch, Pip spp, Pip spp/Msch, Rhip, Tten. Roosts: 40 Rfer, 3000 Reur, 50 Rmeh,1690 Mmyo, 32010 Msch, 3 Rhip, 3 Mdau/Mmys
Bioinsight, Alto dos Forninhos, 2016, Portugal	May 2015 to April 2016	Mainly pine forests, some holm oaks, cork oaks and other hardwood trees	4 SENVION MM92 (2.05mW each)	MM: Weekly between March and October and monthly between November and February. AS: monthly from March to October (10-min survey at each sampling point), for methods see above Roosts: Visits in May, June, July and September 2015 and March 2016. Bats were counted and identified locally.	MM: 2 dead bats, 2 Ppip. AS: Eser/Eisa, Hsav, Mema/Mesc/Mbech/Mdau, Nlei, Nlei/Eser/Eisa, Nnoc/Nlas, Nnoc/Nlas/Nlei, Pkuh, Ppip, Ppip/Ppyg, Ppip/Ppyg/Msch, Ppyg, Tten. Roosts: 60 Rfer, 2630 Reur, 15 Rmeh, 10051 Msch, 1 Mbec
Bioinsight, Alvaiázere, 2016, Portugal	January to December 2015	Mainly cork oak forests and common gorse bushes	9 ENERCOM E-82 (2.0mW each)	MM: Weekly between January and December. AS: monthly from March to October (10-min survey at each sampling point), for methods see above Roosts were visited in February, April, May, July and October.	MM: 3 dead bats, 1 Pkuh, 2 Pip sp. AS: Bbar, Ept spp., Nlas/Nnoc, Nlei, Nlei/Ept spp., Nyc spp., Nyc spp/Ept spp., Pkuh, Pkuh/Ppip, Ppip, Ppip/Ppyg, Ppyg/Msch, Reur/Rmeh, Rfer, Rmeh/Rhip, Rhi sp., Tten. Roosts:4012 Msch, 1 Mdau, 17 Mmyo, 4 Myo sp., 317 Rfer, 23 Rhip
Bioinsight, Vale de Estrela, 2017, Portugal	March to December 2016	Mainly bushes and grasslands, with some rocky outcrops and occasional oak forests.	11 ENERCOM E-92 (2.3mW each)	MM: Weekly between March and October. AS: monthly from March to October (10-min survey at each sampling point), for methods see above	MM: 0 dead bats. AS: Eser/Eisa, Nlei, Mmyo/Mbly, Mesc, Myo spp., Hsav, Pkuh, Ppip, Ppyg, Ppyg/Msch, Ppip/Ppyg/Msch, Paus/Paur, Rfer, Rmeh/Reur, Tten. Roosts: 2 Ppip, 2 Msch, 2 Ppyg, 17 Mmyo, 27 Rfer, 8 Rhip, 2 Bbar, 1 Reur

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Annex 3 - Questionnaire on post-construction monitoring and on implementation of mitigation measures - analyses of responses 2017, full report

Introduction:

The IWG on Wind Turbines and Bat Populations has distributed two questionnaires in the past, in 2004 and 2009. An analysis of the responses was presented during the StC4/AC15 in 2010. The main objective of this new questionnaire is to complement the previous ones. Some questions are repeated in order to be able to follow the development of the land-based wind industry on a Pan-European scale.

Nevertheless, considering recent conservation evidence on bat mortality (Voight *et al*. 2012, 2015; Mathews *et al*. 2016, Frick *et al*. 2017), this questionnaire focused on evaluation of best practice and legislation that is implemented under the scope of UNEP/EUROBATS Agreement in order to mitigate high mortality rates across EUROBATS area.

Methodology:

Questions left unanswered are treated as unknown in the analysis.

Table of range states, parties and non-party range states is available via EUROBATS website and presence of operating onshore (=land based) windfarms was extracted from The Wind Power Database, France (date: 13th March 2017) (Table 1). Additionally, The Wind Power Database with hyperlinks to countries factsheets on windfarms operating which is not official and is to be used as an orientation and is to be treated with caution (Table 2). According to this database, 50 out of 63 range states have onshore windfarms operating.

Table 1. UNEP/EUROBATS Range states (source: www.eurobats.org, March 2017) with operating offshore and onshore windfarms, and windfarms under construction included (source: www.thewindpower.net, 13th March 2017)

No	Country	UNEP/Eurobats Agreement	Onshore Windfarms present
1	Albania	Party	YES, under construction
2	Algeria	Range state	YES
3	Andorra	Range state	NO
4	Armenia	Range state	YES
5	Austria	Range state	YES
6	Azerbaijan	Range state	YES
7	Belarus	Range state	YES
8	Belgium	Party	YES
9	Bosnia and Herzegovina	Range state	NO
10	Bulgaria	Party	YES
11	Croatia	Party	YES
12	Cyprus	Party	YES
13	Czech Republic	Party	YES
14	Denmark	Party	YES
15	Egypt	Range state	YES
16	Estonia	Party	YES
17	Finland	Party	YES
18	France	Party	YES
19	Georgia	Party	YES
20	Germany	Party	YES
21	Greece	Range state	YES
22	Holy See	Range state	NO
23	Hungary	Party	YES
24	Iran	Range state	YES
25	Iraq	Range state	NO
26	Ireland	Party	YES
27	Israel	Party	YES
28	Italy	Party	YES
29	Jordan	Range state	YES
30	Kazakhstan	Range state	YES
31	Kuwait	Range state	NO

32	Latvia	Party	YES
33	Lebanon	Range state	NO
34	Libya	Range state	YES
35	Liechtenstein	Range state	NO
36	Lithuania	Party	YES
37	Luxembourg	Party	YES
38	Macedonia, FYR	Party	YES
39	Malta	Party	NO
40	Moldova	Party	NO
41	Monaco	Party	NO
42	Montenegro	Party	YES
43	Morocco	Range state	YES
44	Netherlands	Party	YES
45	Norway	Party	YES
46	Palestinian Authority Territories	Range state	NO
47	Poland	Party	YES
48	Portugal	Party	YES
49	Romania	Party	YES
50	Russian Federation	Range state	YES
51	San Marino	Party	NO
52	Saudi Arabia	Range state	YES
53	Serbia	Range state	YES
54	Slovak Republic	Party	YES
55	Slovenia	Party	YES
56	Spain	Range state	YES
57	Sweden	Party	YES
58	Switzerland	Party	YES
59	Syrian Arab Republic	Range state	NO
60	Tunisia	Range state	YES
61	Turkey	Range state	YES
62	Ukraine	Party	YES
63	United Kingdom	Party	YES

Table 2: Wind Power Database with hyperlinks to countries factsheets on windfarms operating (source: www.thewindpower.net, 13th March 2017)
** corrected number of windfarms via countries links doesn't necessarily corresponds to capacity neither to official countries data and is used as indication of presence*

Number	**Country**	**Continent**	**Number of Wind farms (onshore and offshore included)**	**Capacity (MW)***
1	Albania	Europe	1	150
2	Algeria	Africa	1	11
3	Armenia	Asia	2	93
4	Austria	Europe	231	2,464
5	Azerbaijan	Asia	4	56
6	Belarus	Europe	3	4
7	Belgium	Europe	148	2,438
8	Bulgaria	Europe	47	638
9	Croatia	Europe	19	466
10	Cyprus	Europe	6	154
11	Czech Republic	Europe	71	322
12	Denmark	Europe	1531	5,266
13	Egypt	Africa	9	745
14	Estonia	Europe	36	310
15	Finland	Europe	172	1,217
16	France	Europe	971	12,018
17	Georgia	Asia	1	21
18	Germany	Europe	4351	46,262
19	Greece	Europe	177	2,283

20	Hungary	Europe	37	513
21	Iran	Asia	11	112
22	Ireland	Europe	185	2,607
23	Israel	Asia	3	28
24	Italy	Europe	361	9,589
25	Jordan	Asia	4	205
26	Kazakhstan	Asia	1	46
27	Latvia	Europe	10	53
28	Libya	Africa	1	20
29	Lithuania	Europe	62	380
30	Luxembourg	Europe	17	93
31	Macedonia	Europe	2	37
32	Montenegro	Europe	1	72
33	Morocco	Africa	15	1,092
34	Netherlands	Europe	508	4,585
35	Norway	Europe	48	2,091
36	Poland	Europe	223	4,047
37	Portugal	Europe	258	5,106
38	Romania	Europe	67	3,201
39	Russia	Asia	10	50
40	Saudi Arabia	Asia	1	3
41	Serbia	Europe	1	10
42	Slovakia	Europe	3	4
43	Slovenia	Europe	2	6
44	Spain	Europe	992	23,331
45	Sweden	Europe	893	5409
46	Switzerland	Europe	12	76
47	Tunisia	Africa	3	243
48	Turkey	Asia	153	6,262
49	Ukraine	Europe	24	635
50	United-Kingdom	Europe	917	20,845

Results:

Number of answers:

Out of 63 EUROBATS range states, 26 answered questionnaires were submitted to Secretariat. Out of 36 Parties, 19 submitted answers (one Party submitted only for one part of the country (Belgium-Flanders), Denmark submitted 2 answered questionnaires and Portugal submitted questionnaires for mainland and Madeira). Jordan and Algeria reported no operational onshore windfarms in questionnaires. Only data from questionnaires answered were used in subsequent analyses.
Representatives from San Marino, Malta and Armenia reported to Secretariat that they will not submit questionnaires since onshore windfarms are not present in their countries. Regarding Russia, information submitted to the group was that there are only few small windfarms which can be disregarded.
Only data from questionnaires that were answered were used in subsequent analyses. Questionnaires from Portugal-Azores and Turkey came too late and were not included in the analyses.

1. Presence of onshore (= land-based) wind farms?

Onshore windfarms are present in 24 range states and not in two.

2. When was the first wind farm built in your country?

Considering the first publication of EUROBATS Guidelines, first windfarms were built only in six range states after 2008, while in 18 range states first onshore windfarms were built prior to 2008 with first windfarm being built in Denmark before 1980.

State	Answer

Denmark	before 1980
Switzerland	1986/1997
Netherlands	1982
Portugal-mainland	1985
Portugal-Madeira	1986
Germany	1987
Norway	1991
Finland	1991
Ireland	1992
Spain	1994
Latvia	1995
France	1997
Poland	1999
Morocco	2000
Slovakia	2003
Belgium-Flanders	2004
Croatia	2004
Lithuania	2004
Serbia	2009
Belarus	2011
Slovenia	2012
Moldova	2013
Macedonia	2014
Georgia	2016
Ukraine	unknown
Algeria	not present
Jordan	not present

3. Number of land-based wind farms and wind turbines

3.1 How many wind farms were operating in your country by the end of 2015?

Germany, Denmark, Poland, Spain and France reported more than 900 onshore windfarms being operational by the end of 2015 (note: Germany probably stated number of wind turbines rather than number of windfarms). Five range states reported in between 100 and 230 windfarms operating by the end of 2015, six range states reported from 10 to 70 windfarms (in addition to Portugal-Madeira), while six countries reported less than 10 windfarms in operation. Moldova, Jordan and Algeria reported no operational windfarms, while Ukraine didn't provide the answer.

State	**Number of operating onshore windfarms**
Germany	approx 26000
Denmark	5251
Poland	1188
Spain	1077
France	943
Portugal-mainland	229
Ireland	215
Netherlands	194
Belgium-Flanders	189

Finland	approx 100
Belarus	70
Latvia	15-30
Lithuania	23
Norway	20
Croatia	16
Morocco	11
Portugal-Madeira	10
Switzerland	6
Slovenia	2
Slovakia	2
Serbia	2
Macedonia	1
Georgia	1
Ukraine	unknown
Moldova	0
Jordan	0
Algeria	0

3.2 What is the minimum and maximum number of turbines per wind farm? Please also state the median (preferably) or average figure, if possible

Number of windfarms doesn't correspond to number of wind turbines per country while minimum-maximum span with median and average number of wind turbines per windfarm provides better overall picture. Morocco and Portugal-mainland reported more than 100 wind turbines as maximum per wind farm, while six range states reported maximums being between 60 and 70 WT/WF (wind turbine per wind farm). Nine range states reported between 12 and 33 WT/WF, while four range states reported 1 to 9 as maximum number of WT/WF. Eleven range states reported minimums of 1 WT/WF. No data on median and average number of WT/WF was provided by 11 range states. Morocco reported highest median of 22 WT/WF with an average of 49 WT/WF, while Slovenia reported the lowest median and average of 1 WT/WF.

State	Minimum	Maximum	Median	Average
Morocco	5	165	22	49
Portugal-mainland	1	120	6	10.9
France	1	70	unknown	unknown
Ireland	1	70	6	9.07
Netherlands	2	69	5	8 (7.8)
Norway	1	68	15	19
Denmark	2	65	unknown	unknown
Poland	1	60	unknown	unknown
Latvia	1	33	unknown	unknown
Moldova	2	24	unknown	unknown
Croatia	4	20	14	12.6
Serbia	5	20	10	15
Lithuania	2	20	unknown	unknown
Macedonia	16	16	16	16
Switzerland	2	16	3.5	5.17
Belgium-Flanders	1	14	4	4.3
Portugal-Madeira	1	12	5	5

Belarus	1	9	2	2.28
Georgia	6	6	6	6
Slovakia	1	4	unknown	unknown
Slovenia	1	1	1	1
Algeria	0	0	0	0
Jordan	0	0	0	0
Germany	3	unknown	unknown	unknown
Ukraine	unknown	unknown	unknown	unknown
Spain	unknown	unknown	unknown	unknown
Finland	unknown	unknown	unknown	unknown

4. Is post-construction monitoring of impact on bats obligatory for new wind farms in your country?

Post-construction monitoring of impact on bats is obligatory for new wind farms in 11 range states, while in 13 it is not obligatory and is based on EIA procedure.

State	**Answer**
Croatia	YES
France	YES
Lithuania	YES
Moldova	YES
Morocco	YES
Netherlands	YES
Portugal-mainland	YES
Portugal-Madeira	YES
Serbia	YES
Slovakia	YES
Spain	YES
Belarus	NO
Belgium - Flanders	NO
Denmark	NO
Finland	NO
Georgia	NO
Germany	NO
Ireland	NO
Latvia	NO
Norway	NO
Poland	NO
Slovenia	NO
Switzerland	NO
Macedonia	unknown
Ukraine	NO?
Algeria	
Jordan	

Answers: "YES, sometimes" was treated as YES; text explanation was treated as unknown

State	***Comment***
Belgium-Flanders:	*"Post-construction monitoring of impact on bats is not standard applied in the region of Flanders. Impact evaluations for bats are part of the procedure of permits that are required for wind turbines and wind farms. Wind farms being defined as 3 or more wind turbines. Pre and post monitoring are not standard included, but can be required at an individual basis."*
Denmark:	*"but a few - ca. 5 one-year post-construction surveys have been prescribed in the last 3-5 years"*
Macedonia:	*"The question is irrelevant. If we are Party of London Agreement that provisions of that agreement are part of Macedonian legislation and normally that monitoring should be obligatory?!?!"*
Netherlands:	*"The construction of a windfarm is a planning & development process which requires a derogation as set in the Flora and Fauna Act (until 01-01-2017) and the Nature Conservation Act (since 01-01-2017). The*

	derogation contains several conditions and mitigating measures to protect the species concerned. The authority granting the derogation may add extra conditions such as post-condition monitoring if they think it is necessary depending on the local situation."
Poland	*"It is not obligatory but if the competent authority (Regional or General Director for Environmental Protection) considers such monitoring as necessarily will impose such obligation in a decision on the environmental condition and describe its scope."*
Portugal-mainland:	*"The need of post-construction monitoring is decided case-by-case, but it was confirmed in the great majority of projects."*
Slovenia:	*"For neither of standing wind mills no specific bat study was done, nor was post construction monitoring effect on bats prescribed."*
Switzerland:	*"Depending on the results of EIA of each windfarm project post-construction monitoring can be obligatory (conflicts existing) or not (no conflicts) according the building permit à evaluation case-by-case"*

4.1 If "YES",

a) When post-construction monitoring was introduced as obligatory?

Post-construction monitoring was introduced as obligatory in Spain (1986), Portugal-mainland and Portugal-Madeira (2000), Netherlands (2002), Croatia (2004), Morocco (2008), in 2010 in Serbia, Lithuania and Slovakia, and in Moldova (2016). Based on EIA Procedure it can be imposed in Poland after 2008.

State	**Answer**
Spain	1986
Portugal-mainland	2000
Portugal-Madeira	2000
Netherlands	2002
Croatia	2004
Serbia	2010
Lithuania	2010
Slovakia	2010
France	2011
Morocco	2013
Moldova	2016
Poland	2008?
Macedonia	Ratification of London Agreement
Belarus	not obligatory
Denmark	not obligatory
Belgium-Flanders	not obligatory
Ireland	not obligatory
Algeria	not obligatory
Georgia	not obligatory
Jordan	not obligatory
Latvia	not obligatory
Norway	not obligatory
Slovenia	not obligatory
Switzerland	not obligatory
Germany	not obligatory
Ukraine	not obligatory
Finland	not obligatory

State	***Comment***
Poland	*The obligation to carry out post-construction monitoring may be imposed according to the Act of 3rd October 2008 on sharing information about the environment and its protection, public participation in environmental protection and environmental impact assessment (Journal of laws of 2016,item 353,as amended)*
Macedonia	*When it was prescribed by the London agreement to which Macedonia is a full party*
Croatia	*First Environmental Impact Assessment (EIA) approval for wind farm project with prescribed compulsory post-construction monitoring of bats was in 2004.*

b) Does this apply to all wind farms based on the year stated in a):

Although obligatory monitoring started to be prescribed in different years per different countries, it didn't apply to all new windfarms after the year obligatory monitoring was introduced in every country. Only six range states reported that it is applied on all new windfarms since the year of introduction, while five range states don't apply such a rule.

State	Answer
France	YES
Lithuania	YES
Macedonia	YES
Moldova	YES
Portugal-mainland	YES
Serbia	YES
Croatia	NO
Morocco	NO
Netherlands	NO
Portugal-Madeira	NO
Slovakia	NO
Spain	NO

State	*Comment*
Croatia:	*In 2005 no wind farm projects were authorised. In 2006 compulsory post-construction monitoring on bats was prescribed in 10 out of 13 EIA approvals for wind farm projects, and in 2007 for 4 out of 5 projects. After that, all EIA approvals for wind farms had compulsory post-construction monitoring on bats prescribed.*
Netherlands:	*The construction of a windfarm is a planning & development process which requires derogation as set in the Flora and Fauna Act (until 01-01-2017) and the Nature Conservation Act (since 01-01-2017). The derogation contains several conditions and mitigating measures to protect the species concerned. The authority granting the derogation may add extra conditions such as post-condition monitoring if they think it is necessary depending on the local situation.*

c) Does this apply only to windfarms that are perceived to present a threat to bats based on the preconstruction assessment?

Additionally, obligatory monitoring is applied to all windfarms in six range states disregarding preconstruction assessment threat on bats assessment, while in six range states it is prescribed only for windfarms that are perceived to present a threat to bats based on the preconstruction assessment.

State	Answer
Lithuania	YES
Netherlands	YES
Serbia	YES
Slovakia	YES
Spain	YES
Croatia	NO
France	NO
Macedonia	NO
Moldova	NO
Morocco	NO
Portugal-mainland	NO
Portugal-Madeira	NO

d) How many windfarms were operating with post-construction monitoring prescribed by the end of 2015?

Post-construction monitoring is prescribed probably for almost all wind farms in Portugal-mainland and Serbia, and more than 60% wind farms in Croatia. In Lithuania approximately 1/3 of all wind farms and a bit less than 30% of all wind farms in Morocco have post-construction monitoring prescribed. In France, with more than 900 wind farms, it is estimated that 20% wind farms have post-construction monitoring prescribed, while in Spain with more than 1000 wind farms reported, less than 0.5% operates with post-construction monitoring.

State	Number of wind farm operating	Number of windfarms with monitoring prescribed	% of wind farm with prescribed monitoring by the end of 2015
Portugal-mainland	229	229?	probably 100
France	943	200?	probably 21.2
Serbia	2	1 or 2	50 or 100%
Croatia	16	10	62.5
Lithuania	23	8	34.8
Spain	1077	less than 5	less then 0.5
Morocco	11	3	27.3
Portugal-Madeira	unknown	3	unknown
Macedonia	1	0	0
Slovakia	2	0	0
Netherlands	194	unknown	unknown

State	***comment***
France	*? In March 2016 we had managed to get hold of 180 post-construction monitoring reports concerning 106 wind farms, 30 of them with unusable data. There are probably over 200 reports up to now*
Portugal-mainland	*It was not possible to get the total number, but it should be closer to the number of wind farms (see previous comment)*
Croatia	*12 windfarms (10 operating and 2 in trial operation)*
Moldova	*None, first was prescribed in 2016*
Netherlands	*The exact number is not clear, but it's limited (see also answer under 4 and 4.2).*

e) Please refer to the law or regulation which prescribes post-construction monitoring:

In 12 range states, there are no law or regulation that prescribes post-construction monitoring, 10 range states have regulations, acts or procedures in which monitoring is prescribed, and in four range states it is reported as unknown.

State	Regulation/Law/other instruments
Algeria	no
Belarus	no
Croatia	Post-construction monitoring on bats is not specifically prescribed by any law or regulation, but it is being prescribed for each wind farm project by the Decision on Environmental Acceptability of the Project at the end of the EIA procedure.
Denmark	The EU Habitats Directive
Denmark - number2	no
Finland	unknown
Flanders/Belgium	unknown
France	Arrêté du 26 août 2011 relatif aux installations de production d'électricité utilisant l'énergie mécanique du vent au sein d'une installation soumise à déclaration au titre de la rubrique 2980 de la législation des installations classées pour la protection de l'environnement et ses annexes ;
Georgia	no
Germany	In most federal states ("Bundeslaender") the option of post-construction monitoring (not obligatory) is determined in guidance documents or decrees of the federal states ("Windenergieerlasse") and is (if applicable) applied within the formal authorisation procedure on the regional level. The extend of bat monitoring and the evaluation of the results differ between the federal states.
Ireland	no
Jordan	no
Latvia	no
Lithuania	Recomendations on Environmental Impact Assessment of the Proposed Economic Activity (Wind turbines) approved by the Order of the Minister of Environment No D1-955 of 29th November 2010
Macedonia	unknown
Moldova	no
Morocco	unknown
Netherlands	It can be a condition included in the derogation of the Flora and Fauna Act and the Nature Conservation Act
Norway	no
Poland	no
Portugal-Madeira	Decree – law nr 179/2015, 27th august – Establishes the environmental impact assessment legal regime.
Portugal-mainland	Decreto-Lei n.º 151-B/2013
Serbia	Law on EIA, Official Gazette of RS, No.135/2004, 36/2009; Simić D., V. Pullen, S. Ivanović, S. Cvetković, M. Tošović. 2010. Guidelines on the Environmental Impact Assessment for Wind farms. UNDP Serbia and Ministry of Environment and Spatial Planning of the Republic of Serbia, Belgrade, 68 pp. <https://www.unece.org/fileadmin/DAM/env/eia/documents/EIAguides/Serbia_EIA_windfarms_Jun10_en.pdf>; Paunović M., B. Karapandža, S. Ivanović. 2011. Bats and Environmental Impact Assessment – Methodological guidelines for environmental impact assessment and strategic environmental impact assessment. Wildlife Conservation Society "MUSTELA", Belgrade, 142 pp. <https://www.researchgate.net/publication/266555086_BATS_AND_ENVIRONMENTAL_IMPACT_ASSESSMENT_Methodological_guidelines_for_environmental_impact_assessment_and_strategic_environmental_impact_assessment
Slovakia	There are only Guidelines of the Ministry of Environment of the Slovak Republic of 21 April 2010 No. 3/2010-4.1 on standards and limits for placing of wind power plants and wind farms on the territory of the Slovak Republic
Slovenia	no
Spain	Royal Legislative Decree 1302/1986 on Environmental Impact Assessment' already considered the need to develop an environmental monitoring programme after the project construction. The above piece of legislation is currently revoked and substituted by 'Law 21/2013 on Environmental Impact'.
Switzerland	no
Ukraine	unknown

4.2 Is the post-construction monitoring done according to the EUROBATS guidelines after implementation years 2008 and 2014?

Post-construction monitoring is done more or less according to EUROBATS Guidelines in eight range-states (France, Croatia, Lithuania, Morocco, Netherland, Portugal-mainland and Portugal-Madeira, Serbia and Spain). In 11 range states it is not done according to the Guidelines (Denmark, Germany, Poland, Belgium-Flanders, Belarus, and Latvia. Moldova, Norway, Slovakia, Switzerland and Ukraine) while in five ranges states it is reported as unknown (Ireland, Finland, Georgia, Macedonia and Slovenia).

State	**Answer**
France	YES/NO
Croatia	YES
Lithuania	YES
Morocco	YES
Netherlands	YES
Portugal-Madeira	YES
Portugal-mainland	YES
Serbia	YES
Spain	YES
Belarus	NO
Belgium-Flanders	NO
Denmark	NO
Germany	NO
Latvia	NO
Moldova	NO
Norway	NO
Poland	NO
Slovakia	NO
Switzerland	NO
Ukraine	NO
Finland	unknown
Georgia	unknown
Ireland	unknown
Macedonia	unknown
Slovenia	unknown

State	***Comment***
Netherlands:	*Monitoring protocols, which correspond to the EUROBATS guidelines, have been developed by the Dutch Mammal Society (Boonman et al., 2013). Nevertheless, systematic fatality searches have been carried out on a very limited scale (Boonman et al. 2011 in Limpens et al. 2013). Boonman, M., H.J.G.A. Limpens, M.J.J. La Haye, M. van der Valk & J.C. Hartman, 2013. Protocollen vleermuisonderzoek bij windturbines. Rapport 2013.28, Zoogdiervereniging & Bureau Waardenburg Limpens, H.J.G.A., M. Boonman, F. Korner-Nievergelt, E.A. Jansen, M. van der Valk, M.J.J. La Haye, S. Dirksen & S.J. Vreugdenhil, 2013. Wind turbines and bats in the Netherlands - Measuring and predicting. Report 2013.12, Zoogdiervereniging & Bureau Waardenburg*
Serbia:	*To the best of our knowledge, since it is proscribed according to EUROBATS guidelines in the EIA studies. However, this information is not certain because the Ministry only have data on EIA studies. In all cases, the decisions on determining the scope and content of the EIA study have included bats (as well as birds) as the subjects of the study. This indicates that the relevant authorities clearly recognize the potential impact of these projects on bats. It remains to be seen if this approach will continue to be applied in the decisions making on the environmental EIA study approval, checking the fulfilment of conditions set out in approval and later supervision over the fulfilment of conditions for each individual project.*
Belgium-Flanders:	*In case post monitoring is imposed, there are no standard procedures or monitoring protocols that are imposed.*
Poland:	*The published guidance is based on EUROBATS guide but is not obligatory. Other methodology could be used as well.*
France:	*The ministry has recognized the guidelines produced by the wind industry in 2015 as national guidelines, but they were rejected by the SFEPM, and most regional environmental services of the ministry try to enforce SFEPM new guidance (2015) that is consistent with EUROBATS guidelines.*
Switzerland:	*According internal unpublished criteria*

5. Are avoidance or mitigation measures prescribed in your country?

In 13 range states avoidance or mitigation measures are prescribed: blade feathering in combination with increased cut-in speed (Croatia, France, Serbia and Switzerland), combination of increased cut-in speed and deterrents (Lithuania, Slovakia and Spain), increased cut-in speed only (Denmark, Netherlands, Poland and Portugal-mainland) while Germany reported prescription of shutdown of the wind turbine during specific hours/migration periods or use of turbine-specific curtailments algorithms..Belgium-Flanders and Netherlands reported probably no prescription of avoidance or mitigation measures. In nine range states no mitigation or avoidance is being prescribed (Belarus, Georgia, Ireland, and Latvia, Moldova, Morocco, Norway, Slovenia and Ukraine).

State	**Answer**	**5.a) blade feathering**	**5.b) increased cut-in speed**	**5.c) deterrents**
Croatia	YES	YES	YES	
France	YES	YES	YES	
Serbia	YES	YES	YES	
Switzerland	YES	YES	YES	
Lithuania	YES		YES	YES
Slovakia	YES		YES	YES
Spain	YES		YES	YES
Denmark	YES		YES	
Netherlands	YES		YES	
Poland	YES		YES	
Portugal-mainland	YES		YES	
Germany	YES			
Portugal-Madeira	YES			
Belgium-Flanders	NO?			
Finland	NO?			
Belarus	NO			
Georgia	NO			
Ireland	NO			
Latvia	NO			
Moldova	NO			
Morocco	NO			
Norway	NO			
Slovenia	NO			
Ukraine	NO			
Denmark-number 2	unknown			
Macedonia	unknown			

State	***Other mitigation measures***
Portugal-mainland	*Due to close locations regarding important underground roosts, two projects were authorized with cut-in speed increased. A project including 7 turbines, one located 158 m from one important hibernating roost (around 4000 Miniopterus schreibersii and 150 R. ferrumequinum), was authorized with cut-in speed increased to 5 m/s in October, November, December, March and April. A project including 4 turbines located less than 7 km from the most important underground roost known in mainland, occupied all over year by many thousands of bats of several species, was authorized with cut-in speed increased to 3.3 m/s.*
Ireland	*NOTE: Individual EIAs with bat studies have made specific individual mitigation measure recommendations, mostly based on Eurobats guidelines (e.g. buffer zones from existing woodland, buffer exclusions for new planting activities, rendering of new windfarm buildings unsuitable for bat roosting). Not aware of any feathering, or cut-in measures. Ultrasonic or radar deterrents recommended by consultant in one report.*
Denmark no2	*The environmental impact assesment take measures to prevent all forms of deliberate killing of bats; blade feathering described in management plan for bats*
Poland	*resignation from particular power station, change the location of wind power station, cut-off wind power station in particular period (e.g. migration period)*
Serbia	*preventive planning of the WT layout and supporting WF infrastructure*
Slovenia	*To my knowledge no such measures were prescribed or are in place for the existing wind mills.*

Switzerland	*in addition compensation measures for resting mortality*
Germany	*shutdown of the wind turbine during specific hours/migration periods or use of turbine-specific curtailments algorithms*
Netherlands	*• change location of turbines (prior to construction) when a high amount of bat fatalities is expected.* *• shut down turbines in periods with the highest risk of bat fatalities (at low wind speed at night) for example by increasing the cut-in speed.* *• Development of alternative foraging area, away from the wind farm.*
Portugal-Madeira	*General ecologic*
Denmark	*increased cut-in speed: but often only at dusk and dawn on calm nights*
Belgium-Flanders	*No avoidance or mitigation measures are imposed, as the environmental impact analysis will yield a result that is yes or no. If a yes with some doubts, a post monitoring will be imposed, no mitigation measures are at this point imposed*
Finland	*Not officially, or in any of the guidance documents (as far as I know). In EIA survey reports and other reports measures might be prescribed.*

6. Is the effectiveness of mitigation measures being monitored?

Effectiveness of mitigation measures is being monitored at least in seven range states (Morocco-probably, Netherlands-sometimes, Poland, Serbia, Switzerland, Portugal-mainland and Portugal-Madeira, Spain and Croatia). In 16 range states effectiveness of mitigation measures is not being monitored (including ones with most windfarms reported: Denmark, Germany and France) while in Ukraine it is not known.

State	**Answer**	**6.a) Any EIA company or equivalent**	**6.b) Any EIA company or equivalent that has a bat expert employed**	**6.c) Any EIA company or equivalent that can subcontract individual experts, expert NGOs, universities etc**
Morocco	YES???			YES
Netherlands	YES, Sometimes		YES	YES
Poland	YES	YES	YES	YES
Serbia	YES	YES	YES	YES
Switzerland	YES	YES	YES	YES
Portugal-mainland	YES	YES		
Spain	YES			YES
Croatia	YES			
Portugal-Madeira	YES			
Belarus	NO			
Belgium-Flanders	NO			
Denmark	NO			
Denmark-number 2	NO			
Finland	NO			
France	NO			
Georgia	NO			
Germany	NO			
Ireland	NO			
Latvia	NO			
Lithuania	NO			
Macedonia	NO			
Moldova	NO			
Norway	NO			
Slovakia	NO			
Slovenia	NO			
Ukraine	unknown			

State	***6.d) Other, please describe/comments***
Portugal-mainland	Although any company can conduct studies on bats, they always employ a bat expert or make a contract with an expert for the study.
Croatia	According to the Ordinance on Requirements for Issuing Approvals to Legal Persons for Performing Professional Environmental Protection Activities from 2010, only legal persons with authorisation were able to conduct monitoring in the field of nature protection connected with the EIA studies. But due to the amendments to the Environmental Protection Act, this is no longer an obligation.

Serbia	To the best of our knowledge, since it is proscribed according to EUROBATS guidelines in the EIA studies. However, it is not systematically controlled by responsible authorities
Switzerland	It's a challenge to guarantee quality of studies but so far we managed to include bat experts for EIA – but there is no legal base to demand an expert.
Germany	Not obligatory; Usually qualified companies (with EIA expertise and with involvement of bat expert – employed or with subcontract) are required (specified within authorisation procedure) and perform the surveys, but the qualification is not specified by law and methodological standards vary between the federal states.
Netherlands	It is done on a case-by-case basis, not nationwide. Like monitoring with bat detectors and fatalities monitoring for wind parks in the area of the Noordoostpolder. Many older wind parks lack monitoring however.
Spain	(as part of the monitoring program associated to the projects approval)
Portugal-Madeira	Quaterly/six-monthly

7. Are implemented mitigation measures controlled by the authorities?

Implemented mitigation measures are controlled by authorities in 10 range states which includes mostly control on random basis (Croatia, Germany, Lithuania) and in two range states is on annual basis (Netherlands, Portugal-mainland). In 10 range states there is no control reported (including Denmark) while situation is unknown in four range states (Finland, Georgia, Slovenia and Ukraine).

State	Answer	annually	biannually	randomly
Switzerland	YES/NO			
Croatia	YES			YES
France	YES			
Germany	YES			YES
Lithuania	YES			YES
Netherlands	YES	YES		
Poland	YES			
Portugal-Madeira	YES			
Portugal-mainland	YES	YES		
Serbia	YES			
Spain	YES			
Belarus	NO			
Belgium-Flanders	NO			
Denmark	NO			
Ireland	NO			
Latvia	NO			
Macedonia	NO			
Moldova	NO			
Morocco	NO			
Norway	NO			
Slovakia	NO			
Finland	unknown			
Georgia	unknown			
Slovenia	unknown			
Ukraine	unknown			

State	***Other types of control***
Croatia	*Implementation of mitigation measures and monitoring prescribed by the Decision on Environmental Acceptability of the Project can be controlled by the Environmental Protection Inspection or Nature Protection Inspection on random basis or if suspected irregularities are reported*
France	*once during the first 3 years of functioning then every 10 years*
Germany	*concerning the implementation, not the effectiveness*
Macedonia	*I have no information. I have asked relevant people from the Ministry and he has no information about such activity.*
Morocco	*post-construction monitoring comply with Eurobats standards are imposed by banks*
Netherlands	*Control of any implemented mitigation measures is usually part of an authorisation under the Flora- and Fauna Act, which allows the construction of a wind farm. The control usually concerns the assessment of a report on the implemented measures, drafted by the beneficiary.*

Poland	*It depends how the particular condition is defined in a decision on the environmental conditions.*
Serbia	*not systematically, only if offence is reported to the authorities*
Spain	*information to authorities will be provided according to the periodicity agreed in the Environment Impact Statement*
Switzerland	*Comment: Depending on the project. Authorities often lack knowledge to control & evaluate measures. In some cases an advisory commission (experts) has been established to control measures instead (as a component of the building permit). These advisory commissions act more intensively the first years after the building of the windfarm and less the following years. We highly recommend the establishment of an advisory commission to guarantee the quality of control of measures. Other: according the formulated measures of … (missing end of sentence)*

8. Are results of such studies (monitoring and mitigation monitoring) available to the public?

Results of monitoring and mitigation monitoring studies are available to public under various conditions at least in five range states (Moldova-probably, Croatia, Netherlands, Poland, Portugal-mainland and Portugal-Madeira, and Serbia). Such studies are not available to public in 14 range states while availability to public in Slovenia is unknown. Bibliographic references to such studies were submitted by six range states (Croatia, Denmark, Germany, Netherlands, Portugal-mainland and Portugal-Madeira, and Spain).

State	Answer
Moldova	YES??
Croatia	YES
Netherlands	YES
Poland	YES
Portugal-mainland	YES
Portugal-Madeira	YES
Serbia	YES
Belarus	NO
Denmark	NO
France	NO
Georgia	NO
Germany	NO
Ireland	NO
Lithuania	NO
Latvia	NO
Macedonia	NO
Morocco	NO
Norway	NO
Slovakia	NO
Spain	NO
Switzerland	NO
Belgium-Flanders	unknown
Finland	unknown
Slovenia	unknown
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