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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
1) preparation of a list of references	Marie-Jo Dubourg-Savage
2) compilation of data on bat mortality per country	Marie-Jo Dubourg-Savage (c) Lothar Bach
3) evaluation/comparison of the 2 questionnaires (2005 & 2009)	Laurent Biraschi (c) Eeva-Maria Kyheröinen Lauri Lutsar Jacques Pir Martin Celuch Branko Mićevski Elvana Ramaj Per Ole Syvertsen Helena Jahelkova
4) updating of tables	Christine Harbusch (c) Marie-Jo Dubourg-Savage
5) mitigation and compensation measures	Luisa Rodrigues (c) Lothar Bach Martin Celuch
6) estimation of mortality rate taking into consideration predation, efficiency and controlled area	Lothar Bach (c) Luisa Rodrigues Eeva-Maria Kyheröinen Martin Celuch Eleftherios Hadjisterkotis
7) impact of mortality rate on populations	Christine Harbusch (c) Lothar Bach Luisa Rodrigues Martin Celuch Eleftherios Hadjisterkotis
8) deterrents	Lothar Bach (c) Luisa Rodrigues
9) table on maximum foraging distances of species	Marie-Jo Dubourg-Savage
10) collect national guidelines (including information on feathering/stopping WTs)	Andrzej Kepel (c) Branko Mićevski

Results

Results are presented by sub-group.

1) Preparation of a list of references

Annex 1 is the continuation of the list of references which had been presented for the AC14 (Doc.EUROBATS.AC14.9.Rev1). It includes new monitoring reports, scientific papers and regional/national recommendations.

2) Compilation of data on bat mortality per country

At the end of 2009, 23 bat species have been killed by wind turbines in Europe. The following table presents per species and per country, the compilation of bat fatalities found both accidentally and during post-construction monitoring studies. A lot of data is missing as in many cases we cannot have access to the reports when there is evidence of bat mortality. The IWG also recalls the countries to send their data to complete the table.

Species	**A**	**CH**	**CRO**	**D**	**EST.**	**F**	**NL**	**N**	**POR**	**SE**	**SP**	**TCHE**	**UK**	**Total**
Nyctalus noctula	3			360		10			2	1	1	3		**380**
Nyctalus lasiopterus				0					1		1			**2**
Nyctalus leisleri		1		50		9			78		1	1		**140**
Eptesicus serotinus				25		7			3		1	7		**43**
Eptesicus nilssonii				2	2			1		8				**13**
Vespertilio murinus				44						1		2		**47**
Myotis myotis				2		1					1			**4**
Myotis dasycneme				1										**1**
Myotis daubentonii				3					2					**5**
Myotis brandtii				1										**1**
Myotis mystacinus				2										**2**
Pipistrellus pipistrellus				229		157	1		113	1	1	3		**505**
Pipistrellus nathusii	1			278		61	1			5		2		**348**
Pipistrellus pygmaeus				21		11			10	1			1	**44**
Pipistrellus kuhlii			4	0		25			13		1			**43**
Pipistrellus spec.		1		22		46			53			2	3	**127**
Hypsugo savii			3	1		1			25		3			**33**
Barbastella barbastellus				0		1								**1**
Plecotus austriacus	1			6										**7**
Plecotus auritus				3										**3**
Miniopterus schreibersii				0		1			1		1			**3**
Tadarida teniotis				0		1			5		1			**7**
Chiroptera spec *				16	1	111			38	30	14		6	**216**
Myotis emarginatus						1								**1**
Myotis bechsteinii				0		1								**1**
Total	**5**	**2**	**7**	**1066**	**3**	**444**	**2**	**1**	**344**	**47**	**26**	**20**	**10**	**1977**

* including 98 still unidentified bat fatalities on one French wind farm

3) Evaluation/comparison of the 2 questionnaires (2004 & 2009)

A total of 25 Range States responded to the 2004 questionnaire, while 27 (out of 48) did so in 2009. 17 Range States responded to both questionnaires, and eight responded in 2009 only. No response/no information was available from ten Range States.

General information

In 2009, most of the 25 Range States mentioned above answered most of the general questions asked in the questionnaire. It appears that wind-turbines do exist in 21 Range States. Concerning the number of wind turbines, 9 range states have indicated a number between “1 to 50”, another 3 a number between “101 to 200”, and 10 a number “> than 750” with a maximum of 14,720 turbines (578 farms) in Spain (1,890 turbines (273 wind farms) in France, and 2,181 turbines in the UK).

The response to the question about the number of wind farms in each country was not that detailed. The numbers varied between 3 (Bosnia) and 273 (France). In 2004, Range States gave an even less detailed response to the question.

In 19 Range States, there are no wind farms in construction, while 14 States mentioned that wind turbines were planned in the near future (total of 1,759 wind turbines and 100 wind farms under planning).

Range States were asked about the responsible authority for the installation of wind turbines. Most replies indicate that different Ministries are in charge of this topic (Ministries of Economy, Labour, Environmental Protection, Culture, Energy etc.). In 10 States, it seems that the private investors and the NGO’s, backed up by the municipalities, have a strong role in the decisions on construction of wind farms/turbines. However, in 16 States (of 19 replies to this point) the national or local Ministry of Environment is concerned in the planning and approval process.

Section on use of the EUROBATS’ guidelines (2009 questionnaire only).

These guidelines were published in 2008 (as EUROBATS Publications Series No. 3), hence the topic was not included in the 2004 questionnaire.

Sixteen Range States responded that the guidelines had been communicated to the relevant services (but not necessarily by all regions in states with a federal government structure), while nine responded that the guidelines had not been communicated. It should be born in mind, however, that the guidelines were still fairly fresh out of the print shop at the time when the 2009 questionnaires were filled in, and it is likely that the situation has changed over the last 12 months.

Among the 16 positive responses, ten also indicated that the relevant services had passed the information on to developers and consultants. Three Range States responded no to this question, while a further three responses were ambiguous.

Fourteen Range States reported that they have plans to develop national guidelines, or already have such guidelines available. Six Range States indicated that they currently have no plans for developing national guidelines.

Planning process

In 2004 nine Range States confirmed that they had recommendations regarding *site selection*, while in 2009 the figure rose to 15. A further four responded partly confirmative in 2004. The number of negative responses was about the same between the two years (seven vs. nine). On balance, it would seem that the situation did not change much over the five year census period. Concerning *size of wind farms*, the ratio between confirmative/negative replies in 2004 and 2009 were more or less equal, with seven confirmative in 2004 and nine in 2009, and 11 vs. 14 negative.

In 2004, no Range States gave a clear confirmative response to the question of *whether guidance was given to minimize negative impacts on bats*, while as many as 19 stated that such guidance was not provided. Five years on, the situation is more or less reversed. Only eight Range States replied that no guidance is given in 2009, and 13 Range States report that guidance to minimize negative impacts on bats is indeed provided.

When it comes to *regulations for buffer areas around protected sites*, little seem to have changed over the five year census period. In 2004 six Range States stated that buffer zone regulations were enforced, while 11 reported that this was not so (three further replies were ambiguous). In 2009 the corresponding figures are eight confirmative and 16 negative (one ambiguous response). Thus, about one third of Range States that responded have such regulations.

The 2009 questionnaire included a question on whether planning authorities are taking account of *habitats that are unsuitable for wind turbines* when granting permits. Sixteen of the Range States that replied to the question stated that planning authorities do take account of protected species and habitats. Seven responded no or an ambiguous yes, apparently reflecting that the issue may frequently be only partly considered. In 2009, Range States were also asked whether they had *plans for regulating new types of wind turbines*. Only two Range States replied confirmative (Ireland and Romania). Nine responded no, while quite a few left the topic unanswered.

Impact studies

Answers given in the 2004 and 2009 questionnaires concerning impact studies are graphically visualized in Annex 2. Here follows a summary of findings.

The importance of bats in impact studies rose – from 37 % to 72 %. Most countries are doing impact studies for birds and also for bats. Studies are initiated mostly by government in 2009 (58 %) and less by wind energy industry (14 %) compared to 2004, when only 24 % of studies was initiated by government and 36 % by wind energy industry.

Only a few countries responded to a new question in the 2009 questionnaire about what proportion of wind farms which were studied with respect to bats. In these 11 countries the proportion varies from 100 % (Hungary, Romania) to less than 10 % (Switzerland, Greece, Germany). Almost in half of all countries (45 %) which replied in 2009 the ministry entices the developers to finance the monitoring studies (new question in questionnaire). The reports indicate that in half of the Range States studies are done both before and after construction in 2009, while in 2004 just 8 % of States responded this way.

EIA studies contained in 2004 more parameters in many countries, while in 2009 studies are more focused on pre-installation surveys on bat species, foraging habitats, flight paths and roosts, and collisions and bat species in post-installation surveys. Methods of the studies are for the most part still not standardised – in 2004 15 % countries have standardised methods, in 2009 still only 22 %. Studies are still mostly short term (2004 – 60 %, 2009 – 69 %), although the proportion of long-term studies rose slightly (2004 – 4 %, 2009 – 9 %). Long-term monitoring after installation is required in one third of Range States that responded in 2009, a clear increase from 2004 (one fourth).

Results of the studies are similarly taken into account during the planning and installation (2004 – 40 %, 2009 – 35 %), although the proportion of negative replies rose from 12 % to 35 % (portion of “No answer” is lower). In 2009 35 % of responding Range States reported that there is evidence of cancellation of installation of wind turbine projects due to a negative assessment by bat studies; in 2004 this figure was only 4 %. Reports from impact studies are mostly available to public in 2009 (65 %, new question).

Research

Based on the questionnaire answers, research on the impact of wind turbines on bat populations was conducted in only 3 countries in 2004. In 2009 the number was 6 countries. In 2009 there were some projects going on to study bat migration, especially new methods to acquire or improve knowledge on bat migration. 8 countries reported that studies take place, but mostly they did not indicate whether these projects include new methodology. This topic was not asked in the 2004 questionnaire.

4) Updating of tables

Annex 3 contains new data about studies done in Europe; this table is an update to Table 1 of EUROBATS Publication Series nº 3 and Annex 3 of Doc.EUROBATS.AC14.9.Rev13. The IWG recalls the countries to send their data, to complete the table.

Annex 4 contains updated data on bats´ behaviour in relation to windfarms; this table is an update to Table 2 of EUROBATS Publication Series nº 3.

5) Mitigation and compensation measures

Since the last report, not much new knowledge was published. There is a German project going on to find out ways to reduce mortality at wind turbines (Brinkmann, pers. com.); first results were presented in June 2009, but the analyzing of data is still going on and there is no report yet.

There is one new scientific paper from Canada about the effect of raise the rotor start-up speed up to 5.5 m/s; fatalities were reduced about 50-70 % (Baerwald *et al*. 2009). In the USA there was also an experiment regarding the effect of cut-in speed at 5.0 and 6.5 m/s (Arnett *et al*. 2009); results showed no difference between the two speeds but it was estimated that fatalities at fully operational turbines were 5.4 times greater than at curtailed turbines.

Arnett EB, M Schirmacher, MMP Huso & JP Hayes (2009) *Effectiveness of Changing Wind Turbine Cut-in Speed to Reduce Bat Fatalities at Wind Facilities*. Annual Report Prepared for the Bats and Wind Energy Cooperative and the Pennsylvania Game Commission.

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

6) Estimation of mortality rate taking into consideration predation, efficiency and controlled area

Two new approaches are still are under development to get a better and more realistic calculation of the mortality rate (Germany: Brinkmann pers. comm. and USA: Huso 2009).

Huso M (2009) *A comparison of estimators of bat (and bird) fatality at wind power generation facilities*. Presentation on the WBWG meeting 14. April 2009, Austin, Texas.

7) Impact of mortality rate on populations

To our knowledge, no study regarding the impact of mortality by wind turbines on bat populations was published since the last report, so this important issue cannot be presently assessed.

8) Deterrents

Regarding the two possibilities that have been tried to deter bats from the surroundings of blades from wind turbines, namely radar and emission of ultrasound noise, since the last report there has only been a paper published about the first one (Nicholls & Racey 2009).

In a preliminary study (Nicholls & Racey 2007) it was showed that bat activity was significantly reduced (circa 50%) in habitats exposed to an electromagnetic field (EMF) strength of greater than 2 v/m when compared to matched sites registering EMF levels of zero. The reduction of bat activity was not significantly different at lower levels of EMF strength within 400 m of the radar. Authors went on with their studies and showed that there was a significant decrease of bat activity and foraging effort (mainly *Pipistrellus pipistrellus* and *P. pygmaeus*) of about one third when they exposed a specific site by a fixed antenna with medium radar pulse length (0.3 ms/1200 Hz), but the radar had no significant effect on the abundance of the captured insects (Nicholls & Racey 2009). It is suggested that it might be possible that only a particular combination of wavelength, pulse repetition rate, power output and target size will lead to a satisfactory reaction of the bats.

There are some other questions/problems that have to be solved. Until now only bat activity in a distance between 10 and 30 m from the radar has been studied, but recent rotors blades have a length of 40-50m. Additionally, nothing is known about possible impacts of radar on other species groups as insects or birds. Taking this information into consideration, radar is still yet not a satisfactory way to deter bats from wind turbine rotors. Nevertheless, its effect on bats was confirmed by Ahlén *et al*. (2009), who observed avoidance of an area around a lighthouse by bats when a navigation radar was on.

Ahlen I, HJ Baagoe & L Bach (2009) Behavior of Scandinavian bats during migration and foraging at sea. Journal of Mammalogy 90 : 1318–1323.

Nicholls B & P Racey (2007) Bats avoid radar installations: Could electromagnetic fields deter bats from colliding with wind turbines? *PloS ONE* 2(3): e297. doi:10.1371/journal.pone.0000297.

Nicholls B & P Racey (2009) The Aversive Effect of Electromagnetic Radiation on Foraging Bats—A Possible Means of Discouraging Bats from Approaching Wind Turbines. *PLoS ONE* 4(7): e6246. doi:10.1371/journal.pone.0006246.

9) Table on maximum foraging distances of species

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

Species	max foraging distance (km)	Height of flight (m)	References	Radio-tracking studies
Nyctalus noctula	26	10 to a few hundred meters	1, 7, 30	Yes
Nyctalus leisleri	17	above canopy	5, 6, 30, 32, 42, 45	Yes
Nyctalus lasiopterus	90	1300m (telescope & radar)	2, 3, 4, 30	Yes
Miniopterus schreibersii	40	2-5 (foraging) and open sky (transit)	8, 30, 41, 40	Yes
Pipistrellus nathusii	12	1-20 (foraging); 30-50 (migration)	43, 45, 46, 47,30	Yes
Myotis myotis	25	1-15m (direct flight in open sky in transit)	26, 27, 28, 29, 30	Yes
Myotis blythii	26	1-15	22, 23, 24, 25, 26, 30	Yes
Myotis emarginatus	12,5	no information	17, 18, 30, 33, 36, 38, 39	Yes
Myotis bechsteinii	2,5	1-5 and in the canopy	12, 30, 31, 38, 39	Yes
Pipistrellus pygmaeus	1,7 (mean radius)	up to the rotor	20, 30	Yes
Pipistrellus pipistrellus	5,1	up to the rotor	21, 61	No; chimiolumi nescent tags

Pipistrellus kuhlii	no information	1-10; up to a few hundreds	30	Yes
Eptesicus serotinus	12	50 (max)	13, 14, 15, 16, 30	Yes
Barbastella barbastellus	10	above canopy	11, 12, 30, 34, 35	Yes
Tadarida teniotis	>30 (Portugal), 100 (Switzerland)	10-300	44, 9, 10, 30	Yes
Hypsugo savii	?	>100	33, 37	No
Vespertilio murinus	6,2 ♀; 20,5 ♂	20-40	48, 49	Yes
Eptesicus nilssonii	30	> 50	51, 52	Yes
Myotis dasycneme	15 to a few dozens	2-5	53	No
Myotis daubentonii	10 ♀; >15 ♂	1-5	57, 58	Yes
Myotis brandtii	10	up to the canopy	49, 54, 55	?
Myotis mystacinus	2,8	up to 15m in the canopy	55, 56	Yes
Plecotus auritus	2,2-3,3	up to the canopy	59	Yes
Plecotus austriacus	1,4	?	60	Yes

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10) Collect national guidelines (including information on feathering/stopping WTs)

Thirty countries filled and returned the questionnaire on the compliance with point 5 of the EUROBATS Resolution 5.6. In eight countries of this group (26,7%), the national guidelines for the assessment of a potential impact of planned wind farms on bats have been produced (Bulgaria, Croatia, France, Germany, Lithuania, Poland, Portugal and United Kingdom), and in two other countries (Belgium – Wallonie and Czech Republic) the general guideline of EUROBATS is used (in the case of Czech – with some local adaptations). At least in France and Lithuania both national and EUROBATS guidelines are recommended for use.

So far, only in four countries (Croatia, Lithuania, Portugal and UK) the national guidelines are officially recommended. In the remaining four countries, where some national guidelines are used, these documents are developed mostly by NGO's and used more or less on a voluntary basis (as the suggestion of the best practices). Out of these four countries, two (Poland and France) expressed the will to prepare officially recommended national guidelines in the near future. A similar statement was also given by five countries, which have no guidelines in use so far and by two countries that currently use only the general EUROBATS guidelines.

Seven national guidelines sent with questionnaires have been collected and are available for interested States. The 8th country (Lithuania) has not send its national guidelines yet.

Stopping the wind turbines during the time when bats are active is a recommendation in some cases, and a mandatory mitigation measure in ten countries (33,3%). However no information on the scale of the use of this method was provided. Some countries have mentioned that this information is unavailable, while other countries wrote that this measure is not used in practice.

In the case of several countries, the lack of implementation of the point 5 of the EUROBATS Resolution 5.6 was explained as it was not necessary to do so (with no or very few wind farms or single turbines having been built). In one case, the economic objections raised by the investors were given as the reason. In the questionnaires of some countries it was suggested that a more active interest of the EUROBATS Secretariat in the implementation of the Agreement resolutions could help to ensure greater compliance.

Final remarks

Available results show that mortality is highly variable between different sites and between different wind turbines within one wind farm. Besides that, mortality varies between years.

Taking into consideration a need noticed during AC14, the IWG tried to get funds to translate some important reports (mainly in German) but this task was not possible.

We highlight the problem that in some countries (e.g. Germany) most of the post-monitoring studies are not published or otherwise officially available. Wind farm developers must be forced to make all reports available, to allow an overview over a broader geographical scale and to increase the knowledge about mortality rate.

We reiterate the opinion that guidelines should not be revised right now; a report will be produced for MoP6, if new data is available.

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(update to Annex 1 of Doc.EUROBATS.AC14.9.Rev1)

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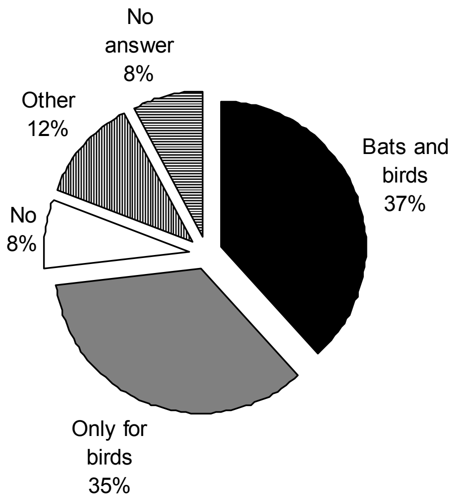
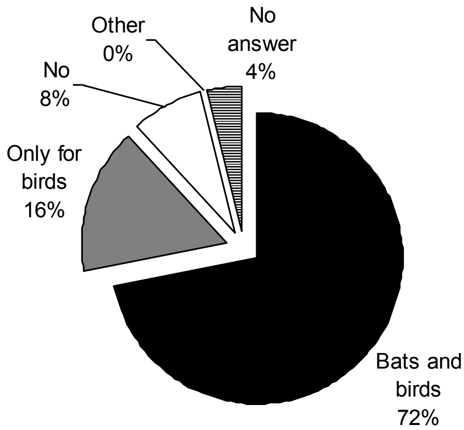
Graphic presentation of studies on impact of wind turbines on European bats as revealed by questionnaires

2004

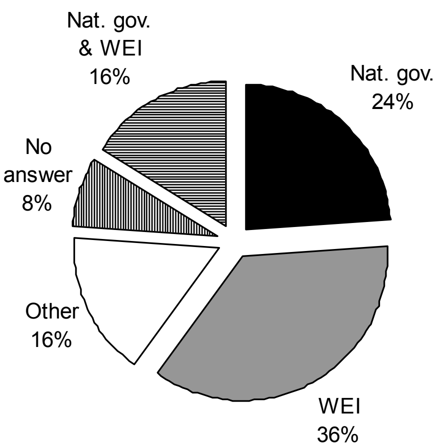
2009

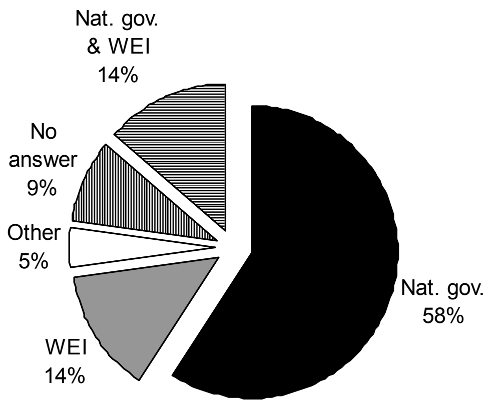
1. Are EIA required before or after the installation of WT?





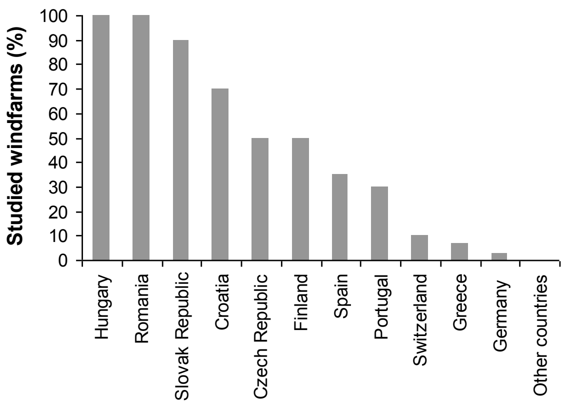
2. By whom they are initiated?





3. How many wind farms have been studied in respect of bats in your country?

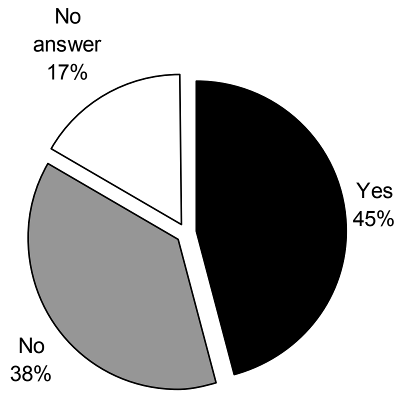
No data



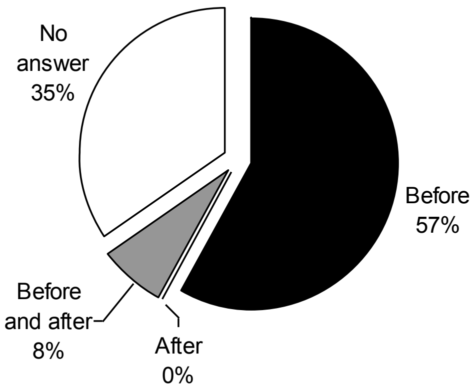
2004 **2009**

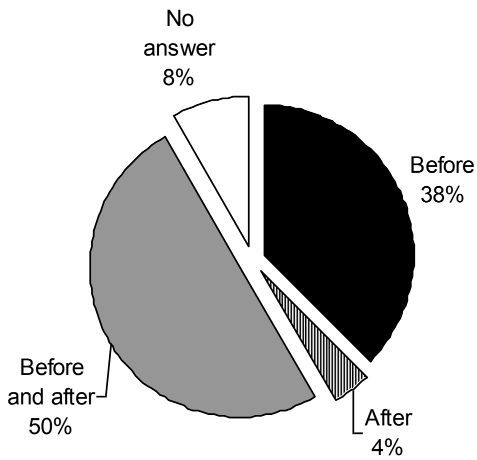
4. Does your ministry entice developers to finance monitoring studies (BACI) and research)?

No data

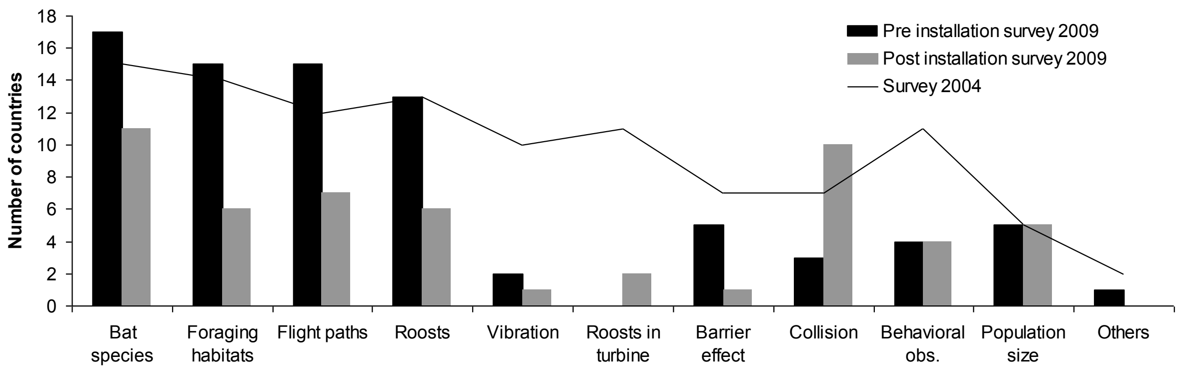


5. Are the studies done: a) before b) after c) before and after?



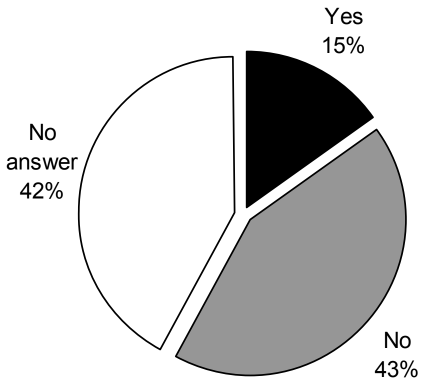


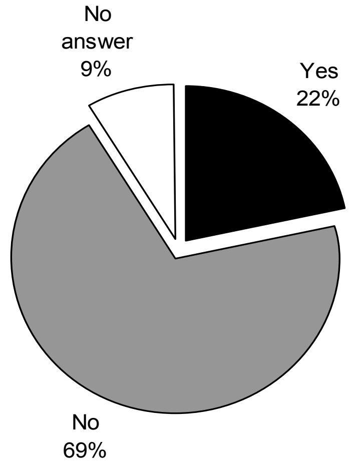
6. Which criteria do the EIA contain?



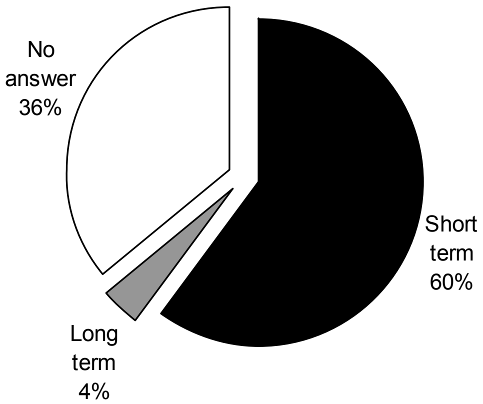
2004 **2009**

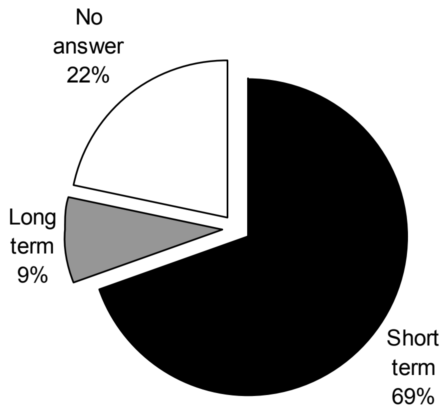
7. Are the methods of the study standardised?



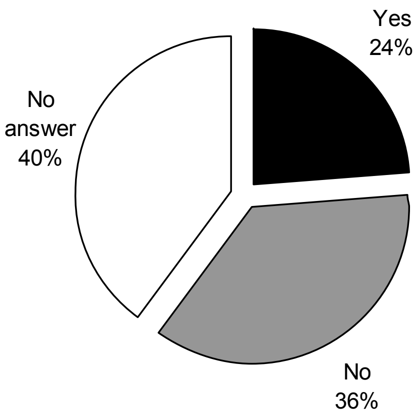


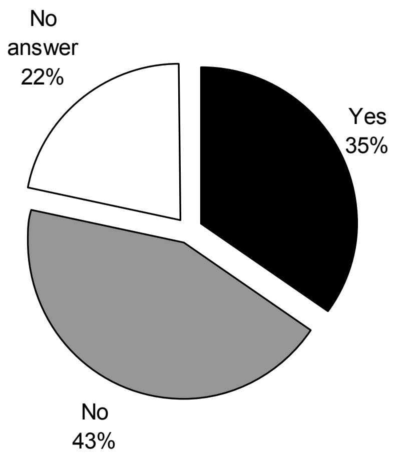
8a. On which time scale are impact studies done?





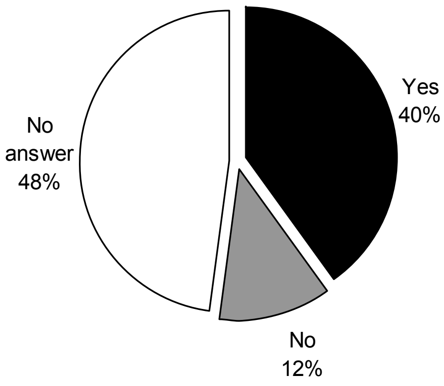
8b. Is long term monitoring required after installation of WT?

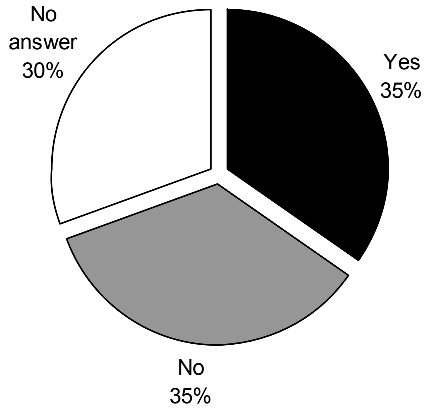




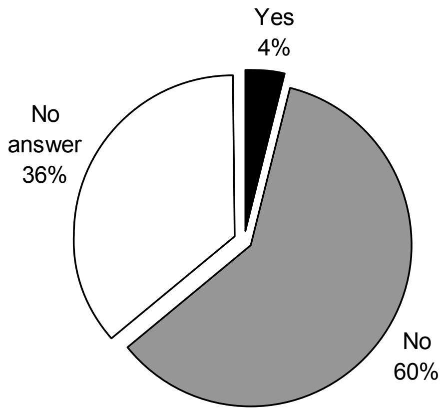
2004 **2009**

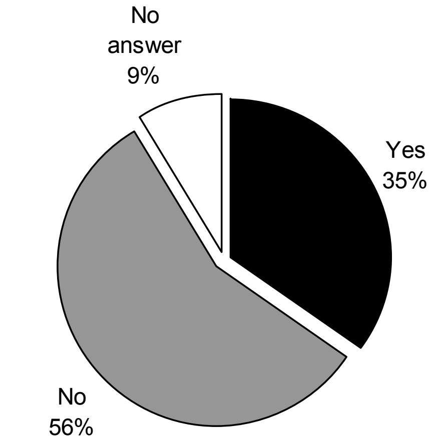
9. Are the results of these studies fully taken into account during the planning and installation process?





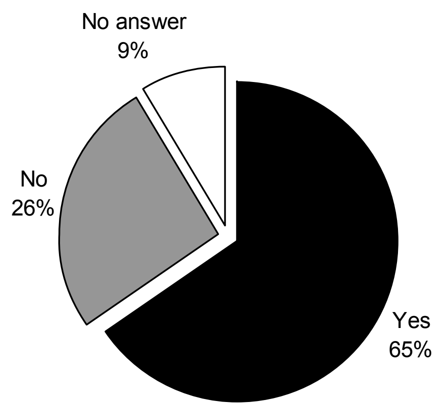
10. Is there evidence of a cancelled installation of WT due or partly due to a negative assessment by bat studies?





11. Are the impact studies and monitoring reports public available?

No data



Doc.EUROBATS.StC4-AC15.22.Rev.1.Annex 3

Studies done in Europe

(update to Table 1 of EUROBATS Publication Series nº 3 and Annex 3 of Doc.EUROBATS.AC14.9.Rev1)

Study (author, year,	time	type of turbines	methods	results	Habitat types
Bach & Bach, (2008), Germany	2008 (mid July - mid October)	ENERCON E-33, 3 WT	searches every 3. day; Search area: 40 m around WT; Tests for search efficiency & predation.	collision rate: 3,1 bats/Year	North Sea coast
Bach & Bach, (2010), Germany	2009 (mid July - mid October)	ENERCON E-33, 7 WT	searches every 3. day; Search area: 40 m around WT; Tests for search efficiency & predation.	collision rate: 1,6 bats/Year	North Sea coast
Bach & Niermann, (2010), Germany	2009 (beginning April - end November)	Vestas V 100 , 6 WT	searches every 2. day during spring and autumn migration period; summer period searches every 3. day; Search area: 50 m around WT; Tests for search efficiency & predation.	collision rate: 4 bats/Year	mixed landscape with farmland and forest
Long et al. (2009), UK		microturbines	lab study with pipistrelle sounds	ultrasound scattering properties of an operational wind turbine increases with distance; blades may not be detectable to a bat at all at a distance greater than half a metre, even when stationary	lab study
Profico Ambiente/Bio3, (2009), Guarda, Portugal	2008 (May - mid June; end August - beginning October)	4 WTs	Weekly searches; Search area: 50 m around WT; Tests for search efficiency & predation.	1 dead bat (Nlei). Mortality rate 0,67bat/WT/12weeks	mean alt. 990m; shrubs and grasslands
Profico Ambiente/Bio3, (2010), Guarda, Portugal	2009 (May - mid June; September - mid October)	4 WTs	Weekly searches; Search area: 50 m around WT; Tests for search efficiency & predation.	no mortality	mean alt. 990m; shrubs and grasslands
Procesl (2009), Alto Minho, Portugal	April-October 2008	75 WTs	Monthly searches around 70% of the WTs; Search area: 50 m around WT; Tests for search efficiency & predation.	9 dead bats (2 Nlei, 5 Ppip, 2 Pip sp.): 7 in September, 2 in October; Mortality rate 1,92 bat/WT/ 7 months	mean alt. 1200m; shrubs; pine plantations; grasslands
Strix (2007a), Seixinhos, Portugal	2006	8 WTs	Tests for efficiency & predation; and mortality search	Mortality rate 0,5 bat/WT/year (the mortality happened in the Summer)	Ridge NE-SW, range altitude 1197-1260m; totally integrated in an important area for the conservation of the biodiversity; low bushes
Strix (2007b), Seixinhos, Portugal	2007	8 WTs	Mortality search; Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	no mortality	Ridge NE-SW, range altitude 1197-1260m; totally integrated in an important area for the conservation of the biodiversity; low bushes
Strix (2009a), Seixinhos, Portugal	2008	8 WTs	Mortality search; Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	no mortality	Ridge NE-SW, range altitude 1197-1260m; totally integrated in an important area for the conservation of the biodiversity; low bushes
EnergieKontor (in prep), Seixinhos, Portugal	2009	8 WTs	Mortality search; Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	no mortality	Ridge NE-SW, range altitude 1197-1260m; totally integrated in an important area for the conservation of the biodiversity; low bushes

Strix (2007a), Penedo Ruivo, Portugal	2006	10 WTs	Tests for efficiency & predation; and mortality search	no mortality	Ridge SW-NE, range altitude 1120-1220m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and pine stand
Strix (2007b), Penedo Ruivo, Portugal	2007	10 WTs	Mortality search; Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	no mortality	Ridge SW-NE, range altitude 1120-1220m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and pine stand
Strix (2009a), Penedo Ruivo, Portugal	2008	10 WTs	Mortality search; Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	no mortality	Ridge SW-NE, range altitude 1120-1220m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and pine stand
EnergieKontor (in prep), Penedo Ruivo, Portugal	2009	10 WTs	Mortality search; Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	no mortality	Ridge SW-NE, range altitude 1120-1220m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and pine stand
Strix (2009a), Mafômedes, Portugal	2008	2 WTs	Mortality search; Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	no mortality	Ridge NE-SW, range altitude 1075-1110m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and pine stand
EnergieKontor (in prep), Mafômedes, Portugal	2009	2 WTs	Mortality search; Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	no mortality	Ridge NE-SW, range altitude 1075-1110m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and pine stand
Mãe d'Água (2007), Lameira, Portugal	2006-2007	8 WTs	Mortality search. Search area 50 meters of ray. Control of 15 among 15 days of all WTs, during two successive days.	Mortality rate 0,63 bat/WT/year	Ridge S-N, mean altitude 1332m; totally integrated in an important area for the conservation of the biodiversity; shrubland
Profico Ambiente (2007a), Outeiro, Portugal	Spring 2006	15 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	Mortality rate 2,52 bats/WT	Ridge NE-SW, range altitude1186-1311m; totally integrated in an important area for the conservation of the biodiversity; low bushes
Profico Ambiente (2007b), Outeiro, Portugal	Summer 2006	15 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	Mortality rate 1,86 bats/WT	Ridge NE-SW, range altitude1186-1311m; totally integrated in an important area for the conservation of the biodiversity; low bushes
Profico Ambiente (2007c), Outeiro, Portugal	Autumn 2006	15 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	Mortality rate 1,60 bats/WT	Ridge NE-SW, range altitude1186-1311m; totally integrated in an important area for the conservation of the biodiversity; low bushes

Profico Ambiente (2007d), Outeiro, Portugal	All seasons 2006	15 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 15 among 15 days of all WTs.	Mortality rate 5,98 bats/WT/year	Ridge NE-SW, range altitude1186-1311m; totally integrated in an important area for the conservation of the biodiversity; low bushes
Cabral et al (2008a), Outeiro, Portugal	Spring 2008	15 WTs	Mortality search; Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	Mortality rate 1,86 bats/WT/year	Ridge NE-SW, range altitude1186-1311m; totally integrated in an important area for the conservation of the biodiversity; low bushes
Cabral et al (2008b), Outeiro, Portugal	Summer 2008	15 WTs	Mortality search; Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	Mortality rate 0,32 bats/WT/year	Ridge NE-SW, range altitude1186-1311m; totally integrated in an important area for the conservation of the biodiversity; low bushes
Cabral et al (2008c), Outeiro, Portugal	Autumn 2008	15 WTs	Mortality search; Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	Mortality rate 2,28 bats/WT/year	Ridge NE-SW, range altitude1186-1311m; totally integrated in an important area for the conservation of the biodiversity; low bushes
Cabral et al (2009), Outeiro, Portugal	All seasons 2008	15 WTs	Mortality search; Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	Total mortality estimated = 67,1 bats died between Março and October of 2008	Ridge NE-SW, range altitude1186-1311m; totally integrated in an important area for the conservation of the biodiversity; low bushes
LEA (2009a), Sobrado, Portugal	Spring 2009	4 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	no mortality	Ridge N-S, range altitude 1240-1290m; totally integrated in an important area for the conservation of the biodiversity; low bushes
LEA (2009b), Sobrado, Portugal	Summer 2009	4 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	no mortality	Ridge N-S, range altitude 1240-1290m; totally integrated in an important area for the conservation of the biodiversity; low bushes
LEA (2010a), Sobrado, Portugal	Autumn 2009	4 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	no mortality	Ridge N-S, range altitude 1240-1290m; totally integrated in an important area for the conservation of the biodiversity; low bushes
LEA (in prep), Sobrado, Portugal	All seasons 2009	4 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	no mortality	Ridge N-S, range altitude 1240-1290m; totally integrated in an important area for the conservation of the biodiversity; low bushes
LEA (2010b), Negrelo e Guilhado, Portugal	Summer 2009	10 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	Mortality rate 0,94 bats/WT	Ridge N-S, range altitude 1000-1100m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and birchs
LEA (2010c), Negrelo e Guilhado, Portugal	Autumn 2009	10 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	Mortality rate 0,46 bats/WT	Ridge N-S, range altitude 1000-1100m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and birchs

LEA (in prep), Negrelo e Guilhado, Portugal	Summer & Autumn 2009	10 WTs	Tests for efficiency & predation; and mortality search. Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	Mortality rate 1,40 bats/WT/2 seasons	Ridge N-S, range altitude 1000-1100m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and birchs
Amorim (2009), Candal Coelheira, Portugal	2007	20 WTs	Tests for efficiency & predation; mortality search; and space use by bats. Search area 60 meters of ray. Control of 7 among 7 days of all WTs.	48 carcasses (14Nlei; 24 Ppip; 10 others). Mortality rate 9,55 bats/WT (most of it on the end of summer). Relation between space use and mortality	Ridge NW-SE, range altitude 1000-1200m; totally integrated in an important area for the conservation of the biodiversity; low bushes, shrubland and outcrops
Strix (2007c), Videira, Portugal	March-October 2006	3 WTs	Monthly searches. 60 m radius arround WTs. Tests for efficiency and predation	no mortality	Range elevation 507-522 m. shrub and grassland. SIC - PTCON0045
Strix (2008a) Videira, Portugal	March-October 2007	3 WTs	Monthly searches. 60 m radius arround WTs. Tests for efficiency and predation	no mortality	Range elevation 507-522 m. shrub and grassland. SIC - PTCON0046
Strix (2009b), Videira, Portugal	March-October 2008	3 WTs	Monthly searches. 60 m radius arround WTs. Tests for efficiency and predation	no mortality	Range elevation 507-522 m. shrub and grassland. SIC - PTCON0047
Strix (2006a), Alagoa de Cima, Portugal	February 2006	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation	no mortality	Oak and Pine woodland
Strix (2007d), Alagoa de Cima, Portugal	Spring 2006	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2007e), Alagoa de Cima, Portugal	Summer 2006	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2007f), Alagoa de Cima, Portugal	Autumn 2006	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2007g), Alagoa de Cima, Portugal	Winter 2007	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2008b), Alagoa de Cima, Portugal	Spring 2007	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2008c), Alagoa de Cima, Portugal	Summer 2007	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2008d), Alagoa de Cima, Portugal	Autumn 2007	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2008e), Alagoa de Cima, Portugal	Winter 2008	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2008f), Caravelas, Portugal	Winter 2006	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2008g), Caravelas, Portugal	Spring 2007	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	1 dead bat (Pip pip). 0,11 bat/WT/3 months	Oak and Pine woodland
Strix (2008h), Caravelas, Portugal	Summer 2007	9 WTs	Monthly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Oak and Pine woodland
Strix (2006b), Portal da Freita, Portugal	Winter 2006	2 WTs	Weekly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Elevation 1344 m - Shrub (*Erica* sp. and *Chamaespartium tridentatum*) and grassland

Strix (2006c), Portal da Freita, Portugal	Spring 2006	2 WTs	Weekly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Elevation 1344 m - Shrub (*Erica* sp. and *Chamaespartium tridentatum*) and grassland
Strix (2006d), Portal da Freita, Portugal	Summer 2006	2 WTs	Weekly searches. 50 m radius arround WTs. Tests for predation and detectability	1 dead bat (Nyctalus sp.). 0,5 bat/WT/3 months	Elevation 1344 m - Shrub (*Erica* sp. and *Chamaespartium tridentatum*) and grassland
Strix (2006e), Portal da Freita, Portugal	Autumn 2006	2 WTs	Weekly searches. 50 m radius arround WTs. Tests for predation and detectability	no mortality	Elevation 1344 m - Shrub (*Erica* sp. and *Chamaespartium tridentatum*) and grassland
Alves et al (2006a), Chão Falcão I, Portugal	March-November 2005	15 WTs	Searches twice/month; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	no mortality	shrubs, eucaliptus
Silva et al (2007), Chão Falcão I, Portugal	March-October 2006	15 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	no dead bats	shrubs, eucaliptus
Hortêncio et al (2008), Chão Falcão I, Portugal	March-October 2007	15 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	3 dead bats (Ppip/Pkuh, Pkuh, Nlei); mortality rate 1,3 bats/WT/year (8 months period)	shrubs, eucaliptus
Alves et al (2006b), Candeeiros I, Portugal	March-November 2005	26 WTs	Searches twice/month; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	1 dead bat (;sch); mortality rate 0,65 bats/WT/year (9 months period)	shrubs, eucaliptus, pine
Barreiro et al (2007), Candeeiros I, Portugal	March-October 2006	26 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	3 dead bats (Pip sp, Nlei, no id.); mortality rate 0,5 bats/WT/year (8 months period)	shrubs, eucaliptus, pine
Barreiro et al (2007), Candeeiros II, Portugal	September-October 2006	11 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	no dead bats	shrubs, eucaliptus, pine
Alves et al (2007a), Freita I e II, Portugal	August-October 2006	16 WTs	Weekly searches; Search area: 50 m around WT; Tests for search efficiency and predation (spting).	4 dead bats: 2 Ppip, 1 Ppip/Ppyg, 1 Tten; mortality rate 0,4 dead bats/WT/year (3 months period)	shrubs, pine
Alves et al (2007b), S. Pedro, Portugal	March-October 2006	5 WTs	Weekly searches; Search area: 50 m around WT; Tests for search efficiency and predation (autumn).	15 dead bats: 4 Ppip, 2 Pip sp,5 Nlei, 4 no id. Mortality rate 12 bats/WT/year (8 months period)	shrubs
Alves et al (2007b), Candal/Coelheira, Portugal	March-October 2006	20 WTs	Weekly searches; Search area: 50 m around WT; Tests for search efficiency and predation (autumn).	29 dead bats: 13 Ppip, 4 Hsav, 9 Nlei, 1 Nyc sp, 1 Tten, 1 no id. Mortality rate 6 bats/WT/year (8 months period)	shrubs, low density pine areas
Barreiro et al (2009), Mosqueiros I, Portugal	May-October 2008	4 WTs	Weekly searches; Search area: 50 m around WT; Tests for search efficiency and predation (autumn).	2 dead bats (Ppip + Tten), mortality rate 3,6 bats/year (6 months period)	shrubs
Alves et al (2009a), Pinhal Interior (Mata-Álvaro), Portugal	March-October 2006-2007	18 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	no mortality	shrubs
Alves et al (2009a), Pinhal Interior (Seladolinho), Portugal	March-October 2006-2007	6 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	2006: 1 Pkuh; mortality rate 1,41 bats/WT/year (8 months period) 2007: no dead bats	shrubs

Alves et al (2009a), Pinhal Interior (Furnas), Portugal	March-October 2006-2007	6 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	2006: no mortality 2007: 1 Hsav; mortality rate 1,41 bats/WT/year (8 months period)	shrubs
Alves et al (2009b), Gardunha, Portugal	August-October 2007	16 WTs in August, 17 in September, 26 in October	Weekly searches; Search area: 50 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	5 dead bats: 3 Ppip/Ppyg, 1 Pkuh, 1 Hsav; mortality rate 3,8 bats/WT/year (3 months period)	shrubs, pine
Hortêncio et al (2007), Caramulo, Portugal	April-October 2006	13 WTs in April-June, 17 in July, 23 in August, 25 in September and October	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	47 dead bats: 5 Ppip, 13 Pip sp, 16 Nlei, 1 Nnoc, 12 no id.; mortality rate 15,1 bats/WT/year (7 months period)	shrubs, pine
Silva et al (2008), Caramulo, Portugal	March-October 2007	45 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	79 dead bats, 2 live bats: 37 Ppip, 3 Ppip/Ppyg, 3 Pip sp., 1 Ppip/Pkuh, 5 Ppyg, 9 Pkuh, 4 Hsav, 11 Nlei, 1 Nlas, 1 Eser, 6 no id.; mortality rate 13,3 bats/WT/year (8 months period)	shrubs, pine
Lopes et al (2009), Pinhal Interior (Moradal), Portugal	June-October 2007	5 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	no dead bats	shrubs, pine
Lopes et al (2008), Pinhal Interior (Proença I)	April-October 2006	18 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	5 dead bats: 3 Pip sp, 1 Hsav, 1 no id.; mortality rate 2,8 bats/year (7 months period)	shrubs, pine
Alves et al (2010), Pinhal Interior (Proença I e II), Portugal	March-October 2007	21 WTs	Weekly searches; Search area: 46 m around WT; Tests for search efficiency and predation (spring, summer, autumn).	2 dead bats (Ppip + Nlei), mortality rate 0,8 bats/year (8 months period)	shrubs, pine
Aves environnement & GCP (2009). St-Martin-de-Crau, France	15/03-30/09/2009	9 WTs	Searches every 3 days (15/03-15/05 and 16/08-30/09) and once a week (16/05-15/08). Tests for predation (4) and detectability (4) and correcting factor for the non-controlled surface (crops)	100 dead bats (90% Pipistrellus sp. and 1 Tten, 1 Mema and the others not identified yet)	grassland, shrubs and 30% cereal fields

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Bats´ behaviour in relation to windfarms
(update to Table 2 of EUROBATS Publication Series nº 3)

Species	Hunting close to habitat structures	Migration or long distance movements	High flight (> 40 m)	Low flight	Max. distance (m) of ultrasonic detection (D980) (data from Michel Barataud)	Max. distance (m) of ultrasonic detection (D240) (* means during hunting) (data from Lothar Bach (a) and Primoz Presetnik (b))	Possibly disturbed by turbine ultrasounds	Attracted by light	Roosting inside nacelle	Known loss of hunting habitat	Risk of loss of hunting habitat	Known collision	Risk of collision
Rhinolophus ferrumequinum	X			X	10	≈5b							
Rhinolophus hipposideros	X			X	5	≈5b							
Rhinolophus euryale	X			X	5	≈5b							
Rhinolophus mehelyi	X												
Rhinolophus blasii	X					≈5b							
Myotis myotis	X	X	X	X	30	20a						X	**X**
Myotis blythii	X	X	X	X	?	≈20b							**X**
Myotis punicus					?								
Myotis daubentonii	X	X	X	X	30	≈10-30b						X	**X**
Myotis emarginatus	X	?	X	X	15	≈10-20b						X	**X**
Myotis nattereri	X			X	20	15a							
Myotis mystacinus	X			X	15	20a							**X**
Myotis brandtii	X		X	X		20a						X	**X**
Myotis alcathoe	X			X	20								
Myotis bechsteinii	X			X	25	15a*						X	**X**
Myotis dasycneme		X	X	X		30a						X	**X**
Myotis capaccini				X		≈10-30b							
Nyctalus noctula		X	X		100	150a	X	X	?		X	X	**X**
Nyctalus leisleri		X	X		60-80		X	X	?		X	X	**X**
Nyctalus lasiopterus		?	X		100		?				X	X	**X**
Eptesicus nilssonii	X		X			50a		X	X			X	**X**
Eptesicus serotinus	X	?	X		50	≈50b	X	X	X	(X)		X	**X**
Vespertilio murinus		X	X			50a		X			X	X	**X**
Pipistrellus pipistrellus	X		X	X	30	≈20-30b	?	X	X			X	**X**
Pipistrellus pygmaeus	X	X	X	X	?	30a	?	X	X			X	**X**
Pipistrellus kuhlii	X		X	X	30	≈20-30b	?	X	X			X	**X**
Pipistrellus nathusii	X	X	X	X	30-40	≈20-30b	?	X	X			X	**X**
Hypsugo savii	X		X	X	40-50	≈20-30b	?	X	X			X	**X**
Plecotus auritus	X		X	X	30	10a*						X	**X**
Plecotus austriacus	X		X	X	30	10a*						X	**X**
Plecotus macrobullaris	?			X	30	≈5-10b							
Plecotus kolombatovici	?												
Barbastella barbastellus	X			X	30	20a						X	**X**
Miniopterus schreibersii	X	X	X	X	30	≈20-30b		X				X	**X**
Tadarida teniotis			X		150-200	>100b	X	X				X	**X**