Pratical measures to save bats from dying in windfarms: smart curtailment

The European perspective

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Reported bat mortality in Europe (2003-2016)

Species	AT	BE	CH	CR	CZ	DE	ES	EE	FI	FR	GR	IT	LV	NL	NO	PT	PL	RO	SE	UK	Total
Pipistrellus pipistrellus	2	16		6	16	632	211			622		1		15		289	3	3	1	46	1863
Nyctalus noctula	46				31	1081	1			39	10					1	16	5	1	11	1242
Pipistrellus nathusii	13	4		20	7	909				183	35	2	23	8			16	12	5	1	1238
Nyctalus leisleri			1	6	3	162	15			72	58	2				262	5				586
Pipistrellus sp	8	2		55	9	76	25			135			2			101	2	4		11	430
Pipistrellus pipistrellus/pygmaeus	1		1				271			49	54					37	1	2			416
Pipistrellus pygmaeus	4			3	2	113				125			1			38	1	2	1	52	342
Hypsugo savii	1			163		1	50			36	26	12				49					338
Pipistrellus kuhlii				112			44			131						45		4			336
Vespertilio murinus	2			14	6	128				8	1		1				7	7	1		175
Eptesicus isabellinus							117									2					119
Eptesicus serotinus/isabellinus							98									16					114
Eptesicus serotinus	1				11	59	2			25	1			1			3				103
Tadarida teniotis				7			23			1						28					59
Eptesicus nilssonii	1				1	5		2	6				13		1		1		8		38
Nyctalus lasiopterus							21			6	1					9					37
Pipistrellus pipistrellus/kuhlii				12							1					19					32
Nyctalus sp / *V. murinus*				1			2			1						17					21
Miniopterus schreibersii							2			5						4					11
Myotis daubentonii						7										2					9
Plecotus auritus						7														1	8
Myotis myotis						2	2			3											7
Myotis blythii							6			1											7
Plecotus austriacus	1					6															7
Barbastella barbastellus						1	1			3											5
Myotis sp						1	3														4
Myotis dasycneme						3															3
Myotis emarginatus							1			2											3
Myotis mystacinus						2					1										3
Myotis brandtii						2															2
Myotis bechsteinii										1											1
Myotis nattereri																				1	1
Rhinolophus ferrumequinum							1														1
Rhinolophus mehelyi							1														1
Rhinolophus sp							1														1
Chiroptera sp	1	11		46	1	72	320	1		192	6	1				113	3		30	9	806
Total	81	33	2	445	87	3269	1218	3	6	1640	194	18	40	24	1	1032	58	39	47	132	8369

http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/Report_IWG_Wind_Turbines.pdf

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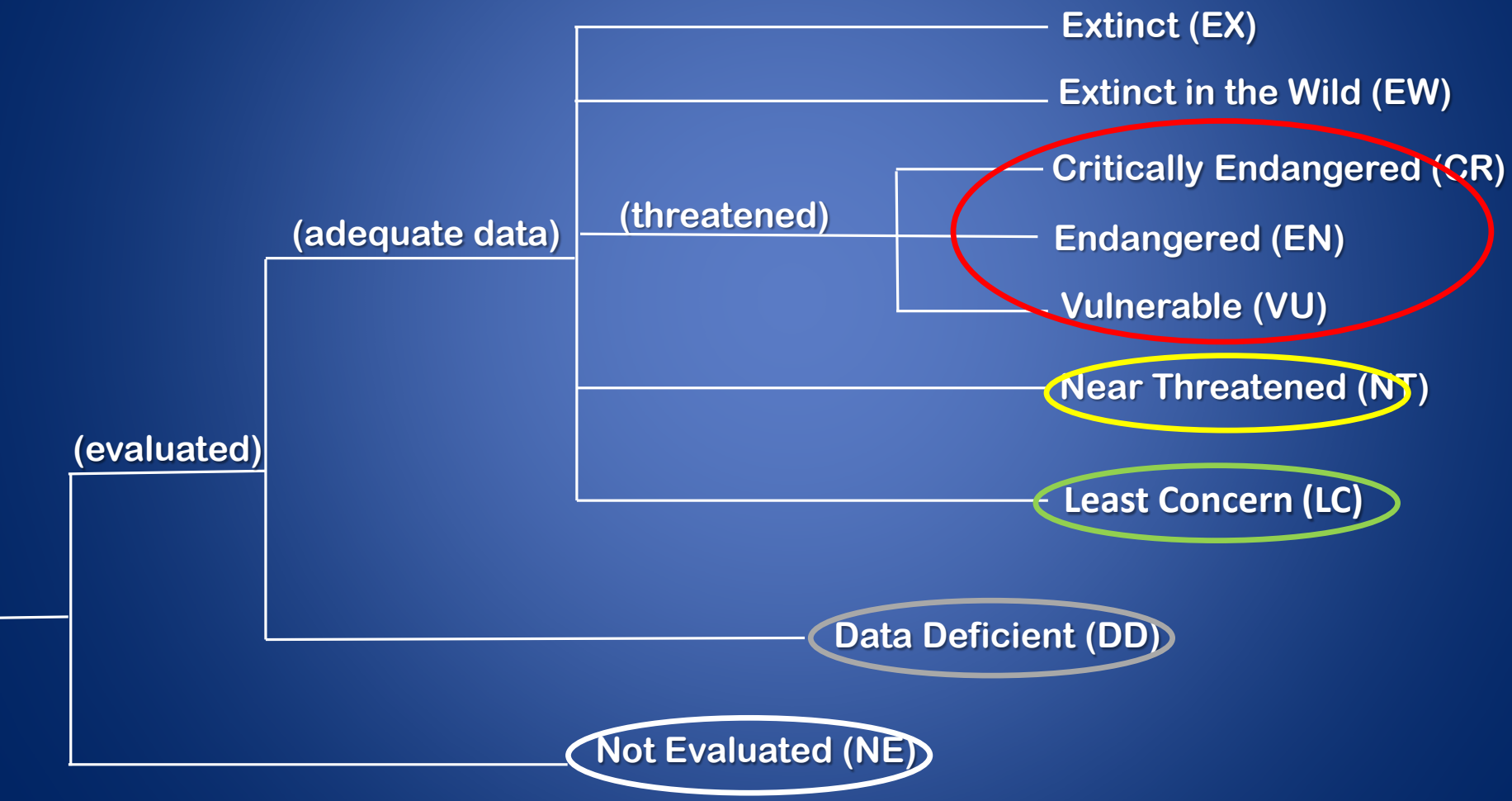

http://www.iucnredlist.org/

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Myotis myotis						2	2			3								
Myotis blythii							6			1								
Plecotus austriacus	1					6												
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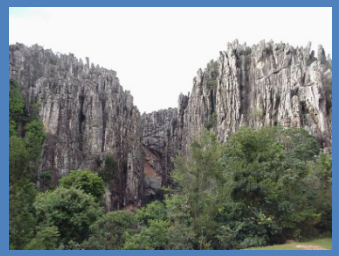
Myotis dasycneme						3												
Myotis emarginatus							1			2								
Myotis mystacinus						2					1							
Myotis brandtii						2												
Myotis bechsteinii										1								
Myotis nattereri																		
Rhinolophus ferrumequinum							1											
Rhinolophus mehelyi							1											

Mitigation measures (Site selection)

Avoidance of

- forests (NLT 2005, Regierungspräsidium Freiburg 2006, LANU 2008)
- flyways (Ahlén *et al.* 2007)
- insect rich habitats (rivers, lakes, etc) (Ahlén *et al.* 2007; LANU 2008)



Buffer zone of at least

- 50 m from any habitat features or structures suitable for roosts (Dürr 2007; Natural England 2009)
- 200 m from woodland areas (NLT 2005; Regierungspräsidium Freiburg 2006; LANU 2008, Rodrigues *et al.* 2008)
- 500 m from maternity roosts (NLT 2005; LANU 2008)
- 500 m from any nature protection areas including Natura 2000 areas (NLT 2005)

http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/AC14_Doc_9_Rev_1_ReportWindTurbines.pdf

Mitigation measures (Operation)

Stop turbines during periods of high risk (Ahlén *et al.* 2007; Dürr 2007)

- parts of the night
- weeks in the season
- weather situations forests

Lock blades in place while turbine is not operating (Smallwood 2006)

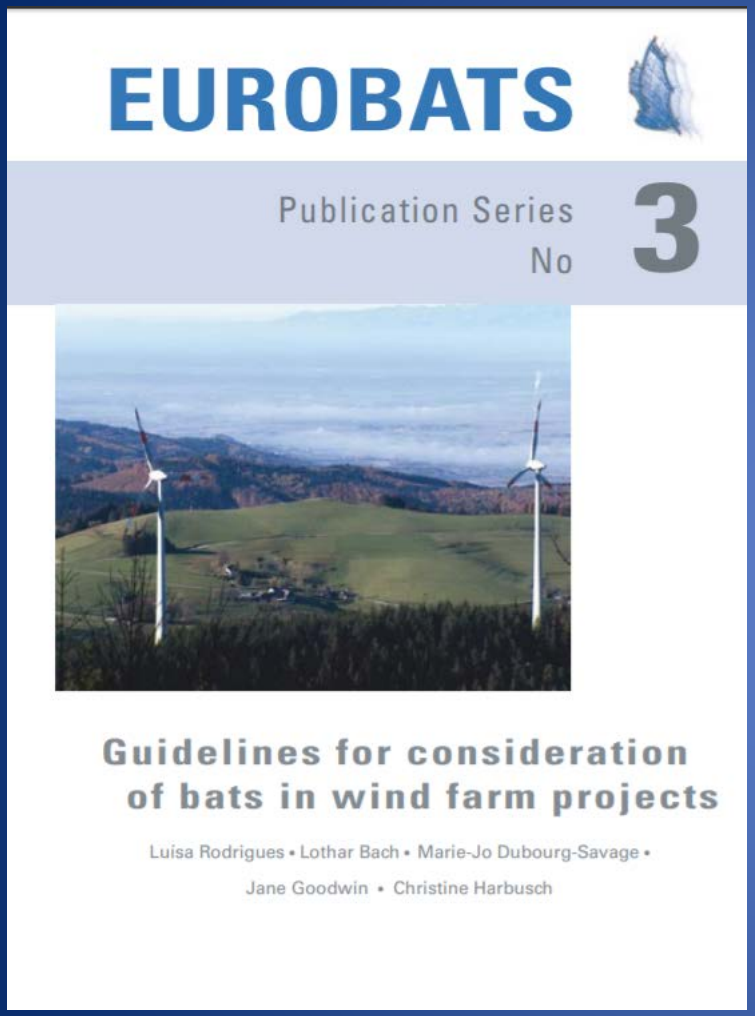
Synchronize the operations of wind turbines in a row of turbines (Smallwood 2006)

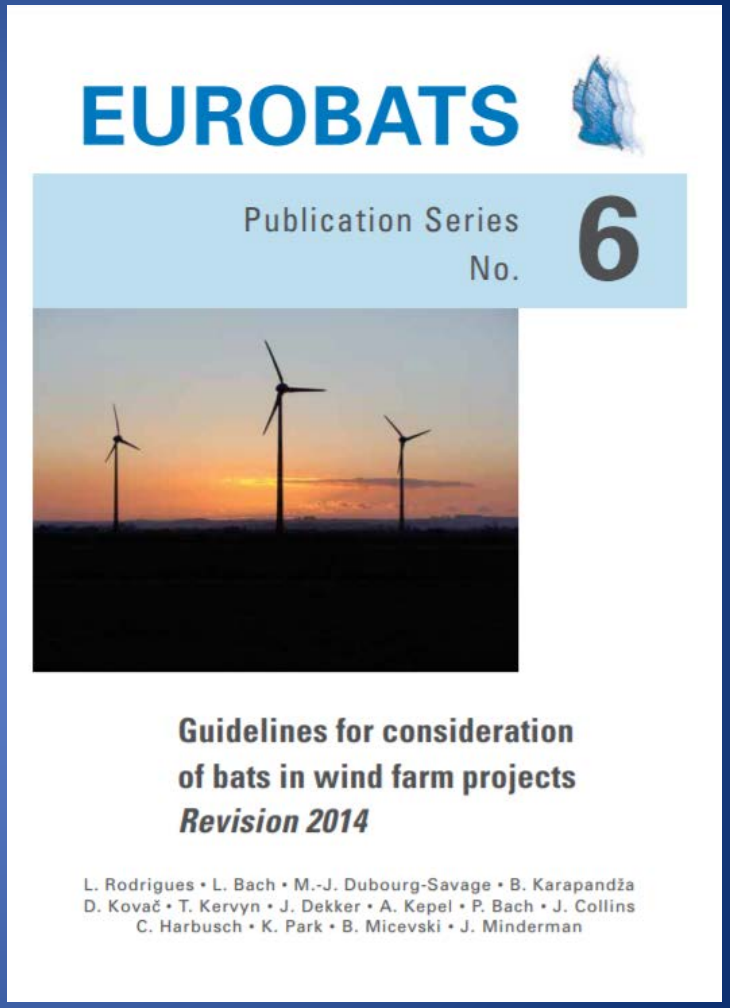
Reduce the amount of flying insects around turbines and blades (Ahlén *et al.* 2007)

Remove or relocate turbines if fatalities are concentrated at specific turbines (Arnett *et al.* 2008)

Remove broken and non-operating wind turbines (Smallwood 2006)

http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/AC14_Doc_9_Rev_1_ReportWindTurbines.pdf





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Deterrents

Radar
(Nicholls & Racey 2007, 2009)

Ultraviolet light
(Gorresen *et al.* 2015)

Emission of ultrasound noise
(Spanjer 2006; Szewczak & Arnett 2007, 2008; Horn *et al.* 2008; BCI 2010; Arnett *et al.* 2011a, b; Johnson *et al.* 2012; BCI & The National Renewable Energy Laboratory 2013; Herman & Furmankiewicz 2013)

http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/AC14_Doc_9_Rev_1_ReportWindTurbines.pdf
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http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/Doc.AC21.8_ReportIWGTurbines.pdf

Increasing turbine cut-in wind speeds (effect on number of fatalities (#))

to 5.0 & 6.5 m/s
12 turbines
reduced 44–93%
no difference between speeds
(Arnett *et al.* 2009, 2010, 2011)

to 3.3 m/s
6 turbines
reduced 31.4%
(LEA 2010)

to 5.0 m/s and 6.5 m/s
reduced 50% at 5.0 m/s
reduced 78% at 6.5 m/s
(Good *et al.* 2011)

to 5.0 m/s and variable cut-in speed depending on wind direction (3.0-6.5 m/s)
reduced 61-88%
no difference between situations
(Hale & Bennett 2014)

to 1.5 m/s
temperatures > 9.5°C
reduced
(Arnett *et al.* 2013)

to 5.5 m/s
15 turbines
reduced 60%
(Baerwald *et al.* 2009)

to 6.0 m/s when nightly wind speeds <6.0 m/s and temperatures >9.5°C
reduced 34-78%
(Martin *et al.* 2017)

to 1.5 m/s
10 turbines
reduced » 50%
(Arnett *et al.* 2013

to 7.0 m/s
20 turbines
reduced
(Brown & Hamilton 2006)

to 6.0 m/s
2 turbines
reduced 65%
(Behr & von Helversen 2006)

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http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/AC17_Doc_6_IWG_wind_turbines_inc%20Annex%20I-II.pdfMartin CM, et al. 2017. Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation. J. Mammal 98(2):378–385.
http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/Doc_StC9_AC19_12_ReportIWG_WindTurbines%20incl_Annexes.pdf
http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/Doc.AC_.20.5.ReportIWGWindTurbines_0.pdf

Blade feathering (effect on number of fatalities (#))

6 turbines
reduced 57.5%
(Baerwald *et al.* 2009)

feather at or below manufacturer's cut-in speed
reduced 72%
(Arnett *et al.* 2013)

16 turbines < 4 m/s "sunset + 5h" and "sunrise – 5h"
reduced 72% 1st period
reduced 50% 2nd period
(Young *et al.* 2011)

http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/AC17_Doc_6_IWG_wind_turbines_inc%20Annex%20I-II.pdf
http://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/Doc_StC9_AC19_12_ReportIWG_WindTurbines%20incl_Annexes.pdf

Comparison of different operational minimization strategies (effect on number of fatalities (#))

2012

control (normal turbine operation 3.0 m/s cut-in)
vs
- blade feather < 5.0 m/s 1st 4h of the night
- blade feather < 5.0 m/s entire night

operational changes based on 3min wind speed averages measured at met tower
reduced 47% 2nd treatment group
significant difference between 2nd treatment group and control
no difference between 1st treatment group and control

2013

control (normal turbine operation 3.0 m/s cut-in)
vs
- increased cut-in speed 5.0 m/s all night
- increased cut-in speed 6.5 m/s all night

operational changes based on 10min wind speed averages measured at met tower
reduced 58% 1st treatment group
reduced 75% 2nd treatment group
significant difference for both treatment groups *vs* control
no significant difference between the 2 treatment groups

2015

(operational adjustment already being implemented during autumn migration period)
control (increased cut-in speeds 5.0 m/s all night) based on 10min wind speed averages at met tower
vs
- 20min wind speed average measured at met tower
- 20min wind speed average measured at turbines

reduced when turbine operations were based on met tower
reduced when decision time was extended from 10 to 20 min

Schirmacher M., A. Prichard, T. Mabee & C. Hein. 2017. Multi-year operational minimization study in West Virginia: potential novel strategy to reducing bat fatalities at wind turbines. Presentation at CWW2017, Estoril.

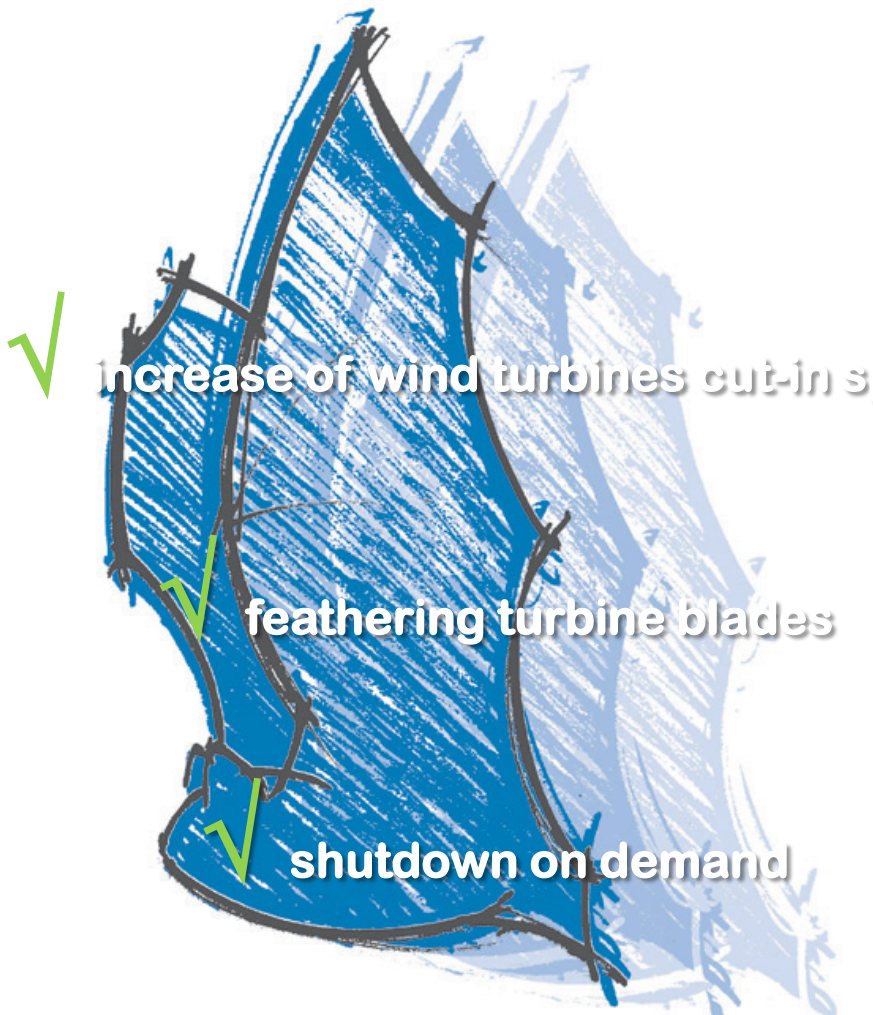
Other approaches to obtained real-time data on bat activity and optimize the operational curtailment of wind turbines

Prototype DTBat system: intends to mitigate the collision risk of the hypothetical 95% of the bats; stops operation mid-March to end of October in the night under certain meteorological conditions (Hanagasioglu *et al.* 2015)

Prototype ATOM system: combines thermal imaging with acoustic and ultrasound sensors to continuously monitor bird and bat abundance, flight height, direction and speed (Robinson Willmott *et al.* 2015)

TIMR system: runs real-time bat activity and weather data in predictive models that link these parameters to bat mortality. Curtail only when bats are present (EPRI 2017)

http://www.euhttp://www.eurobats.org/sites/default/files/documents/pdf/Advisory_Committee/Doc.AC21.8_ReportIWGTurbines.pdf
EPRI. 2017. Bat Detection and Shutdown System for Utility-Scale Wind Turbines. Electric Power Research Institute.



√ increase of wind turbines cut-in speed

√ feathering turbine blades

√ shutdown on demand

UNEP

EUROBATS

EUROBATS.MoP5.Record.Annex9

5th Session of the Meeting of Parties

Ljubljana, Slovenia, 4 – 6 September 2006

Resolution 5.6

Wind Turbines and Bat Populations

...

Urges Parties and Range States to:

...

2. Raise awareness of the existence of some unsuitable habitats or sites for the construction of wind turbines at a local, regional and national scale;

http://www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/MoP5_Record_Annex9_Res5_6_wind_turbines_incl_tables.pdf

EUROBATS.MoP6.Record.Annex14

6th Session of the Meeting of Parties

Prague, Czech Republic, 20 – 22 September 2010

Resolution 6.11

Wind Turbines and Bat Populations

EUROBATS

...

Urges Parties and Range States to:

...

6. Encourage the use of blade feathering to mitigate bat mortality.

http://www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/MoP6_Record_Annex14_Res_6_11_WindTurbines.pdf

EUROBATS.MoP7.Record.Annex8

7th Session of the Meeting of the Parties

Brussels, Belgium, 15 – 17 September 2014

Resolution 7.5

Wind Turbines and Bat Populations

...

Urges Parties and Range States to:

...

9. Promote the use of blade feathering, higher turbine cut-in wind speeds and shutting down turbines temporarily to reduce or avoid bat mortality respectively.

http://www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/MoP7.Record.Annex8-Res7.5-WindturbinesandBatPopulations_adopted.pdf


Jens Rydell

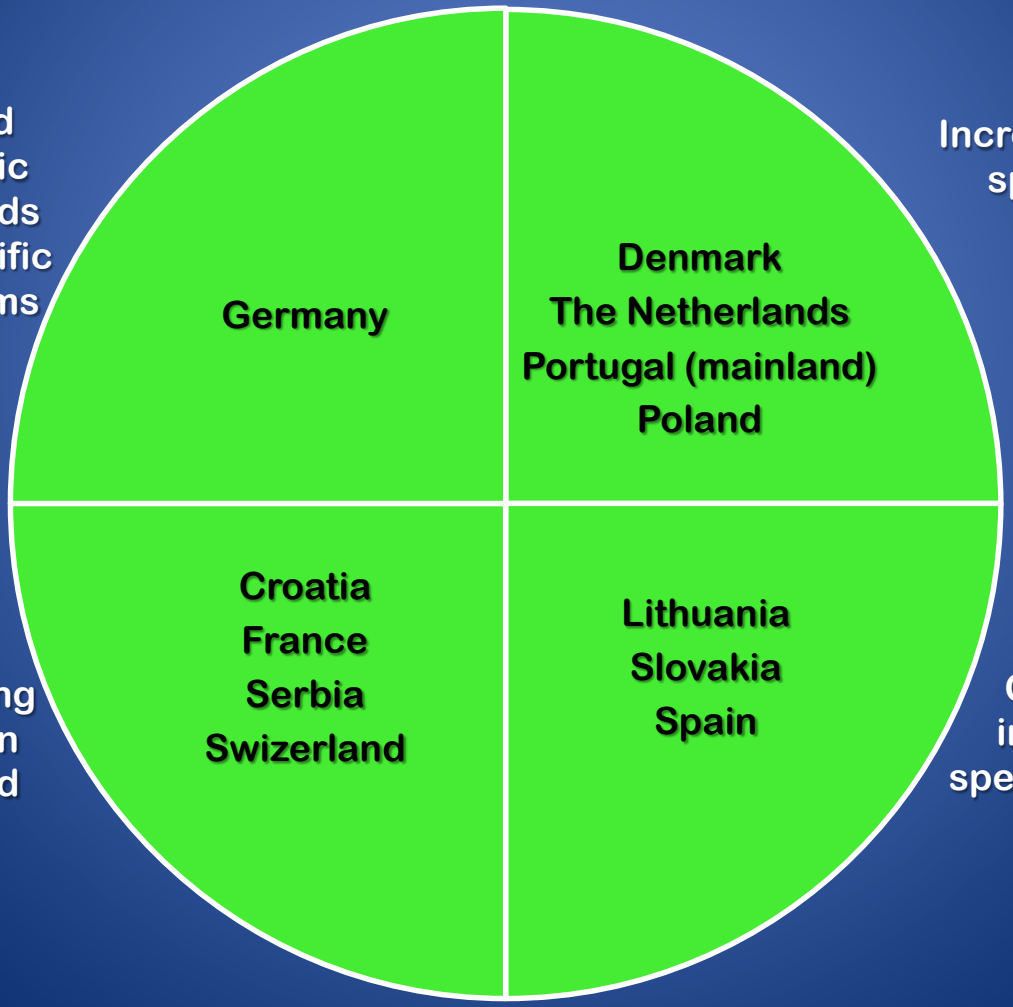
Questionnaire on post-construction monitoring and on implementation of mitigation measures (2016)

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.

Please note that the questions left unanswered will be treated as unknown in the analysis.

Implementation of mitigation or avoidance measures

Belarus, Georgia, Ireland, Latvia, Moldova, Morocco, Norway, Portugal (Azores,) Slovenia, Turkey, Ukraine



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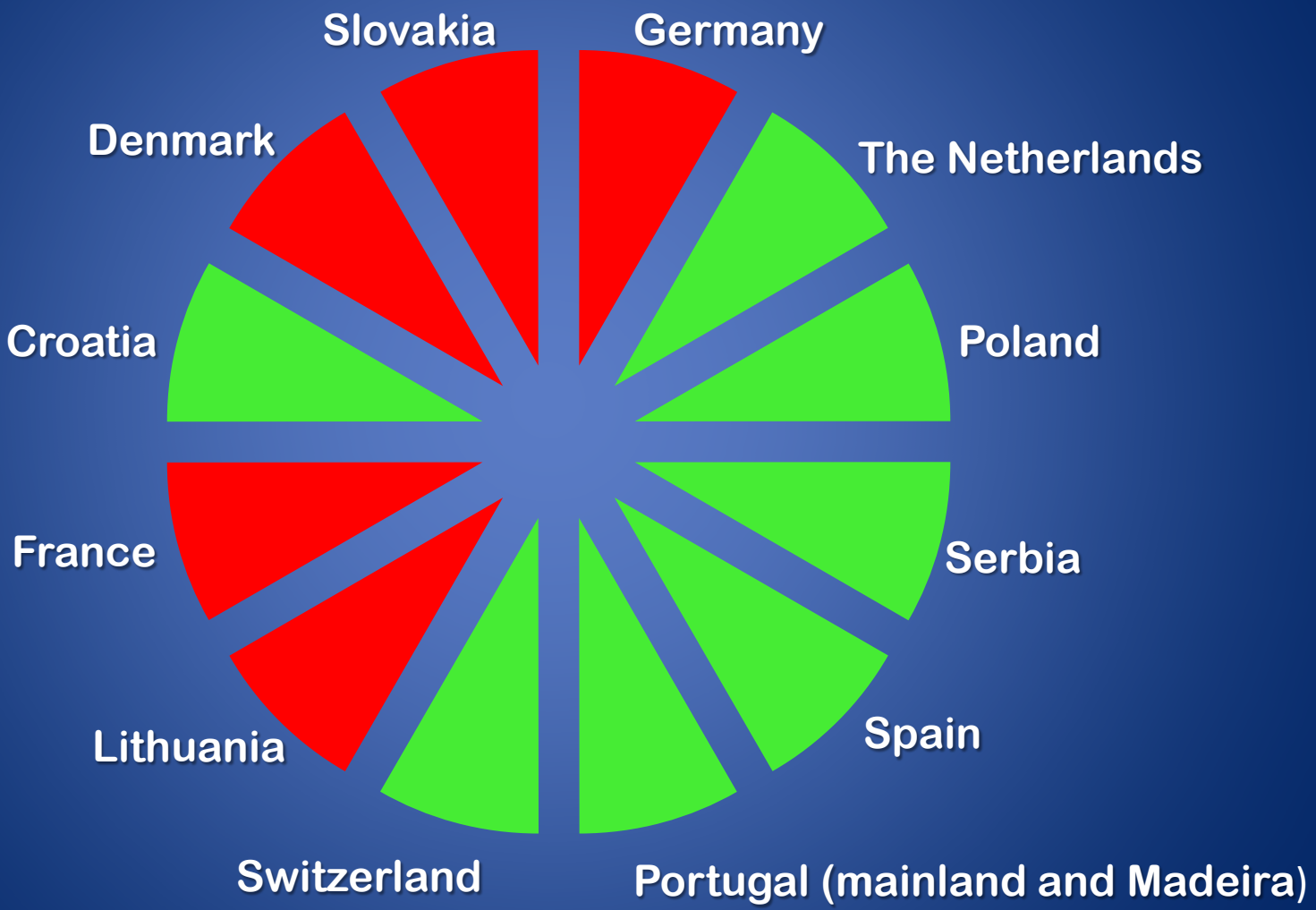
Monitoring of effectiveness of mitigation measures



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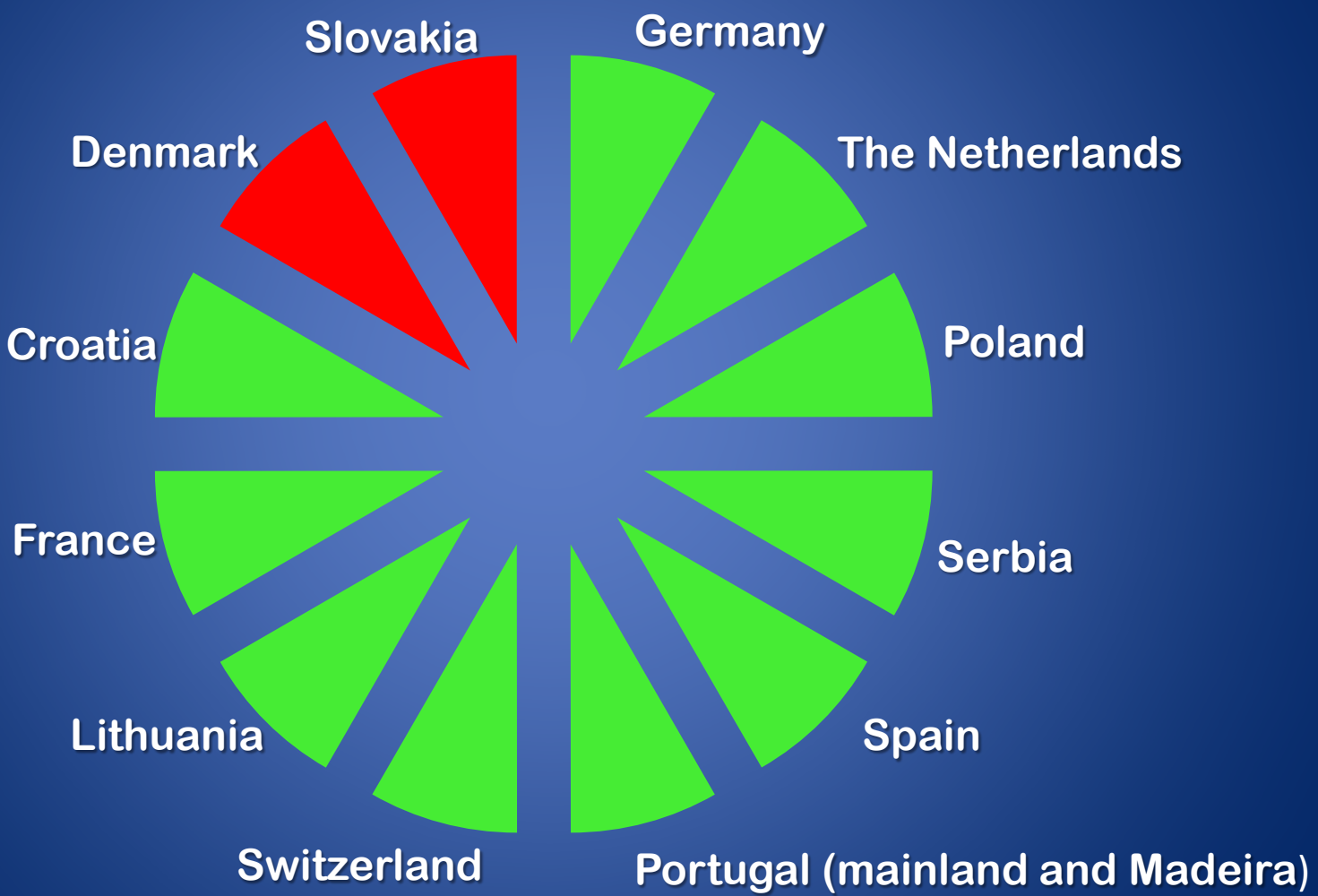
Implemented mitigation measures controlled by authorities



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Thank you for your attention!

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