14th Meeting of the Standing Committee
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Report of the IWG on Wind Turbines and Bat Populations

Members

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Subgroups

To simplify the work, several sub-groups were created:

Sub-group	**Coordinator (c) and members**
Update/reorganizing of the list of references	Marie-Jo Dubourg-Savage (c), Laurent Biraschi
Compilation of data on bat mortality per country	Marie-Jo Dubourg-Savage (c) Lothar Bach
Updating of tables on monitoring studies done in Europe and on bats´ behaviour in relation to windfarms	Anna Nele Herdina (c) Laurent Biraschi Marie-Jo Dubourg-Savage
Mitigation and compensation measures	Joana Bernardino (c) Branko Karapandža Dino Scaravelli Lothar Bach Luisa Rodrigues Dragoş Ştefan Mantoiu 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 Dragoş Ştefan Mantoiu
Impact of mortality rate on populations	Jasja Dekker (c) Christian Voigt Lothar Bach Rita Bastos Emra Çoraman
Deterrents, technical mitigation systems and automated monitoring systems	Lothar Bach (c) Branko Karapandža Dino Scaravelli Luisa Rodrigues
Maximum foraging distances of species	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 Dragoş Ştefan Mantoiu
Comparing measurement of activity at ground level and rotor height	Lothar Bach (c) Jan Collins Johanna Hurst

	Marie-Jo Dubourg-Savage Petra Bach Dragoş Ştefan Mantoiu Thierry Kervyn
Small Wind Turbines	Kirsty Park (c) Lothar Bach
Offshore windfarms	Lothar Bach (c) Jasja Dekker Herman Limpens Dragoş Ştefan Mantoiu
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
200m buffer distance to edge habitats particularly important for bats	Branko Karapandža (c) Noam Leader Mirna Mazija
Sensitivity maps	Noam Leader (c) Mirna Mazija Dragoş Ştefan Mantoiu

The IWG thanks Charlotte Roemer for comments on "Comparing measurement of activity at ground level and rotor height", and Suren Gazaryan for general review.

<u>Results</u>

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, Annex 1 of Doc.EUROBATS.AC22.10.Rev.1, 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 2017. 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 30 species have been killed by wind turbines in EUROBATS range states.

Reported bat fatalities in Europe (2003-2017) - State 3/06/2018

Species	**AT**	**BE**	**CH**	**CR**	**CZ**	**DE**	**ES**	**EE**	**FI**	**FR**	**GR**	**IL**	**IT**	**LV**	**NL**	**NO**	**PT**	**PL**	**RO**	**SE**	**UK**	**Total**
Nyctalus noctula	46	1			31	1144	1			46	10						2	16	76	14	11	**1398**
Nyctalus lasiopterus							21			7	1						9					**38**
N. leisleri			1	6	3	173	15			92	58		2				273	5	10			**638**
Nyctalus sp./ *V. murinus*				1		2	2			1							17		8			**31**
Eptesicus serotinus	1				11	60	2			26	1				1			3	1			**106**
E. isabellinus							117										2					**119**
E. serotinus / isabellinus							98										17					**115**
E. nilssonii	1				1	5		2	6					13		1		1	1	13		**44**
Vespertilio murinus	2			14	6	135				9	1			1				7	15	2		**192**
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							1					**4**
M. brandtii						2																**2**
M. mystacinus						2					1											**3**
M. nattereri																					1	**1**
Myotis sp						1	3			1									4			**9**
Pipistrellus pipistrellus	2	20	7	6	16	664	211			734			1		15		323	3	6	1	46	**2055**
P. nathusii	13	4	6	20	7	1011				198	35		2	23	8			16	90	5	1	**1439**
P. pygmaeus	4			3	2	120				171				1			42	1	5	18	52	**419**
P. pipistrellus / pygmaeus	1		3				271			36	55						38	1	2			**407**
P. kuhlii				112			44			189		12					51		10			**418**
P. pipistrellus / kuhlii				12						1	1						19					**33**
Pipistrellus sp	8	2		55	9	87	25			169	1			2			109	2	48		11	**528**
Hypsugo savii	1			163		1	50			54	28		12				56		2			**367**
Barbastella barbastellus						1	1			3												**5**
Plecotus austriacus	1					7																**8**
Plecotus auritus						7															1	**8**
Tadarida teniotis				7			23			1							39					**70**
Miniopterus schreibersii							2			5							4					**11**
Rhinolophus ferrumequinum							1					1										**2**
Rhinolophus mehelyi							1															**1**
Rhinolophus sp							1															**1**
Rhinopoma microphylum												2										**2**

Taphosus nudiventris												2										**2**
Chiroptera sp	1	11		46	1	76	320	1		217	8		1				120	3	7	30	9	**851**
Total	**81**	**38**	**17**	**445**	**87**	**3510**	**1218**	**3**	**6**	**1967**	**200**	**17**	**18**	**40**	**24**	**1**	**1124**	**58**	**285**	**83**	**132**	**9354**

AT = Austria, BE = Belgium, CH = Switzerland, CR = Croatia, CZ = Czech Rep., DE = Germany, ES= Spain, EE = Estonia, FI = Finland, FR = France, GR = Greece, IL = 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, Annex 2 of Doc.EUROBATS.AC21.8, and Annex 2 of Doc.EUROBATS.AC22.10.Rev.1.

Mitigation and compensation measures

For several years now, low wind speed curtailment (by raising the cut-in speed of wind turbines, and/or feathering turbine blades) has proven effective at reducing bat mortality at wind farms. Currently, the challenge lies on optimizing the models / algorithms that adjust turbines operation based on wind speed (in relation to season, time of the year, temperature, precipitation, etc.) and/or bat activity in real-time, to minimize both bat fatalities and revenue losses.

Schirmacher *et al*. (2017a, b) completed a 3-year study at a wind energy facility in West Virginia, U.S., which tested, among other combinations, normal turbine operation (3.0m/s cut-in; control) versus increased cut-in speed of 5.0m/s and 6.5m/s, with operational changes being based in 10-minute wind speed averages measured at a meteorological (met) tower. These treatments showed an average 58% and 75% reduction in bat fatalities, respectively. In the third and last year, only the 5.0m/s scheme based on 10-minute wind speed averages measured at the met tower was tested, versus a 5.0m/s scheme based on 20-minute wind speed averages measured at the met tower or at the individual wind turbine. The 5.0m/s scheme based on 20-minute wind speed data from the met tower was the most cost-effective, since it showed significantly fewer bat fatalities than the scheme using 20-minute wind speed data from the individual turbine, and had less transitions (i.e., turbine start-ups and shut-downs) with slightly more power production compared to the 5.0m/s scheme based on 10-minute wind speed data from the met tower. The authors hypothesize that longer measurement of wind speed before initiating start-up (i.e. 20-min vs. 10-min average), and wind speed measurement from the met tower (rather than from the turbine anemometer) would be more accurate and result in lower fatalities. Nevertheless, further research should be undertaken to investigate the impact (on bat fatality and revenue losses) of increasing the decision time to initiate turbine curtailment.

Măntoiu *et al.* (pers. comm.) tested a cut-in speed curtailment measure during a 2-year study in eastern Romania, increasing it to 6.5m/s during the bat migration period (2015-2016). Prior to this method, another two years of observations without curtailment were recorded (2013-2014), allowing specialists to pin point turbines with high impact and to compare the results. The method reduced the overall mortality rate by 78%, with turbine variations from 62 to 93%, decreasing the impact on migratory species, such as *Pipistrellus nathusii* and *Nyctalus noctula*, up to 90%. Another two years were added to the measure (2017–2018), considering energy optimization as an important incentive for the wind farm administration. Cut-in speed was decreased to 6m/s in 2017, with a slight increase in bat mortality, but also energy production. In 2018, the cut-in speed will be set to 6.5m/s in some cases, but a temperature threshold will be added in order to decrease energy loss (13°C). This value has been considered appropriate by analyzing correlations between 10-minute interval temperature and wind speed values obtained from the turbines, compared with acoustic bat activity patterns recorded at ground level during a 5-year monitoring scheme.

Martin *et al*. (2017) tested an operational mitigation design that incorporated both wind speed and temperature. The 2-year study was conducted at a wind farm located in Vermont, U.S., and in which the cut-in speed at treatment turbines was raised from 4.0 to 6.0m/s whenever nightly wind speeds were <6.0m/s and temperatures were >9.5°C. This curtailment scheme was responsible for a 34.2%-77.5% reduction in bat mortality, and an energy loss of <3% for the study season (late spring and early fall) and approximately 1% for the entire year. Incorporating temperature into the operational mitigation design decreased energy losses by 18%. Pettersson & Rydell (2017) also concluded in a study conducted at seven different wind farms in southern Sweden that, bat activity at rotor height occurred mostly when wind speed and temperature were <6m/s and > 14ºC, respectively. The strong dependence of bat activity on temperature reinforces the importance its incorporation in curtailment algorithms to avoid unnecessary revenue losses.

The development of bat-friendly curtailment algorithms (and software) that combine wind speed data with bat acoustic monitoring at the nacelle has been underway in Germany (Behr *et al*., 2017; see previous IWG report). Alongside, Energies, EPRI and its member companies funded a study to develop a new curtailment hardware and software system

– “Turbine-Integrated Mortality Reduction (TIMRSM)” – which is prepared to be incorporated in wind farm SCADA system with minimal customization (EPRI, 2017). It runs real-time bat activity and wind speed data in predictive models that link these parameters to bat mortality and issue a current risk value used to drive turbine operation. In 2015, the system was tested at a wind farm located in Wisconsin, U.S. during the fall migratory season (July 15 to October 31). Ten turbines were operated normally and 10 were operated the model, using a 30-minute curtailment period (to reduce the possibility of rapid changes in turbine operating mode). Real-time data for the study were supplied by acoustic monitoring of bat activity (calls) and wind speed recordings at the turbine nacelle. The curtailment scheme consisted in:

i) if wind speed was <3.5m/s, turbine blades were pitched out (rotor at ≤ 2rpm);

ii) if wind speed was ≥3.5m/s and <8m/s, and at least 1 bat call was recorded in the previous 10 minutes, turbines were curtailed;

iii) if wind speed was ≥8m/s, turbines were not curtailed (regardless of the level of bat activity).

This first test demonstrated an average 83% reduction in bat fatality, which was consistent across all operated-turbines and bat species. The estimated revenue loss was of 10-14% for the study season.

After several tests described in previous reports (Doc.EUROBATS.AC17.6, Doc.EUROBATS.AC18.6), Chirotech© is being applied on several windfarms in France and Belgium. The system is based on meteorological parameters (windspeed, temperature, rain, date, hour) gathered in the windfarm; an algorithm computes the collision risk to see whether it should send a START or a STOP order. Presently bat activity is not recorded in real-time. The first results with the Chirotech system or other algoriths have been reported in postconstruction monitoring reports and some are now available. However the lack of standardisation regarding the length of the experiment, the season and the number of regulated turbines does not allow a straightforward analyses and comparison between wind farms. A first analysis should be presented in the next report.

For other minimization measures such as discouragement of bats from approaching wind turbines, please see section “deterrents”.

To the best of our knowledge, no study has been published on the development, test and/or implementation of compensation measures for bats on the wind energy context, between 2017 and the beginning of 2018.

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).

EPRI. 2017. Bat Detection and Shutdown System for Utility-Scale Wind Turbines. Technical report prepared by Normandeau Associates, Inc. for Electric Power Research Institute (EPRI). 3002009038 Final Report, July 2017. Palo Alto, California, U.S (98 pp).

Martin C.M., E.B. Arnett, R.D. Stevens & M.C. Wallace. 2017. Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation. Journal of Mammalogy, 98(2), 378-385.

Pettersson S. & J. Rydell. 2017. Bat activity at nacelle level and its implications for mitigation. In Book of Abstracts of the 4th Conference on Wind Energy and Wildlife Impacts (CWW). Estoril, Portugal. September 6-8. 2017. (pp. 243)

Schirmacher M., A. Prichard, T. Mabee & C. Hein. 2017a. Multi-year Operational Minimization Study in West Virginia: Potential Novel Strategy to Reducing Bat Fatalities at Wind Turbines. Proceedings of the Wind Wildlife Research Meeting XI. May 2017. (pp. 103-106).

Schirmacher M., A. Prichard, T. Mabee & C. Hein. 2017b. Multi-year operational minimization study in West Virginia: potential novel strategy to reducing bat fatalities at wind turbines. In Book of Abstracts of the 4th Conference on Wind Energy and Wildlife Impacts (CWW). Estoril, Portugal. September 6-8. 2017. (pp. 74-75).

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

Whether for logistical and safety constraints (e.g. rugged terrain) or simply for cost-efficiency reasons, carcass searches are often restricted to areas (inside a pre-defined search plot) that can be searched effectively by human observers. Rabie *et al.* (2017) proposed a new statistical method – weighted maximum likelihood estimation of density models for carcass distributions – to adjust fatality estimates for unsearched areas. The authors tested the performance of this new approach *versus* the Logistic regression approach, previously proposed by Huso & Dalthorp (2014). Preliminary results suggest that both model-based methods can provide reliable area correction factors but each has its limitations, and their implementation (or not) may be context-specific. For example, a minimum number of carcasses and/or searchable area is needed to accurately model carcass distribution around wind turbines. Thus, when the number of fatalities is low or few carcasses are found (i.e., in a situation of rare event monitoring), the restriction of carcass searches, for example, to graveled road and turbine pad areas (for cost-saving reasons) is not a valuable option, or at least it will have always to be combined with some full plot sampling in order to achieve adequate precision.

Over the years, several fatality estimators have been developed to address the constraints associated to carcass searches around wind turbines (e.g. imperfect detection, carcass removal, limited search area). Despite the latest improvements, the available estimators have inherent differences in their assumptions that can lead to significantly different estimates of fatality, resulting in confusion and poor inferential capacity (Hein & Huso, 2017).

Marques *et al.* (2018) reviewed 225 monitoring reports submitted to Portuguese EIA authorities (between 2005 and 2015) to assess which estimators are most used by environmental consultants to calculate bird and bat fatality at Portuguese wind farms. Several companies started using simpler estimators such as the adapted version of Meyer (1978), Erickson *et al.* (2000) or Shoenfeld (2004) estimators in 2005-2006, and ended up using Huso (2011) and/or Korner-Nievergelt *et al.* (2011) estimators, in 2013-2015. In some reports, more than one estimator was used to have a better understanding of the ranges of possible fatality caused by the wind farm in study. Nevertheless, there were also companies that used always the same estimator over the years (usually the simplest one, i.e., Meyer's estimator) which suggests that the complexity of the latest estimators may be compromising their use by consultants.

Recognizing these difficulties, statisticians and biologists who developed several of the estimators in current use at wind power facilities ("GenEst Working Group") are developing a software that will allow non-statisticians to test assumptions regarding input parameters, select the approach that best reflects their study design and data, and finally produce fatality estimates under a single generalized estimator (Hein & Huso, 2017). The ultimate goal is to produce statistically valid results across a wide spectrum of study designs with greatly reduced potential for user error. A beta version of the *GenEst* software was presented and tested by the attendees of the workshop "Estimating wildlife fatality at wind facilities using a generalized estimator" which preceded the conference CWW 2017 (Estoril, Portugal, 6-8 September, 2017). The software should be online and freely available to all users by the end of 2018. It's important to note that *GenEst* is not a rare-event estimator and, thus, is not intended for use when fatalities are low or few carcasses are found. In those cases, different methodological approaches should be used, such as the ones proposed by Bastos *et al.* (2013) or Huso *et al.* (2015).

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

Erickson W.P., G.D. Johnson, M.D. Strickland & K. Kronner. 2000. Avian and bat mortality associated with the Vansycle wind project, Umatilla County, Oregon: 1999 study year. Technical report prepared by WEST Inc. for Umatilla County Department of Resource Services and Development, Pendleton, OR. 25 pp.

Hein C. & M. Huso. 2017. Challenges and opportunities of accurately and precisely estimating fatality of birds and bats at wind energy facilities. ESA 2017 Annual Meeting, Portland, August 6-11, Oregon, USA.

Huso M. 2011. An estimator of wildlife fatality from observed carcasses. Environmetrics, 22(3), 318–329.

Huso M. & D. Dalthorp. 2014. Accounting for unsearched areas in estimating wind turbine-caused fatality. Journal of Wildlife Management, 78: 347-358.

Huso M., D. Dalthorp, D. Dail & L. Madsen. 2015. Estimating wind-turbine-caused bird and bat fatality when zero carcasses are observed. Ecological Applications, 25(5), 1213–1225.

Korner-Nievergelt F., P. Korner-Nievergelt, O. Behr, I. Niermann, R. Brinkmann & B. Hellriegel. 2011. A new method to determine bird and bat fatality at wind energy turbines from carcass searches. Wildlife Biology, 17(4), 350-363.

Marques J., L. Rodrigues, M.J. Silva, J. Santos, R. Bispo & J. Bernardino. 2018. Estimating Bird and Bat Fatality at Wind Farms: From Formula-Based Methods to Models to Assess Impact Significance. In Mascarenhas, M., Marques, A.T., Ramalho, R., Santos, D., Bernardino, J. & Fonseca C. (editors). Biodiversity and Wind Farms in Portugal: Current knowledge and insights for an integrated impact assessment process. Springer. pp.151-204.

Meyer J.R. 1978. Effects of transmission lines on bird flight behaviour and collision mortality. Bonneville Power Administration, Engineering and Construction Division. Portland, Oregon, USA. 200 pp.

Shoenfeld P. 2004. Suggestions regarding avian mortality extrapolation. Technical memo provided to FPL Energy. Davis, WV, West Virginia Highlands Conservancy. 6 pp.

Rabie P., D. Dalthorp, D. Riser-Espinoza, J. Studyvin & J. Roppe. 2017. Area Correction Methods for Efficient Post-Construction Fatality Monitoring Studies. Proceedings of the Wind Wildlife Research Meeting XI. pp. 73-76.

Impact of mortality rate on populations

The subgroup did not have access to new information since the last report (Doc.EUROBATS.AC22.10.Rev.1).

Deterrents, technical mitigation systems and automated monitoring systems

During the last years several deterrent and technical mitigation systems appeared in Europe in the hope to reduce shut-off or curtailment events, but for most of them efficiency hasn´t yet been proven. KNE (2018) gives an overview of various deterrent systems for birds and bats, describing the systems and their functioning and limitations.

System	Functioning	Major limitations	Manufacturer's info
BirdSentinel/Safe Wind (for birds and bats)	- a real time video-surveillance system combined with an acoustic deterrent and connected to turbine's control electronic - activates acoustic deterrent or curtails the turbine according to activity and/or environmental conditions	- effectiveness for bats not validated - sensitivity depends on visibility conditions - high number of false triggers - acoustic deterrent doesn't comply with German regulations - lacks automated species identification	https://goo.gl/k8HZUH
DTBat	- acoustically detects bats around turbines and	- dependent of visibility conditions - small acoustical range	http://www.dtbat.com/

	optionally invokes a software that stops turbines depending on a real-time bat activity and/or environmental conditions	- high number of wrong "positive" detections - acoustic deterrent doesn't comply with German regulations	Hanagasioglu *et al*. (2015)
TADS (Thermal Animal Detection System) (for birds and bats)	- a real time infrared video-surveillance system that monitors activity and collisions around up to 8 turbines: can be coupled with a radar for cameras' orientation	- high number of false triggers for birds, no data on bats - limited angle of surveillance (20 degrees) - manual detection of collisions - currently, doesn't control turbines	https://goo.gl/A33FD4
VARS (Visual Automatic Recording System)	- a real time infrared video-surveillance system with an automated day-and-night detection of flying objects, also monitors environmental conditions	- designed for birds - high number of false triggers - limited angle of surveillance (22 degrees per camera) - no automated species identification - manual detection of collisions - currently, doesn't control turbines	https://goo.gl/NxJVGD
ATOM (Acoustic-Thermograpic Offshore Monitoring system)	- a real time infrared video-surveillance combined with acoustic monitoring of birds and bats. Allows to track objects applying the SwisTrack software and monitor environmental conditions	- species identification is possible only comparing acoustic and visual data - reliability of acoustic identification depends on the background noise - no detection of collisions - identification of flying objects relates to the quality of formulated criteria - currently, doesn't control turbines	https://goo.gl/MnrcJS
Radar systems (various models)	- detection by radar technology; fixed or portable installation - real-time day-and-night acquisition of height, direction and speed for flying objects as well as outlining flight corridors are possible with 360° theoretical coverage (even small flying	- limited functionality in rugged terrain, proximity to turbines (radar shadow) and attenuation in humid weather conditions (rain) - depending on the system used, detection is possible in limited area (horizontal angle or altitude)	

	objects (eg songbirds and bats) can be detected at 1000m distance) - software is applicable for targeted filtering and interpretation of data (bird-like or bat-like flying objects) - automated identification to size classes (large, medium, small) and partially to species groups is feasible - quantification of flight activity and distinction between local and migrating individuals is implementable - combination with both turbine control and acoustic deterrents is possible - prototype: automated real-time identification by wing beat frequency is possible at the species level	- experts are required for enabling targeted data interpretation - comparatively high costs	
B-finder	- sensors detect dropping collision victims regardless of daytime and weather, messages information on time and coordinates by e-mail or SMS	- no data from trials is available - automated species identification impossible both for active animals and victims - questionable potency of revealing sub-lethal injuries (barotrauma)	https://goo.gl/6vsKaY
ID-Stat	- acoustical detection of collisions with microphones in the rotor area - date, time, turbine and sensor IDs of potential collisions are stored and messaged to the user - noise filtering, detection of objects >2.5g	- no data from trials is available - option of visual identification is absent - automated species identification impossible - personnel required for search and identification of carcasses	

	- monitoring and documentation of collision events		
Access-Tool ProBat	- examines data from detectors in the nacelle area - generates plant-specific shutdown algorithms based on the wind speed and bat activity - collision risk might be adjusted to a certain threshold - allows further tweaking of algorithms employing other parameters (e.g. precipitation, temperature)	- effective turbine control depends on the quality of detector data - validated only for species which occur in Germany (*) - not applicable at locations with high activity of *Pipistrellus nathusii* (*) - too specific shut-off algorithms considering the operating time of a WT (*) - approving authority determines a fatality threshold (*)	

Note: * means Bach, pers. comm.

KNE. 2018. Synopse der technischen Ansätze zur Vermeidung von potentiellen Auswirkungen auf Vögel und Fledermäuse durch die Windenergienutzung. KNE (Kompetenzzentrum Naturschutz und Energiewende), Berlin. 28 pp.

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

The subgroup did not have access to new information since the report presented in 2016 (Doc.EUROBATS.AC21.8).

Collect national guidelines

It was not possible to update the information regarding this topic since the last report (Doc.EUROBATS.AC22.10.Rev.1).

Use of dogs vs humans during carcass searches

Since the last report (Doc.EUROBATS.AC22.10.Rev.1) there have not been many new published studies on use of dogs vs humans during carcass searches.

In a doctoral thesis by Moyle (2016) the impacts of small and medium scale wind turbines upon bats were examined in Wales and south west (SW) region of England. An estimate of bat fatality rates was calculated, using a dog trained specifically for bat carcass searches and handler. Field monitoring was carried out in 2012 (13 sites), 2013 (14 sites) and 2014 (4 sites). 5–3 bat carcass searches were conducted at approximately equal intervals at each site. The handler worked the dog along parallel 100 m transects spaced approximately 5-10m apart, traversing a 100x100m square centered upon the turbine.

The dog was allowed to deviate 106 from these transects in order to follow scents. A search efficiency trial with methods following Mathews *et al*. (2013) was conducted at most sites (25/31) to assess the dog and handler's search performance. Dog/handler team achieved an average efficiency of 90.2% in locating trial carcasses.

Bioinsight, in collaboration with the Eskom/Endangered Wildlife Trust strategic partnership South Africa, set up an experimental design at a wind farm in the north of Western Cape in South Africa during the hottest season to evaluate the performance of sniffing-dogs detecting bat and bird carcasses (Campbell *et al*. 2017). The influence of vegetation type, wind speed, air temperature and visibility in the accuracy and efficiency of detection dogs and humans was investigated. It was estimated that human accuracy is influenced by the vegetation and type of carcass, and have at least less 20% probability of detecting carcasses than sniffing dogs. Still, it was also stated that the increased accuracy and efficiency of detection comes at a higher cost than employing human searchers, and recommends that the use of human searchers is considered before dogs are deployed in areas favoring higher human detection rates. 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). For this reason bat workers are always urged to make assessments of the accuracy and efficiency of the dog–handler team at each wind farm location (Mathews *et al*. 2013).

Bennett E. 2014. Observations from the use of dogs to undertake carcass searches at wind facilities in Australia. In: Hull C.L., E. Bennett, E. Stark, Elizabeth, I. Smales, J. Lau, M. Venosta, eds. 2014. Wind and Wildlife: Proceedings from the Conference on Wind Energy and Wildlife Impacts, Vol. Part II. October 2012, Melbourne, Australia. Dordrecht. p. 113–123.

Campbell C., R. Ramalho, F. Cervantes, K. Retief, J. Marques, J. Paula, T. Neves, M. Mascarenhas, L. Leeuwner & M.D. Michael. 2017. Using detection dogs in bat and bird carcass searches in a South Africa's wind farms context: benefits and constraints. In: Book of Abstracts - Conference on Wind energy and Wildlife impacts, Estoril, Portugal, p. 42–43.

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.

Moyle A.I. 2016. The Impacts of Small and Medium Wind Turbines on Bats - Thesis for the degree of Doctor of Philosophy in Biological Sciences. University of Exeter, UK, 341 pp.

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.

Comparing measurement of activity at ground level and rotor height

Wellig *et al.* (2018) studied vertical bat activity profiles (at 5, 20, 35, 50 and 65m) using a truck-mounted crane at two sites close to a planned wind farm in the Lower Rhone Valley (SW Switzerland). Overall, the activity decreased with increasing height. In particular, the activity of *Myotis myotis/blythii* decreased rapidly. Also, the activity of *Pipistrellus pipistrellus* (the most recorded bat species) and *Hypsugo savii* decreased but to a much lesser extent. In contrast to that the activity of *Miniopterus schreibersii* slightly increased with increasing height. Overall, bat activity in the rotor swept zone (50-159m above ground) decreased with increasing wind speed, dropping below 5% above 5.4m/s.

Roemer *et al.* (2017) studied bat activity on a vertical axis at 23 wind masts in France and Belgium between 2011 and 2016. Microphones were installed close to the ground (2-11m) and at height (35-85m). All *Nyctalus* bats, *Tadarida teniotis* and *Vespertilio murinus* spent more than 40% of their activity at height. *Rhinolophus* bats were never recorded at height. *Plecotus auritus* and *P. austriacus* were both recorded at height. From the *Myotis* group only *M. daubentonii* was found at height. *Pipistrellus pipistrellus* spent on average about 10% of the time it was recorded at height. A significant correlation was found between total number of bat passes at height and the raw fatality counts. There was also a high correlation between number of bat passes close to the ground and the number of bat passes at height for *Nyctalus noctula* and *N. leisleri*, but not for *Myotis* species or *Pipistrellus pipistrellus*.

Due to the new very long rotor blades (>60m) and the limited echolocation range of e.g. *Pipistrellus* the activity of these species is likely to be underestimated in the rotor swept zone. That might explain the findings of very low activity of e.g. *Pipistrellus nathusii* at nacelle height and comparatively high numbers of fatalities of that species northwestern Germany (Bach *et al.*, 2015). In northwestern Germany we suggest one fatality of *Pipistrellus nathusii* on average every 22nd contact* (monitoring years 2008-2014; 73 wind turbines). These results led to the practice of installing a second microphone about 10m below the bottom of the rotor swept zone (height 65-80m). To date, data are available from 10 wind turbines with microphones installed in this arrangement (Bach, unpublished). The data shows that the activity of *Pipistrellus nathusii* at the bottom of the rotor swept zone was on average 5.2 (2-19) times higher than at nacelle height. No correlation was found between activity at the bottom of the rotor swept zone and fatalities. But these data are useful to understand the number of fatalities of *Pipistrellus nathusii* found when only low levels of activity are recorded at nacelle height. Bats are already in danger when active at the bottom of the rotor swept zone. Due to this, in future these activity data will be used to develop a site-specific shut-off algorithm in NW Germany.

*Note: * “contact” here means one or more passes of one species in a minute is counted as one contact. Only if two different individuals are recorded in the same minute will it be counted as two contacts.*

Bach, P., L. Bach, K. Eckschmitt (2015): Activities and fatalities of Nathusius´ pipistrelles at different wind farms in Northwest Germany. – oral presentation at CWW2015, 10.-12. March 2015, Berlin, Germany.

Wellig, S.D., S. Nusslé, D. Miltner, O. Kohle, O. Glaizot, V. Braunisch, M. Obrist & R. Arlettaz (2018): Mitigation the negative impacts of tall wind turbines on bats: vertical activity profiles and relationships to wind speed. – PloS ONE 13(3): e0192493. https://doi.org/10.1371/journal.pone.0192493

Roemer, C., T. Disca, A. Coulon & Y. Bas (2017): Bat flight height monitored from wind masts predicts mortality risk at wind farms. – Biological Conservation 215: 116-122.

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. Schweers (2017) studied bat activity at three different small wind turbines (nacelle height: 25.5m, 30m, 30.5m; rotor blade length: 7.5m, 3.7m, 3.7m) in northwestern Germany. Bat activity was recorded via long-term automatic surveys (AnaBat systems) between 4th of July and 10th of October. Total bat activity was always lower at the small wind turbines than at reference sites. A closer view to the activity of different species showed, that *Pipistrellus pipistrellus* and *P. nathusii* as well as *Eptesicus serotinus* had a significant higher activity at least one SWT but lower activity at another, compared with the reference site. *Nyctalus noctula* had a significant higher activity at one SWT. *Myotis* species had significantly higher activity at one SWT but a much smaller activity at another, compared with the reference site. No roosts were found close to the turbine sites. There has been another German study about bats and SWT in northern Germany financed by Federal Ministry of Nature Protection (BfN) but the report is not available yet.

A thesis published by Tatchley (2016) used acoustic surveys of bat activity to quantify disturbance of use of linear features (e.g. hedgerows, treelines), habitat important to bats for commuting and foraging, caused by small wind turbines. An experimental study (Chapter 2) showed that bat activity declined after installation of SWTs 5m away from linear features (two models used both 6m high at nacelle; rotor blade length 0.5m, 0.9m). This decline was species-specific with *Pipistrellus pygmaeus* showing declines in activity in close proximity to the SWT associated with SWT operation, while *P. pipistrellus* activity declined in response to installation both at the SWT site and 30m away. A survey of existing turbines (10–20 m in hub height; Chapter 3) indicated that bat use of linear features is lower when SWTs are located nearby. In particular, *P. pygmaeus* activity at linear features is lower the closer a SWT is to the feature, and at high wind speeds *Myotis* spp use of linear features is similarly lower where SWTs are located nearby. This disturbance did not dissipate along the linear features away from the SWT for at least 60m. This is much further than previously documented disturbance of bats by SWTs, which appeared fairly localised, and may be due to the importance of linear features specifically for commuting between habitat fragments. If so, the cumulative impacts of such disturbance will be important in areas where suitable foraging and roosting habitats is limited and fragmented, and linear features suitable for commuting between habitat fragments are already rare. These results offer support for recommendations that SWTs should be subject to siting restrictions that create a buffer distance between them and important bat habitats such as linear features. Specifically, this work suggests that in landscapes with few alternative commuting routes or where particularly rare bat species are present, SWT installations require buffer distances to ensure they are a minimum of 60m away from linear features.

Schweers M. 2017. Auswirkungen von Kleinwindenergieanlagen auf Vögel und Fledermäuse. Masterthesis at Carl von Ossietky Univ. Oldenburg, Germany: 93 p.

Tatchley C. 2016. Wildlife impacts of and public attitudes towards small wind turbines. Unpublished PhD thesis, University of Stirling. Available at UoS Online Research Repository: http://dspace.stir.ac.uk/handle/1893/22894#.VuhGnNKLRpg

Offshore windfarms

Măntoiu *et al*. (2016) presented a monitoring study conducted both onshore and offshore of the western Black Sea area. Using ultrasound monitoring systems, mist netting, stable isotope analysis and wind farm mortality reports, they have found that *Nyctalus noctula*, *Nyctalus leisleri*, *Pipistrellus pipistrellus* and *Pipistrellus kuhlii* use flight paths both onshore and at large distances offshore (over 100km – Autumn 2016) east of the Romanian coastline, during migration and dispersion.

Thompson *et al*. (2015) reported a large number (dozens) of *Myotis sp.* (probably *M. lucifugus*) about 110km from the nearest land in the Gulf of Maine, flying around a fishing vessel and overnighting there. Although it is not in Europe it shows that bats can appear very far out at sea.

Lagerveld *et al*. (2017) present the results of an offshore monitoring program for 2015 and 2016 in the southern North Sea. Most of the observations were located in the Dutch Exclusive Economic Zone (EEZ), with one exception (FINO 3) in the German North Sea part, at the border with Denmark. They investigated 12 offshore locations (including wind turbines) and 5 locations at the coast. *Pipistrellus nathusii* was the most common species at sea and occurred mainly from late august until late October and to a lesser extent from early April until end of June. The most important factor that triggers bat migration at sea was low to moderate wind speed followed by date (seasonality). At sea the activity was strongly peaked (late August/early September and late September). High temperatures increased the occurrence of bats. At sea wind directions of NE and SE (tailwind) resulted in highest presence of bats whereas at coast this was E and SW wind directions.

Increasing moonlight raised the presence of bats at sea and at the coast, whereas rain decreased it. The recorded activity at nearshore locations (22-25km from the coast) peaked about 4 hours after dusk, at offshore locations activity often started close to dusk. The latter means that bats have spent the day out at the monitoring locations at sea. Beside *Pipistrellus nathusii*, few other species were recorded: *Pipistrellus pipistrellus, Nyctalus noctula, Nyctalus leisleri, Eptesicus serotinus, Eptesicus nilsonii and Vespertilio murinus*.

Brabant *et al*. (2016) studied bat migration from a vessel at the Belgian part of the North Sea in autumn 2014 and spring 2015. They found four species (*Pipistrellus nathusii, Pipistrellus pipistrellus, Vespertilio murinus* and *Myotis daubentonii*). *P. pipistrellus* and *V. murinus* were only found within 5km from the coast, while *P. nathusii* was found up to about 30km off the coast, *M. daubentonii* was recorded about 10km far out.

A list of reports and papers about bats and offshore in Europe was collected by Poirson *et al*. (2017).

In Germany the BfN/BMU project about offshore bat migration (BATMOVE) went on in 2017 and will continue in 2018 but no new report is available yet.

Brabant R., Y. Laurent, L. Vigin, R.-M. Lafontaine & S. Degraer. 2016. Bats in the Belgian part of the North Sea and possible impacts of offshore wind farms. In Degraer, S., Brabant, R., Rumes, B., Vigin, L. (Eds.) (2016). Environmental impacts of offshore wind farms in the Belgian part of the North Sea: Environmental impact monitoring reloaded. Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management Section, Chapter 14: 235-246.

Lagerveld S., D. Gerla, J.T. van der Wal, P. de Vries, R. Brabant, E. Stienen, K. Deneudt, J. Manshanden & M. Scholl. 2017. Spatial and temporal occurrence of bats in the southern North Sea area. – Wageningen Marine Research (University and Research Centre), Wageningen Marine Research report C090/17: 52 p.

Măntoiu D.S., K. Kravchenko, L.S. Lehnert, S. Kramer-Schadt, A. Vlashchenko, I.-C. Mirea, C.-R. Stanciu, R. Popescu-Mirceni, R. Zaharia, G.B. Chisamera, O.M. Chachula, M.C. Nistorescu, O.T. Moldovan & C.C. Voigt. 2016. Bat migration in the western Black Sea area: stable isotopes analysis (dHf), ultrasound monitoring and wind turbine mortality events. – In: Popa, L.O., C. Adam, G. Chişamera, E. Iorgu, D. Murariu & O.P. Popa L,.Book of Abstracts - International Zoological Congress of “Grigore Antipa” Museum, 16-19 of November 2016, Bucharest, Romania: 74-75.

Poirson C., V. Leman, S. Dutilleul & V. Cohez (CMNF). 2017. Synthèse des connaissances sur les mammifères marins et les chiroptères dans le détroit du Pas-de-Calais. - chapitre Chiroptères: 61 p.

Thompson R.H., A.R. Thompson & M. Brigham. 2015. A flock of Myotis bats at Sea. – Northeastern Naturalist 22(4): N27-N30.

Wind farms and forests

The only recent publication the sub-group became aware of is dealing with exploitation and foraging behaviour of *Barbastella barbastellus* in south-west Germany (Budenz *et al*. 2017). The authors conducted a 2-year study in a sub-mountainous forested area at two lattice towers. Bats moved along the lattice towers at heights of between 3.5 and 35m. The almost complete lack of echolocation calls above 50m at the first study site and above 20m at the second study site makes it unlikely that explorative behaviour may expose *B. barbastellus* to significant risk.

Budenz T., B. Gessner, J. Lüttmann, F. Molitor, K. Servatius & M. Veith. 2017. Up and down: B. *barbastellus* explore lattice towers. Hystrix 28(2): 272-276.

Implementation of mitigation and post-construction monitoring

The IWG on Wind Turbines and Bat Populations distributed two questionnaires in 2004 and 2009, and an analysis of the responses was presented during the StC4/AC15 in 2010. A third questionnaire was distributed in 2017 and an analysis of the responses was presented in the last report. In order to increase the number of responses, it was decided to send the same questionnaire again. A complete analysis of responses received in 2017 and 2018 is presented in Annex 3.

200m buffer distance to edge habitats particularly important for bats

Using same methodological set-up as Kelm *et al*. (2014), Heim *et al.* (2018) have come to conclusions that further support "Guidelines for consideration of bats in wind farms projects – revision 2014"' recommendation of 200 m buffer for wind turbines from forests and other habitats particularly important for bats, specifically linear structures and small ponds. They have studied bat activity at 20 locations – arable fields in northern Germany, locating static detectors at perpendicular lines from the forest patch edge / linear structure at 0, 50, 100 and 200m from the edge, pairing locations with and without small ponds present. Activity of all species has been the highest at forest edges and low at 200m distance, dropping off manifold already at the 50m distance for *Pipistrellus* spp. and *Myotis* spp., while decreasing more gradually for *Nyctalus noctula.* Similar patterns have been found at linear structures, except for *N. noctula* (whose activity there was as low as at the 200m distance from the forest edge). Also, significantly higher activity of *N. noctula* and *P. pygmaeus*, threefold and twice, respectively, has been found above the arable field at distances of 50–200m when a pond was present.

Heim O., J. Lenski, J. Schulze, K. Jung, S. Kramer-Schadt, J.A. Eccard & C.C.Voigt. 2018. The relevance of vegetation structures and small water bodies for bats foraging above farmland. Basic and Applied Ecology 27: 9–19. https://doi.org/10.1016/j.baae.2017.12.001

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

Wind park design on a regional scale often lacks considering the cumulative effect of the mortality events in the case of bats and birds (Kunz *et al.* 2007). Some studies have shown that dispersion, feeding or migratory behavioural movements of bats often tend to change after wind parks become operational, attracting animals within the sites (Horn *et al.* 2008, Rydell *et al*. 2016). This may have a high potential to negatively affect the long-term population viability of certain migratory bat species (Frick *et al*. 2017), especially if the turbines are placed near linear landscape elements or other important bat flyways. In order to address this issue, sensitivity maps regarding the impact of wind parks on bats can be created both prior to the construction phase, in order to help plan a more sustainable approach, or during the operational period, after data has been gathered regarding mortality events and other technical or spatial variables. The latter can be used to plan and propose suitable mitigation measures in order to reduce the impact on bats on a regional or local scale. The limitations of this approach lie within the common understanding of bat behaviour at wind parks, their movement patterns, the use of various mortality assessment methods at different energy facilities which often do not have similar technical characteristics and the predictors used in order to produce these results, all being subject to biases based on expert opinion.

General spatial representations of bat species richness and potential wind park productivity areas, compared prior to massive wind energy development efforts, are good indicators of potential conflict zones, as shown in Bernard *et al*. (2014). Their study has focused on identifying hotspots and data gaps for bats and wind farms in Brazil, raising concern about future development trends.

In a small-scale study, Ferreira *et al*. (2015) developed a spatially explicit agent-based model in order to determine the foraging area of *Nyctalus leisleri*, using multiple replicates of virtual bat flightpaths. This produced sensitivity maps of bat mortality at a wind park in Portugal. The simulations were conducted on individual patches of 25x25m, containing environmental data, wind turbine positions, climate data, linear landscape elements such as forest edges or roads, bat ecology and behavioural variables and simulated bat mortality events. The approach offers a local decision-making tool that can be used to position turbines within habitat patches, with base recommendations to keep a 3.5km radius distance between bat roosts and turbines.

Santos *et al*. (2013) have used habitat suitability modelling (Maxent) to predict bat fatality risks at wind parks in Portugal. The approach offers a regional scale view of the potential mortality risk of wind parks in the area. The models were constructed based on variables which include fatality data and environmental layers. The mortality data was comprised of 290 fatalities recorded between 2003 and 2011 and the focal species were *Hypsugo savii*, *Nyctalus leisleri*, *Pipistrellus kuhlii* and *Pipistrellus pipistrellus*. The environmental layers took into account global scale climatic layers, topographic variables, such as altitude, slope orientation and inclination, distance-based variables from key landscape features which may hold significance for bats (forests, water and slope reclassifications), and habitat values (land use). The main conclusions were that wind turbines which were positioned closer than 5km to forests, 600m from steep slopes (more than 15°) had a potential higher risk of bat collisions. Additional conclusions were based on climatic data, associating higher mortality risks with more humid areas with milder temperatures.

In a similar approach regarding habitat suitability modelling on a regional scale, Roscioni *et al*. (2013) identified the cumulative impact of wind parks in Italy, using Maxent. The focal species were *Nyctalus leisleri* and *Pipsitrellus pipistrellus* and occurrence data was obtained via acoustic surveys. The environmental variables were comprised of a digital elevation model, a land use layer and hydrographic data. The isolated and combined foraging areas were transformed into indices via FRAGSTATS, analysing statistics based on patches. This offered a spatial approach for habitat fragmentation in relation to wind turbine development in the area. The main results showed that the existing wind turbines generated an impact on the foraging habitats of the focal species and that newly proposed facilities (at that given time) would slightly increase feeding habitat disturbances and have an increased negative effect on forest edges. The approach can be useful for identifying regional scale disturbances caused by existing and proposed wind parks.

Using the same study area, Roscioni *et al*. (2014) conducted a connectivity analysis on *Nyctalus leisleri*, highlighting the effects of current and future wind park development in relation to local and regional movements of the species. Using a set of environmental layers and presence data, a Maxent habitat suitability model was obtained, and later on processed for a connectivity analysis via UNICOR. The potential commuting corridors were overlapped with the wind turbine distributions and recommendations were made regarding sensible areas which may block the species connectivity. The approach can be useful for both local and regional scale studies, also for both existing and proposed wind parks.

Using a deterministic approach on a regional scale in eastern Romania, Măntoiu *et al*. (2015) constructed a bat fatality risk model based on known mortality observations at that specific time (132 cases) and various environmental variables, such as the land use (obtained via a supervised multispectral image classification method), topographic positions indexes (ridges, valleys and slopes), digital elevation models and multiple distance datasets (forests, limestone outcrops, water, settlements and linear anthropic elements). Using ArcGIS (ESRI), a fuzzy membership was generated for each raster dataset through a linear model and a fuzzy overlay was performed in order to combine the results. The turbines which have registered mortality events were intersected with the final dataset. The obtained values were used to reclassify the fuzzy model, generating a sensitivity map which allowed the identification of other turbines with bat mortality risk. The main results showed that the areas close to forests, water bodies, ridges or valleys may pose a significant threat to both local and migrant bat populations. The study was also added to the national best practice guideline for wildlife mortality at wind farms in Romania (Doba *et al*. 2016).

Sea based sensitivity maps are even harder to address, due to a limitative amount of information and lack of geographic references in order to construct spatial models. Key findings within this area include basic assumptions regarding bat biology and behaviour, such as the fact that bats navigate using linear landscape elements, e.g. coastlines, archipelagos or even commercial navy routes. Bat activity in certain key regions, such as the Baltic Sea (Ahlén *et al*. 2009) or the Black Sea, has been shown to peak during migration, in certain points. More research is needed to address this issue.

Ahlén I., H.J. Baagøe & I. Bach. 2009. Behavior of Scandinavian Bats during migration and foraging at sea. Journal of Mammalogy, 90(6), 1318–1323. https://doi.org/10.1644/09-MAMM-S-223R.1

Bernard E., A. Paese, R. Bomfim & L.M. de S. Aguiar. 2014. Blown in the wind: bats and wind farms in Brazil. Natureza & Conservação - Brazilian Journal of Nature Conservation, 12(2), 106–111. https://doi.org/10.1016/j.ncon.2014.08.005

Doba A., T. Papp, M. Nistorescu, A.A. Nagy, S. Stănescu & D.S. Măntoiu. 2016. Ghid de bune practici în vederea planificării şi implementării investiţiilor din sectorul energie eoliană. Bucureşti: Asociaţia Grupul Milvus, EPC Consultanţă de Mediu SRL.

Ferreira D., C. Freixo, J.A. Cabral, R. Santos & M. Santos. 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. https://doi.org/10.1016/j.ecoinf.2015.04.001

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. https://doi.org/10.1016/j.biocon.2017.02.023

Horn J., E.B. Arnett & T.H. Kunz. 2008. Behavioral Responses of Bats to Operating Wind Turbines. Journal of Wildlife Management, 72(1), 123–132. https://doi.org/10.2193/2006-465

Kunz T.H., E.B. Arnett, W.P. Erickson, A.R. Hoar, G.D. Johnson, R.P. Larkin, M.D. Strickland, R.W. Thresher & M.D. Tuttle. 2007. Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. Frontiers in Ecology and the Environment, 5, 315–324. https://doi.org/10.1890/1540-9295(2007)5[315:EIOWED]2.0.CO;2

Măntoiu D. Ștefan, G. Chişamera, O.M. Chachula, G. Mărginean, P. Irina, P. Viorel, C. Hodor, C.R. Stanciu, R. Popescu-Mirceni, A. Telea, D. Bălăşoiu & I.C. Șandric. 2015. A bat fatality risk model at wind farms in Dobrogea, Romania, using a GIS approach. in 4th International Berlin Bat Meeting. Berlin.

Roscioni F., H. Rebelo, D. Russo, M.L. Carranza, M. Di Febbraro & A. Loy. 2014. A modelling approach to infer the effects of wind farms on landscape connectivity for bats. Landscape Ecology, (February). https://doi.org/10.1007/s10980-014-0030-2

Roscioni F., D. Russo, M. Di Febbraro, L. Frate, M.L. Carranza & A. Loy. 2013. Regional-scale modelling of the cumulative impact of wind farms on bats. Biodiversity and Conservation, 22(8), 1821–1835. https://doi.org/10.1007/s10531-013-0515-3

Rydell J., W. Bogdanowicz, A. Boonman, S. Pettersson, E. Suchecka & J.J. Pomorski. 2016. Bats may eat diurnal flies that rest on wind turbines. Mammalian Biology - Zeitschrift für Säugetierkunde, 81(3), 331–339. https://doi.org/10.1016/j.mambio.2016.01.005

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

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 per cent 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

Update/reorganizing of the list of references

(includes new references and it is an addendum to Annex 1 of Doc.EUROBATS.AC20.5, Annex 1 of Doc.EUROBATS.AC21.8, Annex 1 of Doc.EUROBATS.AC22.10.Rev.1, and chapter 9 of EUROBATS Publication Series no. 6)

Arroyo G.M., M. Mateos-Rodriguez, L. Barrios Jaques, A. Rodriguez, A. de la Cruz & D. Cuenca Espinosa. 2017. Bats and wind energy in Southern Spain: temporal patterns and potential consequences for wind power facilities management. Poster, Conference on Wind energy and Wildlife impacts, 6-8 September 2017, Estoril – Portugal.

Bach P., L. Bach & K. Eckschmitt. 2015. Activities and fatalities of Nathusius´ pipistrelles at different wind farms in Northwest Germany. – oral presentation at CWW2015, 10-12 March 2015, Berlin, Germany.

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Annex 2. New studies done in Europe

addendum to Table 1 of *EUROBATS Publication Series Nº 3*, Annex 1 in *EUROBATS Publication Series Nº 6,* Annex 2 to *Doc.EUROBATS.AC20.5,* Annex 2 to *Doc.EUROBATS.AC21.8,* and Annex 2 to *Doc.EUROBATS.AC22.10.Rev.1*

Study (author, year, area)	Time	Habitat types	Data on WTs	Methods	Results
Bach, L. & P. Bach (2018a; NW-Germany)	15.4.-15.10.2016; 15.4.-15.10.2017	argiculture area, meadows and fields	Post contruction monitoring on 2 WT (Enrcon E-101, NH 99m)and 2 WT (Enercon E-92, NH 104m)	carcass search every third day (50m radius), constant monitoring with Avisoft detectors (at nacelle height, constant monitoring with Avisoft detectors (at nacelle height and ground) in 4 Wt; in 2017 1WT with curtailment <6,6 m/s	carcasses: 2016: 3 Pnat; 1 Nnoc, 1 Ppip; 2017: 1 Eser, 1 Ppip acoustics: ground: Nnoc, Nlei, Vmur, Eser, Pnat, Ppip, Ppyg, Mdau, Mdas, Mnat nacelle: Nnoc, Pnat
Bach, L. & P. Bach (2018b, NW Germany)	10.5.-30.11.2017	argiculture area, meadows and fields (e.g. chinese weed) some hedges	Post contruction monitoring on 5 Wt (Enercon E-101; NH 135)	constant monitoring with Avisoft detectors (at nacelle height and mid of tower ca.10m below rotor blade) in 5 Wt, all Wt with a curltailment >10°C and < 7,5 m/s from	acoustics: mid of tower: Nnoc, Nlei, Eser, Pnat, Ppyg, Mdas; nacelle: Nnoc, Nlei, Eser, Pnat, Ppyg
Bach, L. & P. Bach (2018c, NW Germany)	13.5.-30.11.2018	argiculture area, meadows and fields	Post contruction monitoring on 4 Wt (Enercon E-101; NH 135)	constant monitoring with Avisoft detectors (at nacelle height and mid of tower ca.10m below rotor blade) in 4 Wt (Enercon E-101; NH 135), all Wt with a <10°C and >8 m/s from 1.6-15.10	acoustics: mid of tower: Nnoc, Eser, Pnat, Ppip, Plspec; nacelle: Nnoc, Eser, Pnat
Bach, L. & P. Bach (2018d, NW Germany)	13.4.-15.10.2016; 5.4.-15.10.2017	argiculture area, meadows and fields near coast	Post contruction monitoring at 6 Enercon E 101; NH 135	constant acoustic monitoring with Avisoft detector in 6 WT at nacelle height and ground	acoustics: Nnoc, Nlei, Vmur, Eser, Pnat, Ppip, Ppyg, Mdau, Mdas, Mnat, Mmb, Plec spec
Bach, P. & L. Bach (2018e, NW Germany)	1.4.-15.11.2017	argiculture area, meadows and fields near coast	Post contruction monitoring at 1 Enercon E 70/E-4; NH 113,5	carcass search every third day (50m radius), constant monitoring with Avisoft detectors (at nacelle height constant acoustic monitoring with Avisoft detector in 1 WT at nacelle height and ground	acoustics:ground: Nnoc, Eser, Vmur, Pnat, Ppip, Ppyg, Mdau Mdas, Mmb, Mmb, Plec; nacelle height: Nnoc, Eser, Vmur; Pnat, Ppip
Bach, P. & L. Bach (2018f, NW Germany)	2016: 1.4-15.November; 2017: 1.4.-15.11.2017	argiculture area, meadows and fields near coast	Post contruction monitoring at 1 Enercon E 101; NH 135	carcass search every third day (50m radius), constant monitoring with Avisoft detectors (at nacelle height constant acoustic	carcasses: 1 Nnoc juv; acoustics :ground: Nnoc, Eser, Vmur, Pnat, Ppip, Mdau, Mmb, Plec; nacelle height: Nnoc, Vmur; Pnat

				monitoring with Avisoft detector in 1 WT at nacelle height and ground	
Bioinsight (personal communication), Candeeiros, Portugal	May 2016 - Nov 2016	Shrubs, eucaliptus, pine	37 wtS (of 3MW)	MM: weekly searches. SAR 50m; SET.	2 dead bats: 1bat in May; 1 bat in Aug
Bioinsight (personal communication), Caramulo, Portugal	March - April 2017	Shrubs; rocks	45 WTs (2MW)	MM: weekly searches (May-Oct2016 and Mar-Apr2017) around all 11WTs. SAR 50m; SET.	3 dead bats: 1 Ppip and 2bats in April
Bioinsight (2016), Alto do Marco, Portugal	March - November 2016	Mean alt. 1250m; shrubs	6 WTs (of 2MW)	MM: weekly searches (Mar-Jul) and bi-weekly searches (Aug-Oct) around all 6WTs. SAR 50m; SET.	10 dead bats: 1 Ppip in May; 2 Ppip, 1 Ppyg and 1 Nleis in Aug; 1 Psp., 2 Ppip and 1Hsav in Sep; 1 Ppip in Oct
Bioinsight (2017a), Candeeiros, Portugal	September 2016 - August 2017	Shrubs, eucaliptus, pine	37 WTs (of 3MW) + 5 (of 2MW)	MM: weekly searches (Sep-Oct 2016 and Mar-Aug 2017) around all 42WTs. SAR 50m; SET.	4 dead bats: 2 Ppip in April, 1 Nleis in August and 1 Nleis in May.
Bioinsight (2017b), Cabeço Alto, Portugal	August 2016 - July 2017	Shrubs	9 WTs (of 1,3MW)	MM: weekly searches (Aug-Oct 2016 and Mar-Jul 2017) around all 9WTs. SAR 50m; SET.	3 dead bats: 1 Ppip, 1 Ppyg and 1 Hsav in Aug
Bioinsight (2017c), Lousã II, Portugal	May 2016 - April 2017	Mean alt. 950m. Shrubs; grassland; pine plantations; deciduous forest	20 WTs (of 2,5MW) + 5 WTs (of 2MW)	MM: weekly searches (May-Oct 2016, Feb and Apr 2017), monthly searches (Nov 2016 - Jan 2017 and Mar 2017) around all 25WTs. SAR 50m; SET.	6 dead bats: 3 Nleis in Aug; 1 Nleis and 1 Psp. in Sep; 1 Esp. in Oct
Bioinsight (2017d), Alvaiázere, Portugal	January - December 2016	Mean alt. 600m. Shrubs	7 WTs (of 2MW)	MM: weekly searches (Jan-Dez 2016) around all 7WTs. SAR 50m; SET.	4 dead bats: 1 Psp. in Apr; 1 Psp. in Jun; 2 Nleis in Sep
Bioinsight (2017e), Lomba Seixa I, Portugal	August 2016 - July 2017	Mean alt. 1147m. Shrubs; grassland; pine	10 WTs (of 1,3MW)	MM: weekly searches (Aug-Oct 2016 and Mar-Jul 2017) around all 10WTs. SAR 50m; SET.	7 dead bats: 1 Ppip, 1 Ppyg and 1 Hsav in Aug; 1 Pkuh in Sep; 1bat in Apr; 1Mema and 1bat in Jun
Bioinsight (2017f), Bornes, Portugal	September 2016 - August 2017	Mean alt. 1100m. Shrubs; rock outcrops; hardwood forest	24 WTs (of 2,5MW) + 5 (of 2 MW)	MM: weekly searches (Sep-Nov 2016 and Apr-Aug 2017) around all 29WTs. SAR 50m; SET.	39 dead bats: 3 Ppip, 1 Hsav in Apr; 4 Ppip in May; 4 Ppip, 1 Pkuh, 1 Hsav, 1 Nleis, 1 Tten in Jun; 1 Ppip, 1Psp., 1 Nnoc in Jul; 1 Pkuh, 1 Hsav, 1 Tten in Aug; 9 Tten, 4 Ppip, 2 Pkuh, 1 Hsav, 1 Nleis in Sep
Bioinsight (2017g, Portela do Pereiro, Portugal	March - October 2016	Shrubs, eucaliptus, pine	4 WTs (of 1,8MW)	MM: weekly searches (Apr, Jun and Oct 2016), monthly searches (Mar, May, Jul, Aug and Sep 2016) around all 4WTs. SAR 50m; SET.	No dead bats found
Bioinsight (2017h), Chão Falcão II, Portugal	June 2016 - May 2017	Shrubs, rocks, eucaliptus, pine	11 WTs + 2WTs (of 2,3MW)	MM: weekly searches (Jun-Oct 2016 and Mar-May 2017) around all 13WTs. SAR 50m; SET.	No dead bats found
Bioinsight (2017i), Chão Falcão III, Portugal	June 2016 - May 2017	Shrubs, rocks, eucaliptus, pine	9 WTs + 3 WTs (of 2,3MW)	MM: weekly searches (Jun-Oct 2016 and Mar-May 2017) around	No dead bats found

				all 12WTs. SAR 50m; SET.	
Bioinsight (2018a), Alvaiázere, Portugal	January - December 2017	Mean alt. 600m. Shrubs	7 WTs (of 2MW)	MM: weekly searches (Jan-Dez 2017) around all 7WTs. SAR 50m; SET.	No dead bats found
Bioinsight (2018b), Vale de Estrela, Portugal	March - October 2017	Shrubs; grasslands; rocky outcrops, occasional oak forests	11 WTs (of 2,3MW)	MM: weekly searches (Mar-Oct) around all 11WTs. SAR 50m; SET.	1 dead bat: 1 Ppip in May
Bioinsight (2018c), Três Marcos, Portugal	April-October 2017	Shrubs; pine	19 WTs (of 2MW)	MM: weekly searches (Apr-Oct 2017) around all 19WTs. SAR 50m; SET.	2 dead bats: 1 Pkuh in Apr; 1 Ppip in Jun
Biota (2017), Sabugal expansion	May 2016 to January 2017	Scrubland, Pine plantation, Oak forest	20 WT (14 from the original wind farm and 6 from the expansion)	8 inspections around WT (50m) during spring, autumn and winter	3 P. pipistrellus, 2 Pipistrellus sp.
Biota (2018), Penamacor expansion	December 2016 to October 2017	Scrubland, Pine plantation, Pseudotsuga plantation	23 WT (19 from the original wind farm and 4 from the expansion)	8 inspections around WT (50m) during spring, autumn and winter	1 Pipistrellus sp., 1 P. khulii, 2 P. pipistrellus
Frey, K. & L. Bach (2018a, NW Germany)	1.4.-31.10.2016	grass land, arable land	Post contruction monitoring at 1 Enercon E 101; NH 136	constant acoustic monitoring with Avisoft detector at nacelle height	acoustics: Nnoc, Nlei, Vmur, Pnat
Frey, K. & L. Bach (2018b, NW Germany)	1.4.-31.10.2017	grass land, arable land	Post contruction monitoring at 2 Senvion 3.2 M 114 NH 121	constant acoustic monitoring with Avisoft detector at nacelle height	acoustics: Nnoc, Pnat, Ppip, Ppyg
LEA (2017). Parque Eólico de Gevancas II. Portugal.	March 2017 to October 2017	mean alt.: 1140-1261 m; shrubs;	5 WTs (of 2,0 MW)	Monitoring Bat Activity: Presence/absence of bats, identification of the species detected, and the existence of feeding activity and social calls were detected. 10 minutes of census were done at each sampling point (N=10), with an ultrasound detector (D240X - Pettersson Elektronik ®). The number of bat passages detected during each listening was registered. Species with vocalizations difficult to distinguish were associated in groups of two or more species. Mortality surveys: Weekly searches March to october around all 5 WTs.	Monitoring Bat ActivityTadarida teniotis, Nyctalus leisleri, Pipistrellus kuhlii, Pipistrellus pipistrellus, Barbastella barbastellus, Hypsugo savii, Eptesicus, Plecotus, Myotis myotis/blythii and Nyctalus lasiopterus/noctula. Mortality surveys: 4 dead bats found during study (3 Pipistrellus pipistrellus; 1 Pipistrellus pygmaeus); Mortality rate: 3,9 Bats/WTs/year.
TPF Planege (2017), Alto Minho I, Portugal	February-October 2016	shrubs; grassland; small forest areas; rock outcrop	10 WTs (new); 52 WTs (existing)	MM: Weekly Mar-Oct 2016 around all 10 WTs. SAR 50 m. AS: monthly (Mar-Oct 2016) 10-min survey at each sampling point (n=12). Bat	No dead bats found.

				activity was recorded at ground level with D240X, Pettersson Elektronik connected to a digital recorder H2, Zoom. Monitoring bat shelters: search of 4 potential bat shelters (Feb and May 2016) - 1 shelter of national importance (ICNF, 2013).	
Couteau, C. (2015), Chapelle-Vallon (Aube), France	8.8-24.10.2014	arable land	12 WTs (of 2,0 MW)	MM : weekly searches (Aug-Oct 2014) around all 12 Wts, square area 60*60m, SET	3 dead bats : Aug : 1 Ppip, 1 Nnoc ;Sep : 1 Ppip. MR : 0,34 bats/WT/month
Albespy, F. (2016), Cuxac-Cabardès, Caudebronde, Lacombe (Aude), France	6.3-3.11.2015	forest, mean altitude : 800m	12 WTs (of 2,0 MW)	MM : biweekly or weekly searches (6 days in march, 3 in april, 2 in may and june, 8 in july to sept., 6 in oct., 2 in nov.) around all 12 Wts, square area 100*100m, SET	8 dead bats : July : 1 Ppip, 1Nlei, Aug : 2 Ppip, 1 Nnoc, Sep : 2 Ppip, Oct. : 1 Ppip. MR : 5 to 10 bats/WT/year
Sauge, A. (2017). Conilhac Corbières	25.4-8.11.2016	scrubland	4 Wts (of 2,3MW)	MM : biweekly 25.4-8.11.2016, around all 4 Wts, SAR : 50m. SET. 3 WT with blade feathering (increasing cut in wind speed to 5,5 m/s, for 5 hours after sunset).	9 dead bats in 2016 : may : 2 Pkuh, june:1 Nlei, aug : 1Ppip, sept. 2Hsav, 1Ppyg : oct. : 1Pnat, 1Pspp. MR 2015 : 49 bats/WF/year,MR 2016 : 18 bats/WF/year. For the 3 regulated WT, 75% reduction in death-rate
Guillosson, T., (2014), Lapalme, Roquerfort-des-Corbières (Aude), France	3.4-1.11.2013	scrubland, near mediteranean coastline	10 WTs (of 2,3MW)	MM : weekly searches (april to july), biweekly (august to octobre). SAR 50m. SET	34 dead bats : May : 1 Pkuh, 1 Mspp. (probably Mbly) Oct : 1 Pspp., 1Msch ; MR : 1,2 to 2 bats/WT/year
Tirello, L. & Sauge, A. (2016) Canet (Aude), France	3.4-30.10.2015	vineyards, arable land	5 Wts (of 2,3 MW)	MM : weekly searches (april to july), biweekly (august to octobre). SAR 50m. SET. WT with blade feathering	8 dead bats in 2015 : April : 1 Pkuh, 1 Ppyg, Aug. : 1 Ppip, Sept. : 1 Nlei, 2 Ppyg, 1Nlei, Oct. : 1 Pkuh. MR 2015 : 0,19 to 0,62 bats/WT/weekly. Reduction in death-rate with blade feathering
Chouinard, S. & Arhuro, R. (2014) Ile d'Olonne (Vendée) France	1.4.2012-31.3.2013	Spinney, hedgerow, uncutivated land, near atlantic coastline	6 WTS (of 0,8 MW)	MM : biweekly (1.4-13.5.2012, 30.7-15.10), weekly (14.5-29.7, 16.10-15.12, 13.2-31.3.2013). Square 100m. SET	50 dead bats in 2012 : 36 Ppip, 7 Pnat, 3 Pkuh, 1Eser, 1 Mema, 2 N/i. MR : 28,14 to 82,05bats/WT/year

Barré, K. (2017), northwest France	07.09-08.10.2016	arable land, hedgerows, wooded countryside	Post-construction, 151 WTs in 29 wind farms	simultaneous full night recordings (9-13 per night) along hedgerows at different distances from the nearest WT (0-.1000m). 207 sampling sites. 1 wind farm per night to minimize the landscape variations for each night.	High losses of activity due to wind turbine proximity have been noted for a lot of species (impacted or non-impacted by mortality) : B. barbastellus, Myotis spp., N. leisleri, P. pipistrellus, Plecotus spp., fast-flying species group and gleaning species group. The most impacted group, gleaning bats, has shown an average decrease of 53.8% in a 1.000 m radius around each currently installed wind turbine. For this group for example, the losses of activity at 500 m from the WT remain around 80%, compared to those at 1.000 m. No optimum was found, thus bat disturbance by WT remains stable even at 1.000 m from the WT: an impact likely underestimated in this study. High underlying losses of habitat use, e.g. for the gleaner group, almost the equivalent of 2.400 km of hedgerows deserted by bats at the scale.of northwest France. Among the 909 WT in the region, 89% and 73% were installed at less than 200 m, respectively 100 m, from any wooded edges.

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Annex 3

Questionnaire on post-construction monitoring and on implementation of mitigation measures - analyses of responses 2017 and 2018, 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 (Voigt *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 in 2017 but were added in 2018. During 2018 we asked again Parties and Range States to either check the answers in this analyses or submit questionnaires if they didn't answer.

We received minor corrections from Germany, Poland and Croatia and new submission from Israel. We also received another questionnaire from France, but since they considered different time-frame we corrected old version in the analyses where appropriate.

Based on that 27 answered questionnaires were analysed (20 Parties and 7 range states).

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

Onshore windfarms are present in 27 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 19 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-Azores	1988
Portugal-Madeira	1986
Germany	1987
Norway	1991
Finland	1991
Ireland	1992
France	1993
Spain	1994
Israel	1992
Latvia	1995
Turkey	1998
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?

Denmark, Poland, Spain and France reported more than 900 onshore windfarms being operational by the end of 2015 (although Germany stated number of wind turbines we may suspect that there are more than 900 onshore windfarms operating). Six 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 seven countries reported less than 10 windfarms in operation (in addition to Portugal-Azores). Moldova, Jordan and Algeria reported no operational windfarms, while Ukraine didn't provide the answer.

State	Number of operating onshore windfarms
Germany	unknown (approx. 26000 wind turbines)
Denmark	5251
Poland	1188
Spain	1077
France	943 (1653 by the end of 2017)
Portugal-mainland	229
Ireland	215
Netherlands	194
Belgium-Flanders	189
Turkey	100
Finland	approx 100
Belarus	70
Latvia	15-30
Lithuania	23
Norway	20
Croatia	16
Morocco	11
Portugal-Madeira	10
Portugal-Azores	8
Switzerland	6
Slovenia	2
Israel	3
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 10 and 33 WT/WF (in addition to Portugal Madeiara and Portugal Azores), 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 13 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
Israel	10	14	unknown	unknown
Belgium-Flanders	1	14	4	4.3
Portugal-Madeira	1	12	5	5
Portugal-Azores	2	10	6	6
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
Turkey	1	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 (in addition to Portugal-Madeira), while in 14 it is not obligatory and is mostly based on EIA procedure (in addition to Portugal Azores).

State	Answer
Croatia	YES
France	YES
Israel	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
Portugal-Azores	NO
Slovenia	NO
Switzerland	NO
Turkey	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."*

Portugal-Azores	*It is not obligatory, but it can be decided by the authorities to obligate, based on the Environmental Impact Assessment (EIA). We have never had post-construction monitoring of impact on bats prescribed in the Azores Autonomous Region, so far.*
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, in 2014 in Israel 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
Israel	2014
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 seven 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
Israel	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 seven range states disregarding preconstruction assessment threat on bats assessment, while in five 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
Israel	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 70% 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 new answer 100% have post-construction monitoring prescribed, whereas 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
France 2018	1653	1653	100
Serbia	2	1 or 2	50 or 100%
Croatia	16	12	72%
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
Israel	3	2	67%

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*
France 2018	*By the end of 2017 there were 1653 windfarms operating and for all monitoring was prescribed*
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	wo orders prescribe post-construction monitoring: 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 autorisation au titre de la rubrique 2980 de la législation des installations classées pour la protection de l'environnement - applicable to wind farms with at least one tower is more than 50 m or to wind farms with at least one tower is more than 12 m and total power is more than 20 MW (https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000024507365&categorieLien=id) 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 - applicable to wind farms with at least one tower is between 12 m and 50 m, and power is less than 20 MW (https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000024507356&categorieLien=id) These Orders provide: "At least once during the first three years of operation of the installation and then every ten years, the operator shall carry out an environmental monitoring in particular to estimate the mortality of the avifauna and bats due to the presence of wind turbines. When an environmental monitoring is recognized by the Minister responsible for classified installations (i.e. the Ministry of Environment, Energy and the Sea), the monitoring is carried out by the operator according to this protocol. This monitoring shall be kept at the disposal of the of the Inspectorate of classified installations. These follow-ups can be consulted by the Inspectorate of classified installations, usually on a sampling basis, either on request or during inspections.
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
Israel	Israel Planning & Building Law. Regulations dictated by the Planning Commission
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 nine range-states (France, Croatia, Israel, Lithuania, Morocco, Netherland, Portugal-mainland and Portugal-Madeira, Serbia and Spain). In 12 range states it is not done according to the Guidelines (Denmark, Germany, Poland, Belgium-Flanders, Belarus, and Latvia. Moldova, Norway, Slovakia, Switzerland, Turkey 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
Turkey	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.*
Germany	*Reference to EUROBATS is made in some documents._*
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. The ministry enforces SFEPM new guidance (2018) that is consistent with EUROBATS guidelines.*
Switzerland:	*According internal unpublished criteria*

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

In 14 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 ten range states no mitigation or avoidance is being prescribed (Belarus, Georgia, Ireland, and Latvia, Moldova, Morocco, Norway, Portugal-Azores, Slovenia, Turkey 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	YES
Serbia	YES	YES	YES	
Switzerland	YES	YES	YES	
Israel	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			

Portugal-Azores	NO			
Slovenia	NO			
Turkey	NO			
Ukraine	NO			
Denmark-number 2	unknown			
Macedonia	unknown			

State	*Other mitigation measures*
Portugal-Azores	*We have never had mitigations measures prescribed related to bats in the Azores Autonomous Region, so far.*
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.*
Israel	*Principally, all the above measures are part of the measures the wind farm's operators should use. Yet, none was actually done, yet*
France	*The impact study can lead to the prescription of mitigation measures, notably stopping during the hunting time of bats, but also for some wind farms devices for detecting bats (chirotech or other).*

6. Is the effectiveness of mitigation measures being monitored?

Effectiveness of mitigation measures is being monitored at least in eight 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, and France) while in Ukraine it is not known. Germany with many windfarms reported only number of windturbines, though it also lack monitoring of effectiveness of mitigation measures.

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

France	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			
Georgia	NO			
Germany	NO			
Ireland	NO			
Israel	NO			
Latvia	NO			
Lithuania	NO			
Macedonia	NO			
Moldova	NO			
Norway	NO			
Portugal-Azores	NO			
Slovakia	NO			
Slovenia	NO			
Turkey	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
France	There is no approved body to control the effectiveness of these measures but the control must be carried out by private expert societies according to the environmental monitoring protocol published on the website of the Ministry in charge of Environment (« Protocole de suivi environnemental des parcs éoliens terrestres révision 2018 »). These controls are realized once during the first 3 years of functioning then every 10 years

7. Are implemented mitigation measures controlled by the authorities?

Implemented mitigation measures are controlled by authorities in 11 range states which includes mostly control on random basis (Croatia, France, Germany, Lithuania) and in two range states is on annual basis (Netherlands, Portugal-mainland). In 11 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			YES
Germany	YES			YES
Israel	YES*			
Lithuania	YES			YES
Netherlands	YES	YES		
Poland	YES			
Portugal-Azores	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			
Turkey	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	*The implementation of these measures is verified during inspections realised by French administration. This verification is realized during the first year of operation, then every 7 years at most.*
Germany	*concerning the implementation, not the effectiveness*
Israel	*No mitigation was prescribed yet, but if they were the control by authorities is anticipated*
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.*
Portugal-Azores	*We have never had mitigations measures prescribed related to bats in the Azores Autonomous Region, so far, but when existing, will be controlled by the authorities as such occurs to all mitigation measures related to EIA*
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 seven range states (Moldova-probably, Croatia, France, Israel, Netherlands, Poland, Portugal-mainland and Portugal-Madeira, and Serbia). Such studies are not available to public in 15 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
France	YES (on request)
Israel	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
Portugal-Azores	NO*
Slovakia	NO
Spain	NO
Switzerland	NO
Turkey	NO
Belgium-Flanders	unknown
Finland	unknown
Slovenia	unknown
Ukraine	unknown

**- No studies done in the Azores Autonomous Region, so far*

Bibliographic references to monitoring studies in range states:

State	References
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Croatia	Geonatura Ltd. (2015): Bat fauna monitoring during the use of Danilo wind farm - annual report 2015-2016 and final report
Croatia	Oikon d.o.o. (2014): Monitoring of the effects on the bat population during the use of the Jelinak wind farm - report for 2013
Croatia	Oikon d.o.o. (2014): Monitoring of bat mortality during the use of the Jelinak wind farm – monthly field reports March - August
Croatia	Eurus d.o.o. (2014): Complementary bat monitoring at Jelinak wind farm (1.7.2014. - 30.9.2014.)
Croatia	Alcalde, Juan Tomás (2015): Bat activity research at Jelinak wind farm (Croatia) in 2014
Croatia	Geonatura Ltd. (2017): Bat fauna monitoring during the use of Ogorje wind farm - annual report 2016
Croatia	Pavlinić, Igor; Đaković, Maja (2014): The results of bat fauna monitoring in the first year after construction of Pometeno brdo wind farm
Croatia	Pavlinić, Igor; Đaković, Maja (2015): The results of bat fauna monitoring in the second year after construction of Pometeno brdo wind farm
Croatia	Fokus - center for research and preservation of nature (Pavlinić, Igor; Đaković, Maja) (2014): The results of bat fauna monitoring in the first year after construction of Ponikve wind farm

Croatia	Fokus - center for research and preservation of nature (Pavlinić, Igor; Đaković, Maja) (2015): The results of bat fauna monitoring in the second year after construction of Ponikve wind farm
Croatia	Pavlinić, Igor; Đaković, Maja (2014): The results of bat fauna monitoring in the first year after construction of Voštane and Kamensko wind farm
Croatia	Pavlinić, Igor; Đaković, Maja (2016): The results of bat fauna monitoring in the second year after construction of Voštane and Kamensko wind farm
Croatia	Pavlinić, Igor (2013): The results of bat fauna monitoring in the first year after construction of ZD 3 wind farm
Croatia	Pavlinić, Igor (2014): The results of bat fauna monitoring in the second year after construction of ZD 3 wind farm
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Croatia	Pavlinić, Igor; Đaković, Maja (2014): The results of bat fauna monitoring in the second year after construction of ZD 2 wind farm
Croatia	Fokus - center for research and preservation of nature (Pavlinić, Igor; Đaković, Maja) (2016): The results of two year bat fauna monitoring at ZD 4 Benkovac wind farm
Croatia	Pavlinić, Igor; Đaković, Maja (2013): The results of bat fauna monitoring in the first year after construction of ZD 6 Velika Popina wind farm
Croatia	Pavlinić, Igor; Đaković, Maja (2014): The results of bat fauna monitoring in the second year after construction of ZD 6 Velika Popina wind farm
Croatia	Falconry Centre (2013): Final report on the survey of impacts of Crno brdo wind farm on birds and bats (1.1.2012. – 31.12.2012.)
Denmark	Therkildsen OR & Elmeros M (eds.) 2015. First year post-construction monitoring of bats and birds at Wind Turbine Test Centre Østerild. - Scientific report no. 133 from Department of Bioscience and Danish Centre for Environment and Energy, Aarhus University.
France	A guide entitled “Guide relatif à l'élaboration des études d'impact des projets de parcs éoliens terrestres” (Guide to the drafting of impact studies for onshore wind farms projects) was published in December 2016: https://www.ecologique-solidaire.gouv.fr/sites/default/files/Guide_EIE_auto%20env_2017-01-24.pdf The French Society for the Study and Protection of Mammals (SEFPM) published in 2016 recommendations in the document "Diagnostic chiroptérologique des projets éoliens terrestres” (Chiropterology diagnosis of terrestrial wind projects) See Version 2 on: https://www.sfepm.org/pdf/20160213_diagnostic_V2.1.pdf Guide « Protocole de suivi environnemental des parcs éoliens terrestres révision 2018 » (Environmental Monitoring Protocol for Wind Farms) to be available soon
Germany	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 S., Institut für Umweltplanung, Hannover. Hannover : Repositorium der Leibniz Universität Hannover, 2016 (Umwelt und Raum ; 7), 369 S.; http://www.bioacoustictechnology.de/result-report-of-the-research-project-reduction-of-the-risk-of-collision-of-bats-at-onshore-wind-turbines-renebat-ii-has-been-published/?lang=en
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Netherlands	Boonman, M., D. Beuker, M. Japink, K.D. van Straalen, M. van der Valk & R.G. Verbeek, 2011. Vleermuizen bij windpark Sabinapolder in 2010. BW-rapportnr. 10-247. Bureau Waardenburg bv, Culemborg
Netherlands	Boonman, M., M. Japink, D.E.H. Wansink. 2015. Vleermuizen in de Eemshaven. Voorkomen en slachtofferrisico van vleermuizen in toekomstige windparken. Rapport nummer 14-271 Bureau Waardenburg, Culemborg.
Poland	Gottfried I., Gottfried T., Ignaczak M., Wojtowicz B. 2011. Preliminary data on bat mortality at wind farms in Poland. Nietoperze 12 (1-2): 29-34. [Polish]
Portugal-Madeira	ACQ – Consultores de Engenhearia, Ambiente e Qualidade, Unipessoal, Lda. (2016). Reequipamento do Parque Eólico da Bica da Cana, Paul da Serra – Monitorização da Fauna, Flora e Vegetação – Fase de Exploração – 14º Relatório – Dezembro de 2016, 26 pp.
Portugal-Madeira	ACQ – Consultores de Engenhearia, Ambiente e Qualidade, Unipessoal, Lda. (2016). Ampliação do Parque Eólico da Perform 3 no Paul da Serra – Monitorização da Fauna, Flora e Vegetação – Fase de Exploração – 17º Relatório – Dezembro de 2016, 26 pp.
Portugal-Madeira	ACQ – Consultores de Engenhearia, Ambiente e Qualidade, Unipessoal, Lda. (2016). Parque Eólico da Fonte do Juncal, Paul da Serra – Monitorização da Fauna, Flora e Vegetação – Fase de Exploração – 17º Relatório – Dezembro de 2016, 28 pp.
Portugal-mainland	AgriPro Ambiente. 2009. Avaliação do impacte nos quirópteros do projecto de execução do parque eólico da Serra da Alvoaça (Nov 2007 – Nov 2008) para a EDP.
Portugal-mainland	Alves P, E Lopes, S Barreiro & B Silva. 2009. Sub-parques eólicos de Mata-Álvaro, Furnas e Seladolinho. Monitorização de quirópteros. Relatório 3 – Ano 2007 (relatório final). Plecotus, Lda

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Portugal-mainland	Bio3. 2011c. Parque Eólico da Lousã II – Monitorização da comunidade de quirópteros. Relatório 2 (Fase II – ano 1 de exploração).
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