Book of Abstracts

Conference on Wind Power
and Environmental Impacts
Stockholm 5-7 February

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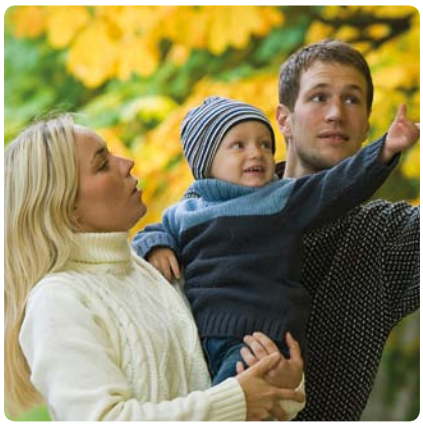
Conference on
Wind Power and
Environmental Impacts



VINDVAL

Book of Abstracts

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Preface

Future wind power development faces many challenges. A firm knowledge base on impacts and mitigation is needed. This conference presents recent Swedish and international research and practice on environmental impacts of Wind Power.

Wind power development has become an important part of energy policies of many countries in the last decade. The world potential for wind power generation is huge. But wind power development may affect the physical environment; the landscape, soundscape, fauna and flora. There is a need for a firm knowledge-base on the impacts, as well as on innovative and efficient mitigation measures.

The conference is held by the Swedish research programme named Vindval. The programme aims at giving a scientifically founded, overall picture of the different environmental impacts of wind power. Much work is also in progress on these issues worldwide, and the Vindval programme now invites expertise and stakeholders from all over the world to share experiences on the environmental impacts of wind power, and to discuss how we should meet the challenges created by the world-wide increase in large scale wind power plant construction.

Stockholm, February 2013

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Conference on Wind Power and Environmental Impacts




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11.00 AM	Keynote speaker	Plenary session	Parallel sessions V
12.00 PM	Lunch break	Lunch break	Lunch break
01.30 PM	Plenary session	Parallel sessions III	Closing session
02.30 PM	Parallel sessions I		
03.30 PM	Poster session	Poster break	
04.30 PM	Parallel sessions II	Parallel sessions IV	
06.00 PM	Social programme	Conference dinner	

Conference on Wind Power and Environmental Impacts




PROGRAMME

PARALLEL SESSIONS

TUESDAY 5 FEBRUARY

08.30 10.00 Registration and coffee

10.00 10.30 Opening session

Chair: Kerstin Jansbo, Programme manager Vindval

- Welcome to Stockholm University and the CWE2013 *Vice-Chancellor Astrid Söderbergh Widding, State secretary Daniel Johansson, Director General at Swedish EPA,Environmental Protection Agency, Maria Ågren*

10.30 11.30 Keynote presentation: Johann Köppel

Chair: Jan Olof Helldin

- Cautious but committed – towards a more adaptive environmental planning approach for wind energy *Johann Köppel, Environmental Assessment & Planning Research Group, Technical University of Berlin, Germany.*

11.30 12.00 Plenary Session

- Environmental opinion towards different forms of power production *Jonas Anshelm & Simon Haikola*

12.00 13.30 Lunch break incl. speakers corner at 13

13.30 14.30 Plenary Session

Chair: Annika Nilsson

- Key issues facing the development of large-scale wind: Results from the TCU-Oxford-Nextera Wind Research Initiative *Michael C. Slattery*
- The Dilemma of the Planner – How to handle birds and bats in the planning process of wind farms *Marc Reichenbach*
- The role of Good Practice in the Consenting Process *Simon Coote*

14.30 15.30 Policy and politics

Chair: Fabien Quetier

- Legal framework for onshore wind energy planning in Germany *Jana Bovet*
- No net loss of biodiversity and the development of wind energy: can we have our cake and eat it too? *Fabien Quetier*
- Minimizing damage to the environment when building a wind power plant *Jonathan E. Colman, Kjetil Flydal, Sindre Eftestøl, Ole Tobias Rannestad & Leif Ryvarden*

Bird behavior and mortality

Chair: Shawn Smallwood

- Effects of wind farms on a Montagu´s harrier (Circus pygarus) population in southern Spain *Jesús Hernández-Pliego, Manuela de Lucas, Antonio-Román Muñoz & Miguel Ferrer*
- A Critical Review of the Effects of Tall Structures on Birds *Kimberly Walters, Karl Kosciuch & Jason Jones*
- Effects of wind farms on breeding and migratory populations of Short-toed Eagle *Beatriz Yáñez, Antonio-Román Muños, Beatriz Martín, Manuela de Lucas, & Miguel Ferrer*

Bat behavior and mortality

Chair: Jens Rydell

- The efficacy of pre-construction bat activity as a predictor for post-construction fatality at wind energy facilities *Cris Hein, Wally Erickson, Jeff Gruver, Kimberly Bay & Ed Arnett*
- Impacts of wind turbines on bats, results of a large scale study in the UK *Fiona Mathews, Suzanne Richardson & David Hosken*
- Mitigating the potential negative effects of tall wind turbines on bats: vertical activity profiles and relationships to wind speed *Sascha Wellig & Raphaël Arlettaz*

15.30 16.30 Poster session with coffee

16.30 18.00 Bird behavior and mortality – continued

Chair: Manuela de Lucas

- Pre- and post-construction studies on the effects on birds at Storrun wind farm in the mountain-region of Jämtland, Sweden *Lars Falkdalen Lindahl, Ulla Falkdalen & Torgeir Nygård*

16.30 18.00 CONT.

- Predicting flight altitudes of birds at offshore wind farms based on weather, wind and distance to the coast – a key requirement for assessing impact *Stefan Heinänen & Henrik Skov*
- Radar monitoring of migrating pink-footed geese – behavioural responses to offshore wind farm development *Jo Milborrow, Pawel Plonczkier & Ian Simms*
- Long term monitoring results of wintering Red-breasted Geese in the AES Geo Energy "Saint Nikola Wind Farm" and the Kaliakra region, NE Bulgaria *Pavel Zehtindjiev & D. Philip Whitfield*
- Effects of small wind turbines on birds and bats and correlates of mortality *Jeroen Minderman, Elisa Fuentes-Montemajor, Chris J. Pendlebury, James W. Pearce-Higgins & Kirsty J. Park*

Bat behavior and mortality continued

Chair: Ed Arnett

- The catchment area of German wind power facilities: A plea for international regulations *Christian Voigt, Ana Popa-Lisseanu, Ivo Niermann & Stephanie Kramer-Schadt*
- Effect of wind turbine mortality on bat populations in Sweden: predictions from a simple population model *Anders Hedenström & Jens Rydell*
- Bat migration in the South Baltic Sea and consequences for wind power development *Johnny de Jong, Petra Bach & Alexander Eriksson*

16.30 18.00 CONT.

- Importance of coastal areas of bat migration at the western coast of Latvia, implications for localisation of wind farms *Gunars Petersons, Jurgis Šuba & Viesturs Vintulis*
- Bats and wind turbines – monitoring of bat activity and bat fatalities in Croatia *Maja Dakovic & Igor Pavlinic*

Social acceptance and public involvement

Chair: Karin Hammarlund

- Coastal residents´perception of offshore wind power – results from a longitudinal study *Gundula Hübner & Johannes Pohl & Christiane Hahn*
- Public involvement in wind power policy and project implementation via direct democracy *Gesa Geißler*
- Still controversial even though main problems have been removed: A case study of Zenibako wind power plant in Japan *Kosuke Sato & Susumu Ohnuma*
- Landscape analysis, environmental knowledge and wind power planning *Sanna Mels*

18.00 Social programme by the posters

PARALLEL SESSIONS

WEDNESDAY 6 FEBRUARY

08.30 09.15

Keynote presentation: Jakob Tougaard

Chair: Lena Kautsky

- Offshore wind farms and the marine environment - lessons from the Danish demonstration project and elsewhere *Jakob Tougaard, Institut for Bioscience, Aarhus Universitet*

09.15 10.00

Keynote presentation: Maarten Wolsink

- A further elaboration of social acceptance of renewables' innovation *Maarten Wolsink, Dept of Geography, Planning and IDS, University of Amsterdam, the Netherlands*

10.00 10.30

Poster break with coffee

10.30 12.00

Plenary Session

Chair: Åsa Elmqvist

- Combining offshore wind and the environment – the case of Denmark *Mette Cramer Buch*
- Predicting collision hazard zones to guide repowering of the Altamont pass wind resource area *K. Shawn Smallwood, Lee Neher & Doug Bell*
- Safety in ignorance: the wind industry, bats and the EU Habitats Directive *Hugh Watson*
- Wind power in open landscape, forest, mountain and sea – an interdisciplinary study *Åsa Waldo, Maria Johansson, Kristina Ek & Lars Persson*

12.00 13.30

Lunch break incl. speakers corner at 13

13.30 15.30

Human perceptions

Chair: Marianne Henningsson

- Perception of wind power in alpine tourism destinations *Alexandra Jiricka & Ulrike Pröbstl*
- Positive wind power planning – an opportunity to ameliorate local environments process of a wind power plant in the archipelago of Norrbotten *Karin Hammarlund & Mike Friesen*
- Implementation of a dialogue based landscape analysis in the permission process of a Wind power plant in the archipelago of Norrbotten *Weronica Ekholm & Karin Hammarlund*
- Perceptions of impacts and compensations associated to offshore wind farm: a cognitive mapping approach *Charlène Kermagoret, Harold Levrel & Antoine Carlier*
- Stakeholder engagement - crucial for successful wind projects *Anna Bjerkesjö & Alberto Mendez Rebollo*

Planning tools

Chair: Johann Köppel

- Bats and wind power – investigations required for risk assessment in Denmark and Sweden *Ingemar Ahlén & Hans J. Baagøe*
- A model based bird migration sensitivity map as a tool for decision makers in wind farm planning *Janine Aschwanden, Susanna Komenda-Zehnder, Jérôme Guélat, María Mateos & Felix Liechti*
- The cumulative impact of wind farms on bats: a regional landscape approach *F. Roscioni, D. Russo, M. Di Febbraro & A. Loy*
- Is Germany much more Beautiful than France? International Comparison of Assessments on Wind Energy´s Impact on Landscape Scenery. Need of a European Approach *Jens Lüdeke*

13.30
15.30
CONT.

- Methods for environmental assessment of wind power policy and plans *Ulla Mörtberg*
- Monitoring bat activity at wind turbines with near infra-red videography *Frank Bonaccorso*

Mitigation of bird and bat mortality

Chair: Roel May

- Mitigating bat fatalities from wind-power plants through targeted curtailment: results from 4 years of testing of CHIROTECH *Hubert Lagrange, Pauline Rico, Yves Bas, Anne-Lise Ughetto, Frédéric Melki & Christian Kerbiriou*
- Foraging activity of bats around artificial light source and possible usage for conservation *Paulina Turowicz, Piotr Zielinski, Anna Kucmus, Andrzej Walkowiak & Joanna Furmankiewicz*
- Long term survey of wind farms impacts on common kestrel´s populations and definition of an appropriate mitigation plan *Ana Cordeiro, Miguel Mascarenhas & Hugo Costa*
- Night-time obstruction lightings for offshore wind farms and birds in Germany. Demands from different interest groups, assessment and migration options *Jan Blew, U. Prall & G. Nehls*
- Tracking needles in a misty haystack – The challenge of assessing impacts of offshore wind farms on night-migrating songbird at the species level *Timothy Coppack, Sissel Sjöberg, Axel Schulz, Konrad Schleicher, Alexander Weidauer, Rachel Muheim, Susanne Åkesson & Thomas Alerstam*
- Off-site mitigation and compensation measures for bats at wind farms *Filipa Peste, Anabela Paula, Joana Bernardino, Hugo Costa, Miguel Mascarenhas, Carlos Fonseca & Maria João Ramos Pereira*

15.30
16.00

Poster break with coffee

16.00
18.00

Workshop:

- Participation in the planning process – How should developers and authorities encourage public participation? *Johanna Olesen*

Planning process

Chair: Jan Olof Helldin

- Wind farms and livestock wolf damage interactions: a case study in Portugal *Cindy Loureiro, Lígia Mendes, José Miguel Oliveira & Gonçalo Brotas*
- Aliens in wind farms – preventing and monitoring impacts on vegetation *Isabel Passos, Maria João Silva, Sílvia Mesquita, Ana Teresa Marques, Joana Bernardino, Hugo Costa & Miguel Mascarenhas*
- Prediction of the future fatalities. Bats and wind energy in Ukraine *Anton S. Vlaschenko, Kseniia A. Kravchenko & Alona S. Gukasova*

Reindeer and reindeer husbandry

Chair: Anna Skarin

- Wind power plants and reindeer feeding behavior, movements and area use *Jonathan E. Colman, Sindre Eftestøl, Diress Tsegaye, Kjetil Flydal, Hilde Rønning, Carolin Tröger & Atle Mysterud*
- Wind Power Plants and reindeer herdsmen; socioeconomically import? *Niklas Labba & Jonathan E. Colman*

16.00
18.00
CONT.

- Wind power effect on land use and reindeer herding practices *L. Mononen, T. Kumpula, B. Burkhard & P. Vihervaara*
- Wind power and the transformation Saami indigenous landscapes, consultation practices and impact evaluation in a struggle for ecological democracy *Anett Sasvari*
- Using pellet-group counts and position data from GPS-collars to illustrate changes in reindeer habitat use in relation to wind power development *Anna Skarin, Lars Rönnegård, Christian Nellemann, Henrik Lundqvist & Per Sandström*

Mitigation of bird and bat mortality

Chair: Martin Green

- Mitigating wind-turbine induced avian mortality: audible, optical and biomechanical constraints and options *Roel May, Kjetil Bevanger, Torgeir Nygård, Ole Reitan & Svein-Håkon Lorentsen*
- Reducing bat fatalities at wind turbines in central Europe – How efficient are bat-friendly operation algorithms in a field-based experiment? *Oliver Behr, Klaus Hochradel, Jürgen Mages, Martina Nagy; Fränzi Korner-Nievergelt, Ivo Niermann, Ralph Simon, Natalie Weber & Robert Brinkmann*
- DTBird - a tool for bird monitoring and bird mortality reduction in wind farms *Agustín Rioperez Postigo & Marcos de la Puente Nilsson*

Workshop:

- How to minimize negative impacts on birds and bats? *Martin Green*

Life under the surface

Chair: Andrew Gill

- Assessing impact from wind farms at subtidal, exposed marine areas *Thomas G. Dahlgren, Marie-Lise Schläppy, Aleksej Shashkov, Mathias Andersson, Yuri Rzhanov, Ilker Fer & Erling Heggøy*
- Do offshore wind farms influence soft bottom communities – results after three year operation of alpha ventus *Andreas Schmidt, Stephanie Preuß, Sabrina von Allwörden, Franziska Kazmierczak, Christine Kern, Sabine Nestler, Anja Schanz, Gunnar Stigge, Stefanie Breyer & Regine Bönsch*
- Impact on fish abundance and distributions patterns from Horn Rev I Offshore wind farm in the North Sea *Claus Stenberg, Grete E. Dinesen, Mikael van Deurs, Casper W. Berg, Henrik Mosegaard, Simon B. Leonhard, Thomas M. Grome & Josianne Støttrup*
- The effect of wind farm generated sound on fish *Peter Sigray & Mathias Andersson*
- Exploring the potential for cumulative effects on marine mammals from pile driving during offshore wind farm construction *Carol Sparling, Gordon Hastie, Cormac Booth, Stephanie King, Nicola Quick, Jared Wilson, Catriona Harris, & Carl Donovan*
- Effects of off shore windfarms on marine wildlife – a risk assessment synthesis for Swedish waters *Lena Bergström, Torleif Malm, Nastassja Åstrand Capetillo, Hans Ohlsson, Magnus Wahlberg, Rutger Rosenberg & Lena Kautsky*

18.00

Conference dinner

PARALLEL SESSIONS

THURSDAY 7 FEBRUARY

08.30 09.15

Keynote presentation: Dale Strickland

Chair: Lars Alfrost

- A guide to the study of the impacts of wind power on wildlife *Dale Strickland, Western EcoSystems Technology, Wyoming, USA*

09.15 10.00

Keynote presentation: Eja Pedersen

- Wind turbine noise – a technical, medical and political issue *Eja Pedersen, Department of Architecture and Built Environment, Lund University, Sweden*

10.00 10.30

Poster break with coffee

10.30 12.00

Noise and health

Chair: Johanna Bengtsson Ryberg

- Health effects from wind turbines *Gösta Bluhm, Mats Nilsson, Karl Bolin & Johanna Bengtsson-Ryberg*
- Sound propagation from wind turbines, what does state-of-art predictions reveal? *Karl Bolin & Ilkka Karasalo*
- Stress of aircraft obstruction markings of wind turbines *Johannes Pohl & Gundula Hübner*
- Noise stress effects of wind turbines *Johannes Pohl & Gundula Hübner*

Monitoring of environmental impact

Chair: Ingrid J-son Horner

- Experiences and examples of environmental monitoring of wind power farms *Niklas Lindberg Alseryd, Anders Enetjärn & Nic Kruys*

Workshop:

- What are the most important factors regarding monitoring programmes? *Ingrid J-son Horner*

10.30 12.00 CONT.

Survey and monitoring in marine environment

Chair: Bertil Håkansson

- Best practice ecological analysis methods for UK offshore wind farms: Robin Rigg, Solway, Scotland and the integrated approach of Marine Environmental Monitoring Programs (MEMP) *Richard Walls, Sally Shenton, Erica Knott, Jane Lancaster, Sarah Canning, Gillian Lye & Chris Pendlebury*

Workshop:

- Offshore wind power plants – marine surveys and monitoring needed *Bertil Håkansson*

12.00 13.00

Lunch break

13.00 14.30

Conference summary

Chair: Kjell Grip

- Conference summary *Bjørn Iuell, Senior Environmental Advisor, Statkraft*

13.30

Panel discussion

Chair: Tomas Kåberger, Chalmers, Gothenburg

- Issues to address in order to reach a sustainable introduction of renewable energy sources
- Dr Tatsuya Wakeyama, JREF, Tokyo, on environmental impacts of solar and wind-energy
- Tomoo Machiba from IRENA in Abu Dhabi on the IRENA study of environmental impacts of large-scale renewable energy
- Invitations to upcoming conferences *Johann Köppel, Emma Bennett*
- Closing remarks *Vindval*

VINDVAL

formas
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning

Swedish Energy Agency

NATUR VÅRDS VERKET
SWEDISH ENVIRONMENTAL PROTECTION AGENCY

POSTERS PRESENTED

Authors	Title
F. ADORF, C. BRAUN, V. KORN, F. ADORF	Which factors increase the risk for fatal collisions by bats at wind turbines?
F. ADORF, C. BRAUN, V. KORN, S.L. HOOD HAILER, F. ADORF	Methods and approaches to study bat fatalities at wind energy farms
Lothar Bach, Petra Bach, Kerstin Frey, Germany	Bat activity at different wind facilities in Northwest Germay
Antje Seebens, Angelika Fuss, Peter Allgeyer, Henrik Pommeranz, Michael Göttsche, Matthias Göttsche, Mathias Mäler, Hinrich Matthes, Christoph Paatsch, Lothar Bach, Germany	Field trial of acoustic survey methods to study bat migration at the German Baltic Sea
Petra Bach, Lothar Bach, Uwe Gerhardt, Kerstin Frey, Germany	Bat fatalities at different wind facilities in Northwest Germany
Karl-Heinz Loske, Lars Gaedicke, Frank Bergen, Germany	Effects of repowering wind turbines on collision risk of raptor species
Miguel Mascarenhas, Hugo Costa, Joana Bernardino, Jose Vieira, Carlos Bastos, Maria Joao Pereira, Carlos Fonseca, Portugal	Wind and biodiversity project: integrated solutions for managing biodiversity in wind farms
Joao Paula, Pedro Pereira, Joana Bernardino, Hugo Costa, Miguel Mascarenhas, Portugal	Surprised scavenger
Andreas Bernhold, Anders Granér & Niklas Lindberg, Sweden	Migrating birds and the effect of an onshore windfarm
Alexander Braasch, Michael Joost, Christian Ketzer, Germany	Responses of harbor porpoises to pile driving on a temporal and spatial scale
Robin Cox, Chris Pendlebury, Chris Robinson, Richard Walls, Scotland	Bats and Offshore/Coastal Wind Farms in the North Sea – is there a conflict?
Ruth de Silva, Kate Grellier, Sarah Canning, Chris Pendlebury, Nancy McLean, Scotland	Marine mammals – survey and monitoring techniques for impact assessment in areas of high marine mammal interest.
Gunnarsson, Christer, Thomas Palo & Jens Rydell	Are wind turbines in boreal forest in Sweden a threat to bats?
Henrik Blank and Sofia Gylje Blank, Sweden	Do bats need to be considered in wind power planning and management in northern Sweden?
Nina Hagner-Wahlsten, Finland	Migrating bats at a wind farm on the Åland Islands, Finland
Krzysztof Herman and Joanna Furmankiewicz, Polen	An effect of high power ultrasound on bat activity – the implication for the protection of bats at wind farms
Johanna Hurst, Horst Schauer-Weisshahn, Robert Brinkmann, Germany	Using automatic measurements of bat activity to develop turbine-specific curtailment algorithms – a case study in two wind parks
Koulouri Angeliki, Moccia Jacopo, Plytas Nikiforos. EWEA, UK?	Research on cost of environmental survey and mitigation measures in offshore wind farms
Jane Lancaster, Amy Walker, Natural Power Consultants	Long term studies on biogenic reefs and implications for offshore developments
Rafaella Lenoir Improta, Enric Pol	Socio-environmental changes with the construction of a Wind Farm in Brazil, Brazil
Valere Martin, Janine Aschwanden, Herbert Stark, Thomas Steuri, Felix Liechti. Switzerland	How to mitigate mass collisions of migrating birds at wind turbines?
Roel May, Norway	Assessing cumulative impacts of wind-power development on birds: A spatially- explicit deterministic index for decision support

Authors	Title
Chris Pendlebury, Jane Lancaster, Sarah Canning, Kate Grellier, Richard Walls, Scotland	Integrated Ecological Monitoring Plans (IEMP) for Offshore Wind Projects
Holger Behm, Timothy Coppack, Alexander Weidauer, Andreas Schmmidt, Germany	The extended seascape: submarine assessment of offshore wind farms
Karin Jodas, Jo-Anne Thomas, Robyn Kadis, Ricardo Ramalho, Barbara Monteiro, South Africa	Facing the challenges of monitoring Bats in South Africa. How much effort is needed?
Karen Jodas, Jo-Anne Thomas, Robyn Kadis, Ricardo Ramalho, South Africa	Bird communities monitoring in South African wind farms: What is the progress?
Gillian Lye, Sarah Canning, Chris Pendlebury, Sally Shenton, Richard Walls, Scotland	Bird communities monitoring in South African wind farms: What is the progress?
Helmut Wendeln, Brigitte Hielen, Dieter Todeskino, Germany	Nocturnal migration during construction of an offshore windfarm:comparison of stationary and mobile radar detection
Kelly Wyness, Sarah Dalrymple, Katherine Arthur, Scotland	Multi-site examples of effective control of Landscape level Hydrological risk from the construction phase for onshore wind farms in Upland Scotland
Thomas Axenrot and Thomas Didrikas, Sweden	Effects of marine parks on pelagic fish
Lena Bergström SLU, Frida Sundqvist & Ulf Bergström, Sweden	Local effects of an offshore wind farm on the demersal fish community
Regina Bispo, Joana Bernardino, Hugo Costa, Miguel Mascarenhas, Portugal	Bird and bat fatality estimation, current approaches and new insights
Scott Cole, Espen Lie Dahl, Sweden	Electrocution prevention as compensatory scaling: Offsetting white-tailed eagle (WTE) mortality losses at the Smøla wind-power plant, Norway
Manuela de Lucas Castellanos and Miguel Ferrer Baena, Spain	Predicting griffon vulture flight trajectories to avoid mortality in wind farms using stimulated wind currents
Bertrand Delprat, France	The barrier effect impact, an issue for wind energy and wildlife conservation
David Douglas and Rowena Langston, UK	Sensitivity analysis for wind farm collision risk models
Jonathan E. Colman, Sindre Eftestøl, Diress Tsegaye, Gunnlaug Røthe and Kåre Rapp	Reindeer area use before, during and after construction of the Fakken Wind Power Plant in Northern Norway
Ruben Fijn, Abel Gyimesi, Karen Krijgsveld, Sjoerd Dirksen, Netherlands	Flight patterns of birds above the North Sea in prospective wind farms far offshore
Thomas Grünkorn, J Blew, T Coppack, M Reichenbach, J von Rönn, A Schultz, H Timmermann, S Weitekamp, Gemany	Large scale prediction and assessment of avian collision risk and mortality at windturbines in northern Germany
Jan Olof Helldin, Jens Jung, Johan Kindberg, Niklas Lindberg, Wiebeke Neumann, Mattias Olsson, Anna Skarin, Fredrik Widemo, Sweden	The impacts of wind power on terrestrial mammals – a review
Marianne Henningsson, S Jönsson, J Bengtsson-Ryberg, G Bluhm, K Bolin, B Bodén, K Ek, K Hammarlund, IL Hannukka, C Johansson, S Mels, T Mels, M Nilsson, E Skärbäck, P Söderholm, Å Waldo, I Widerström, N Åkerman, Sweden	The impact of wind power on human interests – a synthesis project
Tim Hipkiss, Holger Dettki, Frauke Ecke, Edward Moss, Carolin Sandgren and Birger Hörnfeldt, Sweden	Habitat use and ranging behavior of GPS tracked Golden eagles in northern Sweden
Gundula Hübner, Johannes Pohl, Germany	Public and local acceptance of transmission lines

Authors	Title
Fränzi Korner-Nievergelt, Oliver Behr, Ivo Niermann, Robert Brinkmann, Germany	A model based method to estimate bat and bird collision rates at wind energy turbines
	No title given
Antonio-Román MUÑOZ, Manuela DE LUCAS, Eva CASADO1 & Miguel FERRER	Methods to reduce the effects on wildlife in operational wind farms: experiences on a major migration bottleneck area.
Paul-Bastian Nagel,Germany	Wind energy in forest – Are you serious?
John Ohlson	Broadening horizons - The FMECA-NETEP model
Jan Pettersson, Sweden	The environmental impacts of windpower on night migration of songbirds and waterfowl over sea
Stefan Pettersson, Sweden	Bat activity at wind turbine livel compared to ground lavel
Chris Robinson, Gillian Lye, Jane Forrest, Catherine Hommel, Chris Pendlebury, Richard Walls, Scotland	Flight Activity and Breeding Success of Hen Harriers at Paul's Hill Wind Faralrm in North East Scotland
Marie Rönnqvist & Anders Enetjärn	Land occupied for wind power farms in Västerbotten - how real measurements relate to what is stated in EIA documents

Keynote abstracts

Johann Köppel

ENVIRONMENTAL ASSESSMENT & PLANNING RESEARCH GROUP, TECHNICAL UNIVERSITY OF BERLIN, GERMANY, KOEPPEL@ILE.TU-BERLIN.DE

Cautious but committed – towards a more adaptive environmental planning approach for wind energy?

Our energy supply has been undergoing a steady transition from a mostly centralized power plant and transmission grid structure to a more decentralized and spatially relevant share of renewable energies. This applies just for wind energy even more as not only rural terrestrial landscapes have faced such change but also marine seascapes. Furthermore, a forerunner on wind energy deployment like Germany with its 30 GW installed capacity approaches a new milestone as far as an extended usage of forested landscapes lies ahead. Steady uncertainties have accompanied these policies and implementation process and we have faced the ongoing dilemma of a sound decision making for wind energy sites without sufficient empirical evidence of its literal impacts. Even planning innovations have been brought forward respectively, be it marine spatial planning, new approaches in regional planning and local zoning, be it outstanding programmatic environmental assessments in the United States or ambitious baseline and monitoring programs as the German offshore EIA standards. At the same time, planning and impact assessments have been used to dealing with uncertainties, thus having challenged traditional approaches by more incremental approaches as well. However, most actors have favoured a definitely cautious roadmap for decision making on wind energy sites, sticking to the precautionary principle as a well established environmental policy approach. This triggered often far-going exclusions of sites already on regional levels and negative planning approaches. Other actors like proponents are questioning the predominance of an overdone precautionary approach and call for a more evidence-based and site-specific planning approach for wind energy, even claiming a necessary paradigm shift. In Germany, a joined federal and states working group, chaired by the Federal Ministry of the Environment, has been discussing such more adaptive policies. However, reluctance to accept uncertainty, the given institutional settings and complex interests still hamper a presumably intermediate approach – based on a more adaptive planning theory in favour of anticipatory modeling and monitoring as a key for step-wise adaption. Learning by doing would then be the lead currency so to speak, but are we ready for a respective change in our planning and impact assessment culture? Encouragingly, profound and presumably never seen before research programs have been launched on the impacts and mitigation potentials of wind energy, for a decade at least now. Last but not least, the Conference on Wind Energy and Wildlife (CWW) 2011 in Trondheim was an outstanding showcase of lessons learned so far and presumably the upcoming CWE 2013 event in Stockholm will further con-

tribute to a step-wise decreasing of the uncertainties at hand. Moreover, an international comprehensive synopsis of what studies on wind energy impacts on wildlife and mitigation efforts have shown so far has been scheduled to be launched in November 2012 in Germany as well – hopefully being able to contribute to the series of CWW/CWE conferences as well in 2014 and to discuss the assumed paradigm shift towards more adaptive planning cultures, too.

Eja Pedersen

DEPARTMENT OF ARCHITECTURE AND BUILT ENVIRONMENT, LUND UNIVERSITY, SWEDEN, EJA.PEDERSEN@ARKITEKTUR.LTH.SE

Wind turbine noise – a technical, medical and political issue

The impact of noise from wind turbines on people living in the vicinity has been discussed since the first modern wind turbines were erected and is still an issue. Eja Pedersen will give an overview of what we know about exposure and response, touch upon possible consequences and highlight some complications.

Dale Strickland

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A guide to the study of the impacts of wind power on wildlife

The objectives of the study of wind/wildlife interactions are to provide sound scientific information necessary to site and design wind energy facilities to minimize impacts to wildlife and to support the design and evaluation of measures to mitigate unavoidable impacts. To meet these objectives the National Wind Coordinating Collaborative (NWCC; http://www.national-wind.org) published the *Comprehensive Guide to Studying Wind Energy/ Wildlife Interactions* in 2011 (Strickland et al. 2011). Dr. Strickland will summarize the methods, metrics, and risk assessment processes presented in this document using case studies and discuss potential applications internationally.

If management decisions are to be influenced by scientific information, managers, other stakeholders, and scientists must agree that the information is of sufficient quality to be useful. The information must be adequate for site selection, prediction and estimation of impacts, evaluation of measures taken to avoid, minimize, or offset significant adverse impacts and identifying risk reduction measures to reduce future impacts. Using generally agreed-upon and scientifically appropriate methods and metrics should enhance both the *credibility* and the *comparability* of study results.

As with any other impact, the important principles in the study of wind energy development impacts on wildlife include:

- Designing study protocols to address the question, species, time period and area of interest
- Replication – within study sites and with multiple study sites
- Randomization of data collection
- Measures to control and reduce errors
- Standardization of related variables and identification of confounding variables
- Minimization of bias

There are also practical considerations for every study including time and budget available for the study and logistical constraints (e.g. access).

Comparability is essential in understanding large scale impacts from multiple facilities such as population level and cumulative impacts. The prediction and estimation of these large scale impacts are based on inferences from the analysis of data from multiple independent studies. If different studies generate comparable results, our understanding of the differences and similarities among wind energy developments is improved, allowing us to infer potential wildlife issues at yet-to-be-developed wind energy sites and to site and develop

new projects so as to minimize impacts. It should also lead to a more efficient use of research and monitoring budgets. Notwithstanding, it is neither possible nor appropriate to provide a detailed “cookbook” approach to every site specific situation. Not all jurisdictions will require the same level of information on wildlife in conjunction with permitting a wind energy development, and each site will be to some extent unique.

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Offshore wind farms and the marine environment – lessons from the Danish demonstration project and elsewhere

Offshore wind energy took off to a slow start in Denmark more than 20 years ago but it was not until the decision to build two large-scale offshore wind farms that the potential impact on the marine environment was seriously considered. This changed when the Danish Government decided to build two large-scale offshore wind farms in a demonstration project intended to test the feasibility of large-scale offshore wind in terms of technical, economic, environmental and socioeconomic challenges. Not only was an extensive environmental impact assessment performed prior to construction but a large scale monitoring program was established in order to follow the actual impact of the two wind farms during construction and first years of operation.

Possible environmental issues with offshore wind farms are separated into disturbance effects during the construction, which typically takes a year or more, and effects (positive and negative) of the operating turbines on the surroundings. Effects include changes in species composition (fish and invertebrates), deterrence by underwater noise (fish and marine mammals), collisions with turbines (birds and bats), and above-water disturbance (resting and foraging birds).

Invertebrates

With few exceptions offshore wind farms are constructed on soft sea beds. The foundations themselves and not the least the boulders often deposited around foundations as scour protection thus introduces a new niche for sessile organisms – hard bottom substrates. Several studies have documented the rapid colonization of foundations and scour protection and results indicate that species composition after a few years resembles the composition found on natural hard substrate reefs in comparable hydrographic environments. The foundations thus appear to work well as artificial reefs.

Fish

Studies of fish have lagged behind studies of other groups of animals, mainly due to methodological difficulties with studies of quantitative changes in abundance, distribution and species composition. Not unexpected, the species composition change in offshore wind farms placed on otherwise monotonic sandy or muddy bottoms due to the artificial reef created by the foundations. The few studies of distribution of fish before and after construction do not indicate negative reactions to the turbines by the fish already present in the area before construction.

Birds

Two separate issues are identified: habitat loss due to the physical presence of turbines and collisions with turbine wings. Habitat loss for resting and foraging sea birds is restricted to the area of the wind farm and its immediate surroundings and is in most cases negligible for the individual wind farm. The cumulative impact from many wind farms in the same area can be significant, however, and must be considered. Studies have shown negative reactions to turbines in several species, such as divers, common scoter and long-tailed duck, but recent results of long-term monitoring demonstrate increasing habituation of the birds to the wind farms, reducing the habitat loss. Collisions between birds and turbine wings have been studied extensively in radar studies and with infrared surveillance cameras. The general conclusion is that migrating birds are well capable of negotiating the turbines and generally have very low risk of collision. As on land, greatest concern surrounds mortalities in long-lived and slow-breeding species.

Marine mammals

As for birds, the effects on seals and harbour porpoises have been extensively studied from the first monitoring program. Main issue has been effects of underwater noise from construction and from operating turbines, although also haul out behaviour and effects of foraging has been studied. During construction the percussive piling of turbine foundations into the sea bed is a particularly noisy procedure and several studies have shown deterrence of harbour porpoises and seals out to distances of tens of km from the construction site. Sound pressures are also sufficiently intense to induce temporary or permanent hearing loss in animals remaining close to the piling site.

Once the turbines are in operation the noise level emitted to the water is very low and if anything only able to generate local effects on behaviour of marine mammals. Studies of seal and porpoise abundance inside operating wind farms show in general no negative effect but there appears to be local differences (in one case a positive effect was seen, in another an negative).

Bats

Conflicts between bats and offshore wind turbines have come into focus in recent years. Although not well studied, it has become clear that not only are bats at high risk for collision with turbine wings, they are also present in the air over open sea to a much higher degree than previously thought. Mitigation measures include avoiding busy flyways and protocols for shut-down of turbines in high-risk situations (low wind speeds during the first part of the night).

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A further elaboration of social acceptance of renewables' innovation

As with all new technologies, renewable energy innovation requires acceptance within society. Historically, for the implementation of wind energy this was considered a relatively simple issue that could be addressed by applying good communication strategies. Social acceptance of wind power was considered a matter of merely public acceptance and any problems with public acceptance were viewed as issues of "communication" and "education". Furthermore, acceptance was primarily negatively defined as 'non-technical factors'. Both have proven to be tragic mistakes.

Innovation must be considered a much broader concept, as there is nothing inevitable about how new technology is developed and implemented, as indeed diffusion of wind power is anything but self-evident (Jacobsson, Johnson 2000).The willingness to accept phenomena related to innovation by all relevant parts of society, which includes all realms beyond "the public", can be subdivided in two broad categories:

- Acceptance of the creation of *new socio-economic conditions needed for implementation*
- Acceptance of *the consequences of the implementation*: implementation will affect current practices in society and forcing some to change, and to avoid such changes the implementation can be resisted

Social acceptance studies must consider all conditions that determine the effective support that applications of wind power get at all different scales and levels of decision-making. The inclusion of renewable energy in energy supply systems will eventually entirely change this so-called socio-technical system (STS). Ultimately, such STSs aim to harvesting a natural resource (renewable energy) in a sustainable way. These systems are designed to manage and utilize a common pool resource. Such systems are complex and the proper management of them are rooted in institutions.

CPR management, as analysed and investigated by Ostrom and her colleagues, requires institutional conditions that favour *self-governance*, develop and foster *trust* among actors in the system, create favourable conditions for *co-operation*. Effective governance of these systems requires nested multi-level governance. Social acceptance is about the willingness to create and the acceptance of these requires institutional conditions by all relevant actors within the society. Hence, the crucial factor in social acceptance becomes the escape from institutional lock-in; it is about institutions, institutional variety, and institutional change (Jacobsson and Johnson 2000; Wolsink 2000; Unruh 2002). *"Institutional arrangements must be complex, redundant, and nested in many layers"* (Dietz et al., 2003, p.1910). Some examples of such insti-

tutional conditions will be presented, including the next phase of renewable energy deployment within smart micro-grid developments.

For example, social acceptance of wind power by individuals is something entirely different from social acceptance of a wind power project. Often, the relation between both is weak as the attitudes-objects are very different because they are determined by entirely different decision contexts. Another example: many developers and authorities alike still think social acceptance equals public acceptance, and unfortunately, as many studies on acceptance are paid by incumbents in the energy sector or by government agencies, many academic studies reproduce this theoretically fully unfounded assumption. As a result, the idea that the main "barriers" –yet another institutionally define frame– are found on the community level in local resistance are reinforced over and over again. However, the main acceptance issues in society can be found among other actors operating at larger scales and in other layers than the community level where the individuals live who aggregate in 'the public'. Actors involved in developments tend to perceive the issue from their own perspective: *they* only see the resistance they are confronted with against *their* projects, and they tend to frame this phenomenon as resistance against wind power per se. This kind of institutionally defined framing is persistent, and it may become an even stronger impediment for positive decisions about wind power deployment, as the strategies developed from this frame often lead to obstruction of collaborative ways of decision making.

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Oral presentation abstracts

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Bats and wind power – investigations required for risk assessment in Denmark and Sweden

We experienced an urgent need among authorities and consultancies to get clear guidelines for planning and field investigations at suggested wind parks. Certain minimum conditions must be fulfilled concerning evaluation of the project area, timing of investigations etc. to provide data necessary for a meaningful risk assessment.

We prepared "Guidelines for bat investigations prior to wind projects" for distribution to authorities. Recommendations were based on our research on bat ecology and behaviour at wind power installations and our many years of experience of bat occurrence and behaviour in the landscape. To avoid misunderstandings our guidelines are detailed and carefully argumented, but only the headline contents can be given here:

Current knowledge justifies an introductory classification of project areas into three categories: 1. high risk sites, 2. uncertain but possible, 3. low risk already documented. Only category 2 needs field investigations, while 1 should be stopped and 3 can go on. This will speed up the planning process and minimize expensive field investigations to the areas in most need of risk assessments.

Field investigations require studies on activity and species composition in a project area also including suitable colony habitats and hunting sites within a radius of at least 2 km. Methods include automatic registration, detector listening etc. to ensure data on species presence, number of observations and facts on activity and status. Investigations are obligatory for the following periods: A) At least two separate nights in the breeding season (late June – early August), B) two nights in mid-August to mid-September when bats migrate or disperse. C) If certain "key habitats" are suspected with mass occurrence of insects in spring, two additional nights of investigation are required in late April – May.

We warn that it is difficult to predict bat activity at wind turbines before they are built. At certain weather conditions turbines may attract huge masses of insects and bats are able to discover such new food resources even if they occur far out in "non-bat areas". This also occurs in the breeding season.

Investigations and risk assessments should be carried out by independent bat specialists with high competence. All data and conclusions must be presented with open access.

Post-construction surveys and stop regulation are suggested for cases with remaining uncertainty about risks.

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Environmental opinion towards different forms of power production

Swedish environmental history shows that every form of grand scale power production has been criticized for its environmental impacts. National environmental organizations and local resistance groups have mobilized to pinpoint the environmental disadvantages with every source of energy. In order to understand what is specific about the environmental opinion directed towards wind power, it is necessary to compare it to the movements that have questioned for example hydropower, nuclear power and bio-energy. Hence, the aim of this project is to analyze the environmental controversies regarding wind power in the light of the environmental debates concerning the most important forms of power production since the 1950s until today. Special emphasis is put on differences and similarities regarding the values advocated by movements of environmental concern.

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A model based bird migration sensitivity map as a tool for decision makers in wind farm planning

Bird migration is a biannual event on a trans-continental scale where birds are repetitively exposed to a collision risk at wind turbines along their flight routes. Up to now, we have not been able to monitor these large scale movements. For the huge majority of billions of migratory birds consisting of relatively small birds (<100 g) we have only some very restricted information on their passage at some sites at the local scale. Therefore, in relation to wind farm planning, reliable quantitative data to assess the sensitivity of a region concerning the collision risk for migrating birds at wind turbines are generally lacking. We decided to overcome this lack for Switzerland by developing a spatially explicit migration model. Based on this model, a bird migration sensitivity map as a tool for decision makers in wind farm planning was elaborated.

The grid based model simulates the distribution of migrating birds crossing Switzerland based on topography, behavioural parameters of birds and on different main wind situations. The model was validated using already existing radar data of previous years and expert knowledge. The result of the model is a map reflecting the intensity of bird migration for the whole area of Switzerland. The airspace within 200 m above ground is the height interval containing the wind farms. Using only the migration intensity within 200 m above ground in combination with assumptions on effective expected collisions, those intensities were categorised into three different levels of sensitivity (weak, moderate, high). Depending on the level of sensitivity of a region, different measures for the construction of wind farms were derived. As it is possible to reduce the risk of collisions for migrating birds using an automatic, radar based switch-off system, no exclusion zones were defined.

With our approach, we were able to produce a useful tool for wind farm planning on a large scale. The tool was elaborated under contract of the Federal Office for the Environment and is in discussion to be integrated into the new Swiss Manual for the Environmental Impact Assessment.

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Reducing bat fatalities at wind turbines in central Europe – How efficient are bat-friendly operation algorithms in a field-based experiment?

Here we present data from an ongoing field-test of 'bat-friendly' operational algorithms for wind turbines. The algorithms trade off the reduction in collision risk against the loss in revenue resulting from mitigation. Algorithms are turbine-specific and are based on data of acoustic bat activity, wind speed, month, and time of night that were previously recorded in 2008 and 2010 at 72 randomly selected turbines in Germany. 18 of these turbines are now part of the ongoing experiment.

To develop the bat-friendly operational algorithms we first modelled acoustic bat activity from the month, time of night, wind speed, and a turbine-specific factor coding the level of bat activity. Next, we used a mixture model to estimate the collision risk from acoustic bat activity. Both models were combined to estimate the collision risk using only wind and time as predictive variables. During times of high collision risk, rotors are stopped to avoid bat fatalities. Times of high risk are defined by a turbine-specific cut-in wind speed that varies with month and time of night.

We are currently running our bat-friendly algorithms in an experimental set-up at 16 wind turbines at 8 sites (2 turbines each) in 4 different geographical regions in Germany and at 2 turbines at one site in France. The two turbines within each site are running with and without algorithms in alternating one-week intervals from July to September of 2012.

All turbines in the experiment are equipped with at least 2 of 3 different acoustic detectors at the nacelle (Anabat SD1, Avisoft Ultra Soundgate, and Batcorder) that sample acoustic bat activity continuously during the night. Additionally, the area under the turbines is searched for animal fatalities each day during the entire time of the experiment.

We will quantify the long-term variability of bat activity comparing acoustic data from 2012 and 2008. From the fatality data we will be able to draw con-

clusions on the effectiveness of the algorithms (loss in revenue per reduction in bat fatality) and on the total cost for their implementation. We will compare the number of bat fatalities predicted for the specific operational algorithm to the number of carcasses found after correcting for search biases. Finally, and most importantly we will develop guidelines and practical examples for the quantification and mitigation of bat fatalities by bat-friendly operation of wind turbines in central Europe.

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Effects of off shore wind farms on marine wildlife – a risk assessment synthesis for Swedish waters

Our knowledge on how off shore wind energy may affect marine landscapes, biodiversity, and other human activities is increasing as empirical evidence from operational wind farms is accumulating. Although only minor effects on biodiversity at local scale are often observed, a common concern is the risk of cumulative effects, due to the fact that large geographical areas are affected, making the link between risk assessment and large scale marine spatial planning obvious. However, the effects on marine wildlife are only rarely assessed together in a more comprehensive way, although holistic risk assessments are an important fundament for an ecosystem-based management and planning.

There is also often a divergent opinion as to whereas wind farms will provide negative or positive effects on the local environment. Effectively, the effect of the wind farm on marine wild life may be valued differently in different areas, depending on both the characteristics of the local ecosystem, and prioritized management targets.

In a spatial planning context, effects on marine biodiversity are also often hard to quantify due to problems related to the mapping of marine habitats and biodiversity. Many marine species are typically highly mobile, covering large geographical areas during their life cycle, for example when migrating between breeding and feeding areas, and the conservation status of a species may vary among different geographical areas.

The study presented here synthesizes the results of several recent Swedish national projects designed to assess risks on marine species, e.g. fishes and seals and marine biodiversity in relation to off shore wind farms, as well as of parallel studies from other countries. The study provides an overview of the main conceived risk for different sections of marine wildlife with respect to different impacts from off shore wind farms, together with an assessment of uncertainty in relation to existing knowledge.

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Night-time obstruction lightings for offshore wind farms and birds in Germany. Demands from different interest groups, assessment and mitigation options

International and national regulations regarding ship and air safety require that wind mills have to be marked with obstruction lights during night-time. High numbers of migrating birds are known to cross large water bodies – e.g. the North Sea – during night-time; orientation of these migrating birds relies on a number of mechanisms from magnetic compass over polarized light to night cues such as sunset and stars. The disturbances of night-migrating birds by artificial lights range from des-orientation to exhaustion and/or collisions.

Approvals / permissions for offshore wind farms in German waters including the Exclusive Economic Zone (EEZ) are only given under the condition that bird migration must not be at risk; furthermore, the ensuing permissions include the collateral clause that bird monitoring is mandatory, and if results suggest that migrating birds are at risk, mitigation actions must be taken.

In a cooperation project – including representatives from ship and air safety, legislation, energy providers and nature conservation – the requirements for night-time obstruction lighting have been presented and discussed; a final scenario has been decided, assessed and discussed.

An overview on the state of knowledge about lights and birds will be given, followed by an ecological assessment of different obstruction lighting options with regard to night-time migrating birds. Results from recent projects in German offshore waters are put into perspective. Finally, mitigation options will be suggested.

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Health effects from wind turbines

The presentation will identify, discuss and comment the current state-of-the-art knowledge regarding adverse health effects from wind turbines. Visual effects and effects of unwanted sound will be highlighted. Praxis and recommendations of exposure to shadows from the blades will be reviewed. Today's knowledge of noise effects such as annoyance, sleep disturbance and increased risk of diseases will be considered. Noise from wind turbines and consequences of this will also be discussed in the context of other noise sources, for example traffic noise.

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Sound propagation from wind turbines, what does state-of-art predictions reveal?

Reliable estimations of sound propagation accounting for the atmospheric- and ground conditions are an essential part of wind turbine noise impact assessments. The Swedish national guidelines assume spherical spreading over land and cylindrical spreading over sea surfaces while the actual sound propagation changes from site to site and varies continuously with changing weather conditions.

This talk presents a methodology for predicting wind mill noise levels by combining state-of-art sound propagation algorithms with terrain data from the Swedish Land Survey Institute (Lantmäteriet) and high-resolution weather predictions from the Swedish Meteorological and Hydrological Institute (SMHI). The method can be used for predictions of the forthcoming day's noise dose and for statistical distributions of the noise dose over time. These outputs can be used in noise dose assessments and to optimize power output from turbines while still restricting the noise dose in relevant areas. Case studies of both offshore and land based noise dose calculations will be presented to illustrate the shifting noise levels occurring at different sites.

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Legal Framework for Onshore Wind Energy Planning in Germany

This presentation analyzes the legal framework for onshore wind energy and its impacts on planning practice. The author concludes by emphasizing the importance of a supra local planning process and suggests the implementation of sectoral planning for energy.

With the EU-Directive 2009/28/EG it has been decided that the contribution of renewable energies (RE) to each Member State's total energy supply should expand to at least 20% by 2020. Germany raised the national commitment to RE from 18% to 35% by 2020 and to at least 80% by 2050. In order to achieve these targets wind energy plays an important role: Wind energy supplies nearly 40% of RE-power generation production which is 6.2% of total power production. Since there won't be a noticeable decrease in future energy demand, the need for further technical and spatial development is obvious.

According to § 35 Federal Building Code (*Baugesetzbuch*) wind energy can be developed in the outer zone (*Außenbereich*) on the basis of permission when there are no conflicting public interests. In general, public interests are deemed to be in conflict when there are pre-existing designated wind-energy areas in a regional plan (*Regionalplan*) or in a municipal preparatory land-use plan (*Flächennutzungsplan*). To establish such a conflict, plans must respect criteria established by case law. First, "substantial space" for wind energy must be provided – but what is considered to be "substantial" is not defined. Second, a comprehensive plan must designate and define priority areas for wind energy as well as defining exclusion areas. Third, the priority areas must contain sufficient wind availability and ease of connection to the power grid, furthermore the preservation of nature, the environment and landscape, and the welfare of local residents, must be taken in account. The states (*Bundesländer)* follow different strategies and so it comes e.g. that forest can be considered as a "taboo zone" or as suitable for wind turbines.

In order to promote wind energy in some *Bundesländer* regional planners recently leave decisions entirely to the municipal authorities. But municipal authorities often overlook supra-local interests like the protection of bird-pathways or the avoidance of landscape-fragmentation. To change the current restrictive nature of wind-energy planning, the legislator should take in account reference values for wind energy and make efforts to establish sectoral energy-planning that analyzes possibilities and restrictions but also provides for timely and comprehensive participation.

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Minimizing damage to the environment when building a wind power plant

As tall, wide-spread landscape elements, wind power plants (WP) with their turbines, roads, buildings and power lines represent considerable environmental encroachment with potentially severe negative consequences for local ecosystems. Planning and implementation of new projects should take into account a series of environmental elements like terrain, soil, vegetation, hydrology, wind and air space, with potential tradeoffs between economy, energy efficiency, and the local ecosystem. But do environmental measures have to be economically costly? We present a case on how to plan, implement and monitor construction of a WP in order to minimize negative effects on the environment, and how this can be done with low economical costs. Main keys for success are to (1) include people with local knowledge, (2) bring engineering plans out in the field and make changes and adjustments based on important ecosystem processes and functions within necessary technical requirements, (3) make an ecological restoration plan detailed enough and appropriate to be used by construction workers in the field, (4) cooperate between ecologists and contractors in order to find optimal solutions, (5) monitor environmental variables before, during and after construction, in order to (6) continuously adjust construction plans and methods, and (7) gather experience for improvements towards future projects. Restoration is not an event, but an ongoing process, and can be planned for from the start of a project. We investigate and implement methods for integrating human disturbances into existing natural processes. We present examples of important biological aims and community goals, and how these are integrated into the local system's existing ecosystems processes and functions. Many ecosystems´ functions and processes depend on the system's structure. With good ecological planning, we show how a WP and access road can become integrated, working parts of the ecosystem structure instead of a dominating and damag-

ing element to the environment. Through holistic and flexible planning, we show how it is possible to integrate new structures into the ecosystem in a way that does not necessarily jeopardize (or at least minimizes disruption of) ecosystem function and processes. We also address possible improvements to the system, such as removing invasive species or improving damage from past human actions, and present methods and results for studying effects of these activities and documenting the ecosystem before and after construction. Importantly, through good planning, minimizing damage removes some of the need and expenses involved with active post-project restoration, as well as helping the environment.

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Wind power plants and reindeer feeding behavior, movements and area use

Renewable energy production from wind turbines has received political support in Scandinavia and numerous wind power plants (WP) are under planning in semi-domestic reindeer (*Rangifer tarandus tarandus*) ranges. A large and dominating new element in the landscape, both moving and making lots of noise, WPs represent potentially negative effects for reindeer. Since 2005, the Norwegian VindRein project has investigated interactions between WPs and reindeer movement patterns, area use, and feeding behavior. Field studies were conducted in five areas, three of which have WP as of august 2012 (Narvik, Kjøllefjord, Vannøy). Field methods developed in collaboration with reindeer herdsmen include direct animal observations, monthly surveys of reindeer populations, counting fecal pellet-group distribution and GPS-tagging. We examined local, on-site feeding behaviour of free ranging reindeer during summer and tested whether the WP was a source of stress for reindeer that could result in reduced feeding efficiency within or near the WP. Contrary to our hypothesis, reindeer feeding inside and in close proximity to a WP took fewer steps while grazing (were less stressed) than reindeer in the control areas. We also tested the extent to which a WP represents a behaviour barrier for reindeer movements on summer range and found no barrier effects for reindeer movements in the WP or neighbouring area. We also found no indication that a WP influenced herding and/or corralling of reindeer into or out of a corral located within 1 km from the WP. Finally, we tested for avoidance effects and compared reindeer distributions in areas where a WP was built with a control area without a WP. We found slight avoidance within 1 km to the access road, but no avoidance effects from the WP, with generally more reindeer in the WP than the control area. Moreover, there was a significant increase in the density of fecal pellet-groups in the WP area after construction of the WP compared to before. Importantly, we found that reindeer chose

high quality habitat and avoided low quality habitat. Thus, if a WP is built in low quality areas, our study indicates that some WP-development might have minor effects on habitat use and behavior for semi-domestic reindeer populations. Contrary to our expectation, our finding contrasts with previous studies finding negative effects from other infrastructure, suggesting considerable variation in the extent to which infrastructure effects reindeer.

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The role of Good Practice in the Consenting Process

Led by the Scottish Government, and completed in October 2012, the GP WIND project was designed to address barriers to the deployment of onshore and offshore wind generation, specifically by recording and sharing good practice in reconciling objectives on renewable energy with wider environmental objectives and actively involving communities in planning and implementation. By bringing together developers, regional and local government, environmental agencies and NGOs from differing countries across Europe to share experiences, it has been possible to develop a Good Practice Guide and a Toolkit, which can be used to facilitate deployment of renewable energy in support of the 2020 targets. These will also be useful in achieving the objectives of the EU Infrastructure Package.

The recommendations and tools in the Good Practice Guide and Toolkit are of relevance to all those involved in the planning, consenting and development of wind installations. Partner organisations and key stakeholders are already making changes to the way they work, based on the findings of the project, which will aid more efficient and streamlined consenting processes and improved engagement between developers, permitting authorities, NGOs and communities.

One example of good practice is the Scottish Windfarm Bird Steering Group (SWBSG). This group is made up of representatives from the Scottish Government, Scottish Natural Heritage, Scottish Renewables and RSPB Scotland. The Group has been formed to consider how windfarms relate to bird populations; acting as a platform for dialogue between the renewables industry, conservation organisations and industry. The Group is developing a meta-data catalogue, that will progressively include information on the data held by development companies and others on birds and wind farms; and it will initiate a research programme, designed to investigate the relationship between a range of bird species and wind farms The Group will collate existing information on how the industry is developing, and on how bird populations respond over the years to come. This work will help, progressively, to build trust and partnership between the parties involved, as well as filling data gaps, which will allow better informed decisions to be made.

This fits in very neatly with the stated aims of the conference – demonstrating the importance of developing a solid knowledge base about the environmental impacts of wind farms in order to facilitate better evidenced decision making and mitigation.

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Tracking needles in a misty haystack – The challenge of assessing impacts of offshore wind farms on night-migrating songbird at the species level

The risk of birds colliding with vertical structures is predicted to be high in monotonous environments that lack anticipatory visual cues. Night-migrating birds crossing the open sea may therefore be particularly prone to collisions with offshore wind turbines when visibility is low. In clear nights, dedicated radars installed next to offshore wind farms allow discrimination and quantification of echoes from songbirds, non-passerines, and even insects. Night-vision cameras mounted onto the nacelles of wind turbines can detect birds (and bats) within the rotor-swept zone. However, these remote sensing techniques often fail under conditions of low visibility and so do not accurately account for the number of affected individuals at the species level, which is decisive information for assessing species-specific vulnerabilities and population effects. In 2011, we installed an automatic radio receiver at a height of 60 m above sea level on the German offshore research platform FINO-2 in the western Baltic Sea in order to detect migrating songbirds equipped with radio tags at Falsterbo peninsula in Sweden (45 km north-northwest of FINO-2). In autumn 2011, 63 birds (9 willow warblers, 8 garden warblers, 20 whitethroats, 15 robins, 11 song thrushes) were tagged. 10 birds (1 willow warbler, 1 garden warbler, 4 robins and 4 song thrushes) passed the sea area around FINO-2. Of all detected birds, 6 individuals chose a direct flyway across the Baltic. The detected flight periods of these birds ranged from 33 minutes to 1.5 hours. 4 individuals vanished after their departure from Falsterbo and were registered on FINO-2 3 to 14 days later. Against our expectation, none of the 20 tagged whitethroats were received on FINO-2, suggesting an alternative flight route for this species. We conclude that stationary telemetry is a powerful tool for analysing species-specific stopover and flight decisions in relation to environmental variation and for delineating fly ways in relation to offshore wind farms. This new approach to the study of bird migration across the Baltic Sea calls for a broad international network of receiving sta-

tions (along the coast and offshore), which would improve spatial resolution and enhance the explanatory power of information derived from multi-scale radar networks, such as the European Network for the Radar Surveillance of Animal Movement (ENRAM). Funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and by the Swedish Research Council.

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Long term survey of wind farms impacts on Common Kestrel's populations and definition of an appropriate mitigation plan

The Portuguese company Bio3 implemented a survey of the bird community in two wind farms, Candeeiros and Chão Falcão, between 2005 and 2007. Both are located in central Portugal. At the end of this period of monitoring, the estimates indicated a high mortality of common kestrels (*Falco tinnunculus*) that could be impairing the local populations of this species.

To better understand the impact of these two wind farms, we developed a protocol that intended to accurately estimate the size of these two kestrels' populations, in order to obtain mortality rates. The methodology consisted on transects and observation points to detect the falcons, nest searching, ringing of individuals and weekly searches of all wind farms' turbines to detect dead birds.

The results, obtained between 2008 and 2012, indicated a population size of 5–7 breeding pairs in the Chão Falcão area and 9–13 breeding pairs in the Candeeiros area. Both populations are also composed of several non-breeding individuals, which rapidly occupy vacant territories. Side by side, we continued to perform carcass searches around the turbines, with Candeeiros wind farm presenting a higher mortality rate.

As a result, Bio3 and the wind farm developer started developing a site-specific mitigation program to Candeeiros wind farm. The 7 years of collected data and the knowledge acquired about the *species* behaviour inside the wind farm and surrounding areas, was considered crucial to the development of an effective plan. On the one hand it aimed to increase the potential success of the proposed mitigation measures and on the other hand to reduce the costs associated with their implementation. This particular mitigation program aims to reduce the mortality of this species, by using mainly habitat management techniques outside the wind farm area, which will keep kestrels away from the turbines.

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Combining offshore wind and the environment – the case of Denmark

Danish experience since 1991 has shown that offshore wind farms are an attractive option for energy generation, even if they have an impact on the surroundings in terms of visual intrusion and limited impacts on nature. A strategic planning process can overcome many nature protection concerns up front.

The Danish Energy Agency will present how the environmental issues are dealt with in a Danish context both when it comes to the planning and approval processes. The presentation i.e. other issues include an outline of the processes and the involvement of different actors.

The presentation will also show the conclusions of the follow-up to the Danish Monitoring Programme for Large Scale Offshore Wind Farms which will be presented in the book "Key Environmental Issues II" by late 2012. This new follow up program is building upon the results of the original program, which are presented in the publication "Key Environmental Issues". The programme is focusing on relevant and outstanding issues related to harbour porpoises, water birds – common scoter in particular – and fish communities.

The project on harbour porpoises surveys cumulative responses of harbour porpoises to pile driving activities and tests the effectiveness of seal scarers.

The surveys of common scoters aim at documenting the occurrence of common scoters and connecting these surveys with a targeted sampling programme on food resources. Furthermore, surveys provide an up-dated overview of numbers and distribution of key seabird species in Danish offshore waters with the aim of improving the basis for spatial planning decisions and environmental impact assessment for future offshore wind farms.

The project on fish communities aims to clarify the effects of the offshore wind farm on fish and fishery interests by documenting the spatial variation in fish communities within an around the wind farm.

The follow-up to the Danish Monitoring Programme for Large Scale Offshore Wind Farms has been carried out by the Environmental Group lead by the Danish Energy Agency and further consisting of the Danish Nature Agency and the two companies, Dong Energy and Vattenfall, who own and operate the wind farms, Horns Rev and Nysted, which have been thoroughly examined.

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Assessing impact from wind farms at subtidal, exposed marine areas

Marine renewable energy conversion typically takes place at locations characterised by harsh physical parameters which are a challenge for monitoring of the marine environment. These challenges are caused both by the lack of experience on what to expect in terms of impact, but also by a general lack of proven methods suitable for the monitoring of high-energy subtidal marine habitats. In this chapter we use the first offshore wind farm to be built in Norwegian waters, a project called Havsul I, as a model to give (i) an overview contrasting the known effects and monitoring methods used at more sheltered offshore wind farms with those expected at a rocky, high energy site; (ii) a description and short assessment of the physical environment (bathymetry, current, wave and wind data) and marine communities at the site, (iii) an assessment of five methods used during the baseline study at Havsul I, including sediment grabs, kelp stipes community samples, video mosaics, fish community and harbour porpoise.

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Bats and wind turbines – monitoring of bat activity and bat fatalities in Croatia

We have investigated bat activity along with bat fatalities caused by wind turbines of two wind power facilities located near Benkovac, Croatia. Bat activity data was collected during the whole season by means of transects with bat-detector, continuous monitoring with Batcorder devices for recording the bat echolocation signals at several locations and by observing bat behaviour with infrared cameras. Results of bat activity showed great difference between methods used with continuous monitoring providing crucial data not only on activity per night/season but also recording some rare species. Activity data has been analysed in relation to habitat and landscape changes caused by the construction of the wind farm and the access road. Since the facility is placed on elevated karstic ground with little or no source of water, a small pond created during the construction highly increased the bat activity at the location which enhanced the probability of collision with a nearby wind turbine. Carcass searches were conducted daily during the same period bay means of qualified observers and trained dog. Scavenger removal of bats proved to be a serious bias during some periods but bats have been found also after a couple of days. Bat fatalities have been correlated with both bat activity data and wind speed data to provide the most efficient protection measures like wind turbine cut-in speed.

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Bat migration in the South Baltic Sea and consequences for wind power development

From previous studies there is evidence that bats migrate in the Baltic Sea area during spring and autumn. This has been demonstrated on Öland and other places along the Swedish coast as well as in off shore studies. However little is known about the actual migration pattern at sea. Long term acoustic bat surveys in remote and inaccessible areas also poses methodological challenges connected to data management, power management, equipment setup and service.

Ecocom AB has on commission from EON conducted a pilot study during 2012 on bat migration at a planned off-shore wind park at södra Midsjöbanken, about 90 kilometers southeast of Öland. The presentation provides an overview of utilized equipment and potential pitfalls.

We will present preliminary data on bat species composition, peak of migration, and activity at different heights, and based on this, discuss consequences for development of wind power in the Baltic Sea.

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Implementation of a dialogue based landscape analysis in the permission process of a Wind power plant in the archipelago of Norrbotten

wpd Scandinavia is planning for a 100 MW wind power plant localized at the island Bergön in Kalix municipality, Norrbotten County. Due to the special circumstances in this project, wpd decided to include a landscape analysis in this process, which preferably should be executed in accordance with the European Landscape Convention. Unlike the ordinary landscape analysis, the method applied in this case goes beyond the expert landscape perspective and includes not only the character of the landscape but also the *experience* of the landscape. This method has been developed in Sweden by Karin Hammarlund at SLU, and she also made the analysis for this project. Due to the localization at an island, the dialogue with the public took place on two boat trips, which included the possibility to see the planned site from different distances, and comparing with photomontages of the planned park. The participants described their experience of the landscape in the surroundings of Bergön and also got the possibility to ask questions, and tell their speculations about the project. In addition to the legal regulated consultation during the early phase of the permission process, this method of making a landscape assessment **together** with the people that live or reside in the neighborhood involves a common learning process which legitimizes and verifies the analyses. The result of the landscape analysis is referred to in the environmental impact assessment (EIA) for the project, in order to represent a well-founded decision basis for the permission authority. The major benefits and challenges connected to implementation of landscape analysis, involving the landscape as perceived by people are summarized in this presentation. Also, lessons learned are concluded from one of the first applications of dialogue based landscape analysis as an important part of an EIA for a specific wind development.

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Pre- and post construction studies on the effects on birds at Storrun wind farm in the mountain-region of Jämtland, Sweden

Storrun wind farm in Jämtland was the first to be erected in the mountainous region of Sweden. It consists of 12 2.5 MW turbines near the tree line on two adjacent hills. Studies of the potential impact on birds in the wind farm area were performed 2005–2011, with an interim during the construction period 2008–2009.

We studied the density of passerines and other land birds in the wind farm area using a before/after – control/impact (BACI) design. Studies of tetraonids were performed by using trained pointing dogs. Flight behavior of birds in the wind farm area was performed during spring and autumn. After the wind farm was completed, we surveyed the wind farm area for collision victims at regular intervals using a trained dog. Radio-tagged carcasses (n=85) of different grouse species were placed in the turbine area and in a control area during one year. The removal rates were investigated at fixed intervals during one-month-periods. The causes of disappearance were determined when possible. Juveniles of Golden Eagle (n=5) and Gyrfalcon (n=8) born in the surrounding area were equipped with GPS satellite tags to give data on their use of the wind farm during their dispersal period.

During a 10-month period, a total of four Willow Ptarmigan were found dead below the turbines, and one actual collision was eye witnessed. All collisions seem to have been with the tower structure itself, not the turbine blades. The removal rate was significantly higher in the turbine area compared to the control area, most likely due to scavenging by foxes. Removal rates imply that some collision victims are likely to have been missed during the study. Data from satellite-tagged Golden Eagles and Gyrfalcons showed only marginal use of the wind farm area.

The results indicate that the wind farm at Storrun in general have had a low impact on local bird life. Avoidance behavior has primarily been noted in

ducks. The eye witnessed collision of a Willow Ptarmigan confirms earlier assumptions from the island of Smøla in Norway that grouse species such as the Willow Ptarmigan tend to collide with the tower structure. This argues for the need of mitigation measures if wind farm developments in mountainous areas continue. Before permanent dispersal, juvenile Gyrfalcons and Golden Eagles used an area with a radius of approximately 5 km. To protect birds of prey, wind farms should not be built close to their nesting areas.

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Public involvement in wind power policy and project implementation via direct democracy

Worldwide installation of wind power turbines is growing. With the rapid increase of large-scale wind energy generation facilities however, social acceptance of this development becomes crucial. Direct democracy (initiatives & referenda) is one element of public involvement and influence in decision-making on renewable energy deployment which is gaining popularity. Direct democracy means procedures allowing "citizens to participate directly in decision-making on policy issues in a ballot vote on propositions initiated by citizens or by a governmental authority".

The aim of the paper is to analyze the opportunities and use of initiatives & referenda in wind power policy adoption and implementation in Germany and discuss the results in the context of international experience. The research covers on the one hand the regulatory conditions through a document and literature analysis. On the other hand the practical use of direct democracy on wind power deployment is analyzed based on datasets covering all relevant cases since the 1990s.

The study reveals with an increasing number of initiatives and referenda on the local level in Germany, a trend to a more frequent use of direct democracy on wind power plant projects. Most initiatives and referenda were aimed at stopping wind power development and the analysis revealed a clear "status-quo-bias" against wind power development. This trend might become relevant for future implementation of wind power projects aiming at further increasing the installed capacity in Germany. The relation and interaction between initiatives & referenda and formalized public involvement in wind power planning and permitting processes lends support to the hypothesis that public involvement in wind power development in general is not sufficient.

The comparison with international experience from Czech Republic reveals similar trends in local wind power referenda. The Californian experience however, is rather different with little local activity but several state level initiatives. Possible explanations for these situations will be discussed.

As this analysis is restricted to the direct effects on wind power deployment, a further consideration of indirect effects such as the "credible threat" that direct democracy regulations impose in regions with experience in use of initiative and referenda would be of interest for further research.

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Monitoring bat activity at wind turbines with near infra-red videography

The magnitude of bat impacts at wind energy facilities has increased the importance of research into methods to better understand the causal factors contributing to fatalities. A pair of studies in Pennsylvania and Hawaii in the fall of 2011 applied near-infrared (NIR) videography and advanced digital motion analysis to detect and track bat (and bird) occurrence, characterize behavior, and document the incidence of apparent bat strikes by turbine blades. Over 300 hours of video were acquired over several weeks at each site. Results from Pennsylvania were compared to acoustic samples of bat echolocation and ground searches of fatalities that were run concurrently. The video system detected bat occurrence both when echolocation was and was not recorded at the turbine nacelle, indicating that acoustic sampling does not perfectly identify bat presence and potential risk. Conversely, not all acoustic detections were associated with a visual detection, indicating that echolocating bats flew outside of the rotor-swept zone imaged by NIR cameras. Video monitoring also detected at least one bat strike subsequently confirmed by ground-search. On several occasions at the Pennsylvania site bats were observed exploring and interacting near the nacelle and upper tower. About four-fifths of video detections in Hawaii were of birds and no strikes were observed although bats approached the rotor-swept area on occasion. Bat detections in Hawaii appeared to be of foraging individuals or those in transit, and no activity in proximity to a nacelle or turbine investigations by bats was seen. Our project is the first field validation of NIR videography to track and quantify target motion at distances >100 m at night under realistic operational conditions and long-term deployment scenarios. We anticipate that the technical capabilities NIR video and motion tracking will steadily improve and yield a highly effective method for monitoring wildlife impacts at wind energy facilities.

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Positive Wind Power Planning – An Opportunity to Ameliorate Local Environments

Every form of electricity generation will have some sort of impact on the surrounding environment, but does this impact need to be negative? The debate surrounding the development of wind power often centres on issues of global benefits (through the reduction of CO_2 emissions for example) vs. negative local environmental impacts. This dialectic serves to further entrench pre-existing positions and embitter actors in the process while failing to unlock the full potential of wind energy developments.

In order to promote innovation in wind energy planning the discussion must be changed to discuss positive local opportunities. A holistic analysis of the landscape, based around dialogue with local stakeholders, can effectively assess and define a community's issues and concerns; this analysis provides a base from which we can suggest wind power projects that will ameliorate the environment.

Some possibilities for positive local impacts include curbing regional sprawl, diversifying agricultural monocultures, providing income to support farmers, improving the legibility of the landscape, increasing job opportunities, and adding new ecological and social functions that can be sponsored by developments. By addressing local ecological, economic and landscape conditions we can substantially improve and diversify our peri-urban areas while increasing the nation's wind energy capacity.

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Effect of wind turbine mortality on bat populations in Sweden: predictions from a simple population model

That bats are killed by the presence of wind farms has been documented by censuses at wind farm sites, where particularly migratory species seem to be vulnerable. But does this mortality factor has any significant effect on a regional population level scale, or is the mortality rate trivia with insignificant effects? To address this question we developed a population model inspired by harvesting theory previously used in assessment of the effect of fishery. The model include the parameters survival of adults and juveniles, fecundity, density dependent fecundity, mortality rate at wind turbines. The effects of different scenarios of wind power development within the range of the Noctule and Nathusius pipistrell were analysed for realistic demographic parameters with the model. A freeze of wind farm development at the present level could potentially lead to significant reductions in the future population sizes of both species, of order 10–20%, while a development over the next 10 years to 5000 turbines could lead to drastic population decline of order 30–50%. These results point at potential effects, but should be treated with some caution since there are assumptions made that may need refinement. Available data on mortality rates at wind farms are from studies in Germany, while data from Sweden, particularly at coastal sites, would be very valuable in order to accurately predict the expected population dynamics in this country.

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The Efficacy of Pre-Construction Bat Activity as a Predictor for Post-Construction Fatality at Wind Energy Facilities

Risk assessment options are needed for wind energy development, particularly as concerns over the potential cumulative impacts of wind powered turbines on bat populations persist. Extensive resources are devoted to studying bat activity patterns at proposed wind energy facilities, but it remains unclear whether these studies provide natural resource managers and wind developers the necessary information required to predict impacts to bats. Pre-construction bat surveys commonly employ acoustic detectors to assess species composition, spatial and temporal activity patterns, and weather conditions under which bats are most active. These data may assist with on-site decision-making and optimizing potential minimization strategies (e.g., raising turbine cut-in speed during periods of high risk). However, using these data to predict post-construction fatality and quantify risk of a site is unproven. Until recently, our ability to investigate this relationship was limited because so few sites conducted both pre- and post-construction studies. Increases in the number and extent of surveys now make meta-analysis possible for a nationwide assessment. In summer fall 2012, we compiled a list of available datasets and assessed which studies were appropriate for inclusion in our analysis. We synthesized these data and evaluated the efficacy of using pre-construction bat acoustic studies to predict post-construction impacts. We also examined factors (e.g., detector height, weather conditions or region) potentially influencing this relationship. Here we present our findings on whether bat activity, as measured by acoustic detectors, provides a useful metric in predicting fatality and offer ideas on how to best to proceed with future surveys.

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Predicting flight altitudes of birds at offshore wind farms based on weather, wind and distance to the coast – a key requirement for assessing impacts

Knowledge of flight altitude, and the factors affecting it, is crucial if we want to assess potential impacts of wind farms on bird populations. Although it is well known that weather and wind have a strong influence on flight altitudes there are few examples of studies that describe the relationships in a manner which enables predictions at a fine resolution, which is urgently needed. One plausible reason for this is lack of data. Another reason could be lack of a suitable method for analysing the data. In this study we present a method capable of doing it; relating observed altitudes of different bird species to weather, wind and topography. The altitude data was collected at the study sites, in Denmark, by using a laser rangefinder. For analysing the data we used a generalized additive mixed modelling (GAMM) approach. By using this method we were able to account for the strong spatial and temporal autocorrelation within the collected altitude tracks, as well as the potential nonlinear relationships between the response (altitude) and the explanatory variables (e.g. wind speed, humidity and distance to the coast). The flight altitudes and responses differed between species and location. However, the birds generally flew, according to the models, much lower in tail winds in comparison to head winds. The birds also generally flew higher with decreasing wind speed and decreasing relative humidity. Clearness, air pressure and temperature were also shown to be important for some species and locations. Many species (e.g. Common Buzzard) gained altitude when leaving land. However, some species (e.g. Honey Buzzards) seemed to descend after leaving the coast. The models enabled us to predict the mean altitude during different weather conditions, and therefore also to assess the weather dependent risks. Our models show that the risk of colliding with the wind turbines is to a large degree species-specific and also highly dependent on the prevailing weather conditions. The risk increases when the birds fly in head winds and poor weather conditions (i.e. low visibility and high wind speeds). Our approach highlights the need for, and makes it possible to incorporate the effect of wind and weather in studies regarding possible impacts of wind farms on birds.

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Effects of wind farms on a Montagu's harrier (Circus pygargus) population in Southern Spain

Wind farms are a relatively new form to obtain clean energy and alternative to fossil fuel use. However, bird collision with blades and displacement from turbines situation are negative impact of construction and operation of wind farms. 111 Montagu's harrier nests locations were recorded. To study the effects of turbines and associated structures, we compare distances from nests to closest several elements between wind farms pre and post-construction phase with a before-after and control-impact (BACI) design. We also analyzed nests and colonies abundances and densities; likewise annual mortality rate by collision. Moreover, real nests and random point locations data were gathered to propose a generalized linear model (GLM) which highlighted the most explicative variables to occurrence of real nests after the wind farms construction. Distances from nests to turbines, power lines, unpaved way, road and boundaries remained invariant throughout the study period. Distance to closest conspecific nest decreased, possibly as a result of the wind farms construction. Nests and colonies abundances and densities did not suffer any variation between before and after the structures construction. Fatality collisions were scarce and did not increase with the number of wind farms. The explicative model suggested that distance to unpaved way and crop type were the best predictors to occurrence of real nests. Our findings show that the construction, operation and maintenance of wind farms did not seem to affect adversely the breeding population of Montagu's harriers.

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Coastal residents' perception of offshore wind power – results from a longitudinal study

While several studies on the social acceptance of onshore wind farms exists only few studies on offshore wind power based on real experience are published. To gain further understanding of offshore wind power acceptance we conducted an interdisciplinary research project including direct experience with offshore wind farms. This project is part of Research at Alpha Ventus (German offshore test project) and funded by the German Federal Ministry for the Environment.

To assess the general acceptance of offshore wind power, anticipated advantages and disadvantages as well as impacts on local economy and tourism we interviewed each 100 residents and tourists in four regions. First, to uncover the unique impact of direct experience we examined two coastal regions where offshore wind farms are planned and under construction as well as two control regions where wind farms are neither constructed nor planned. Further, to investigate the impact of time we conducted three surveys: a baseline survey before respective while the offshore wind farms were build and a first follow up two years later, after construction. In the third year, as a social intervention was set up: The results from the first two surveys were reported to and discussed with the local residents in three workshops. Next, the surveys' as well as the workshops' results were summarized in a brochure based on social psychological theories on information processing. This brochure was distributed to half of residents before respective after a second follow up in autumn 2012. Since the last follow up was still in progress at the time written the present abstract refers to the first two resident surveys. The surveys we conducted as interviews based on detailed standardized questionnaires.

Overall, the findings corroborate earlier results that offshore wind farms located at relatively large distance from the shore are evaluated more positively compared to short distance farms. However, at a closer look of the data revealed dis-similarities depending on direct experience and concerning different topics. For example, while the impact on tourism of a close to shore offshore wind farm was evaluated less negative after the wind farm commenced operation, the fear of shipping accidents due to the wind farms nearly remained unchanged. Again, the impact on marine mammals was evaluated indifferently for close and far shore wind farms.

Based on research results and the experiences of the local residents recommendations are discussed how to promote social acceptance of offshore wind power.

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Perception of wind power in alpine tourism destinations

This current survey is part of an interdisciplinary research project centred around an integral view on renewable energy application in the Alps. One of the central points is a detailed analysis of feasibility both in technical and touristic respect. Taking into consideration on the one hand the image benefits and discussing on the other hand the acceptance of strongly renewable-energy-focussed tourism in the Alps. Due to the topography and related visual impacts wind energy is a highly controversial form of energy supply in these areas. The study researches alpine tourists' sensitivity towards changes to natural heritage and the landscape. This offers valuable feedback and reflects the perception of change in the sensitive alpine region.

During the winter season of 2010/2011, winter sports tourists (n=1100) were surveyed in four Austrian skiing regions. Currently the survey is repeated during the summer season to gain also the opinion of summer tourists (same sample size envisaged). First tendency of differences in the acceptance and consideration of impacts could be observed already among these winter sport tourists who come back in the summer season to the same region.

The survey areas were selected with a view to covering a diversity of winter sports markets – from the luxury segment to the family destination, from areas with a strong international orientation to those mainly frequented by domestic tourists. Thus, the study allows comparisons to be drawn between different tourism segments and tourist nationalities regarding perception, appreciation and acceptance of wind energy amongst other forms of renewable energy in the alpine region.

The survey shows the high sensitivity of tourists towards wind turbines – especially larger sized ones (similar as towards larger biogas plants and large photovoltaic fields). Whereas the impact on the landscape is viewed critical regarding large size turbines, effects on the environments are assessed less negative for smaller compact wind turbines close to existing infrastructure. This is in coherence with outcomes for other forms of renewable energy supply (such as photovoltaic shields on buildings or biogas plants affiliated to existing infrastructure).The positive effect of wind power on the CO2-balance is opposed by the negative impact wind power infrastructure has on the region's nature and landscape beauty. Therefore potential marketing benefits or negative impacts are discussed critically against this background.

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Perceptions of impacts and compensations associated to offshore wind farms: A cognitive mapping approach.

Although the renewable marine energies are widely deployed in the Northern Europe, France is still at a planning and design stage. Four proposed offshore wind farm are now underway along the French Atlantic coast. Even if the goal of the French marine renewable energy program is to have a sustainable strategy regarding the energy provisioning, it is also a major source of changes for marine habitats and for human uses and can be perceived as a source of negative impact by local stakeholders. It is why most of the offshore wind farm projects propose some compensatory measures to local stakeholders, both for maintaining the local level of ecosystem services and of well-being, in an integrated coastal zone management perspective. Cognitive mapping is used for the second stage of the general methodology of the thesis to identify perceptions about impacts and compensations associated to the proposed offshore wind farm of the bay of Saint-Brieuc. The stage is currently ongoing and should be completed in October. A total of about fifty semi-structured interviews will be conducted among various community of practice (tourists, residents, naturalists, fishermen, boaters) where participants will draw cognitive maps depicting their views. A collective cognitive map will be constructed for each community of practice in order to reveal perceptions about impacts on ecosystem services and compensations of these impacts. This method seems to be an interesting tool for revealing stakeholders knowledge and perceptions, understanding complex relationships between ecosystems and society, and for creating public participation about the challenges related to these new facilities. Another challenge is now to quantify them in order to be able to balance what is lost through the impacts and what is won through the compensation in the intent to respect environmental no net loss goals and to facilitate social acceptability of wind farm projects.

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Wind Power Plants and reindeer herdsmen; socioeconomically import?

The Norwegian VindRein project integrated biological and social studies, providing realistic and usable results for stakeholders. Sámi reindeer herdsmen occupy a fragile balance between modern society and an Arctic indigenous culture and lifestyle. They welcome many aspects of modernization, but the rate of change and potential consequences of modern infrastructure, such as wind power plants (WP), may threaten their subsidence, especially at a local scale. We investigated issues raised by herdsmen and developers such as; what short-term and long-term consequences may WPs have on herdsmen's daily operations? How is their livelihood affected? How negative is WP development, contra how positive could it be? What measures used for reducing negative impacts actually work? Most herdsmen have strong feelings against infrastructure, yet very little or no experience with WPs. Will this change over time given various post-development outcomes? We conducted qualitative interviews with herdsmen in areas where a WP was planned and during the process of before, during and after development in one area so far. Incorporating «wheel mapping», we identified and tested changes in work effort and production for herdsmen in areas with WPs. The analyses begin with categorizing interviews into two wheels. The interviews are further divided according to keywords/subjects. Production included keywords "herd growth", "mortality/loss", "harvest" and "condition/weight" and work process included "burden of labor", "culture/tradition", "division of labor" and "costs/expenses". The center of a wheel begins with zero and radiates out to a value of 10. Each keyword receives a point between 0–10 based on the respondents experiences towards the topics discussed. When each keyword is summarized along their respective gradients (along the radius for each keyword within each wheel), a line is drawn connecting the points along each axis for each keyword, illustrating the results for each wheel. The illustration for production and work-process varies over time as the herdsmen and their way of life changes. By connecting this to data on other changes occurring within their district, such as WP development, results can be based on understanding how the various internal and external changes are interconnected. Long term data such as ours is capable of capturing true effects, both posi-

tive and negative, but importantly, is dependent on long term funding. Results from two areas will be presented, but multiple study areas are necessary, as each herding district and WP produce independent results. Presently, limited funding inhibits the continuation of our study, an interesting result in itself.

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Mitigating bat fatalities from wind-power plants through targeted curtailment: results from 4 years of testing of CHIROTECH©.

An increasing number of bat fatalities are reported on some European wind energy facilities, which raises concerns about their impact on the viability of bat populations. It has been repeatedly suggested that targeted curtailment, i.e. stopping the wind power plant during periods of high bats activity, could effectively limit bat mortality. It also generates lost energy production and it is essential to ensure that curtailment is cost-effective.

In order to check this hypothesis, we built a multi-factorial algorithm describing bats' theoretical activity under a wide range of environmental conditions and integrated it as a plug-in into wind turbine supervisory control and data acquisition software (SCADA). This has allowed us to remotely stop and start wind turbines according to modelled bat activity, whilst at the same time limiting losses of energy production.

The efficiency of this patented device, called CHIROTECH©, was tested for two consecutive years on the 8 wind turbines of Bouin (north-eastern France), and two consecutive years on the 9 wind turbines of Saint-Martin-de-Crau (Southern France) as well as during bats fatality period in Bisnett, (southern Ontario), Frontline (southern Ontario), Cruscades (southern France), Coume (Northern France).

Our results, based on an analysis of the number of bat carcasses found under regulated and controlled wind turbines, demonstrates a significant decrease of fatalities under regulated wind turbine, with a power output loss of less than 0.5% of annual production. These promising results offer renewed perspectives for reducing bat mortality induced by wind turbines facilities without compromising production targets or the economic viability of wind power plants.

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Experiences and examples of environmental monitoring of wind power farms

Uncertainties about the effects of wind power farms on the natural environment result in authorities often demanding environmental control programmes (e.g. flora, fauna and reindeer husbandry) as a condition for permits. It is important that control programmes are designed adequately in relation to the specific questions posed. The consultancy Enetjärn Natur has been involved in designing and carrying out control programmes for several large wind power farms and has considerable experience and several examples of good practice as well as examples of how the process can be improved. The environmental control programmes mainly cover follow-up of birds, mammals, reindeer husbandry, flora and wetlands. The presentation will focus on recommendations for avoiding pitfalls that would otherwise obstruct a well-designed follow-up. Our experiences can be summarised as follows: Conditions that warrant a control programme must be clearly stated in the permit, e.g. which question the control programme is intended to answer. This provides incentive for the developer to plan and budget for a relevant control programme. Conditions must be so clearly written and explained that any uncertainties and misinterpretation can be avoided even if people in key positions are replaced at later stages. The questions that the control programme is designed to answer must be based on known causal connections, vital knowledge gaps as well as on expected risks concerning the development schemes localisation and design. The control programme should not be characterised by the authorities ”wish-list” of varied investigations that are deemed interesting due to a general lack of knowledge about a specific area, or a lack of basic scientific research. A control programme is a cost for the developer both during design and implementation stages. It is therefore important that the programme is designed to generate data of sufficient quality and time span to answer the programmes objectives. A scientific approach should be applied to the control programme, utilising the knowledge of experts (preferably in an external reference group) and applying accepted methodology used in research and monitoring. Well-known methods and reasonable input should be sufficient for the developer to answer the questions that warrant the con-

trol programme. Methodology used in national environmental monitoring programmes are sometimes a good starting point for the design of control programmes, and can in some cases provide substantial reference data. If reference areas are used to draw conclusions on changes over time it is important that the reference areas can be secured during the entire length of the control programme.

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Wind farms and livestock wolf damage interactions: a case study in Portugal

In the last decade, Portugal established an ambitious renewable energy program. Wind energy significantly contributed to that program with more than 3500 MW of installed capacity by the end of 2011. Most of the wind farms in the northern and central regions of the country were developed in remote mountain areas, which are socially and economically characterized by low demographic densities, ageing population, agricultural/livestock based economy and low income per capita. These areas have significant biodiversity values, such as the Iberian wolf, that sometimes collide with the local rural economy. Livestock damages caused by wolves are "threats" to the rural populations' way of life. On the other hand, wind farms represent a huge economic added value to this population, through land lease incomes and taxes.

Alto Minho I is one of Europe's largest wind farms, with 120 wind turbines (240 MW) distributed over an area of 11 km^2 and was constructed between 2007 and 2009. We analyzed the wolf damages data over a period of 8 years (2004 to 2011) for an area of 830 km^2 around this wind farm in order to: i) determine the livestock wolf damages spatial distribution, ii) analyze their evolution over the years, iii) determine the influence of wind farm construction and operation on livestock wolf damages, and iv) analyze the influence of other factors, such as agricultural incentives, wolf population, and livestock densities on livestock wolf damages.

We have detected some differences on livestock damages over the years (P£0.05). Although the preliminary results indicate that the construction of the wind farm may have had indirect influence on livestock wolf damages, those results can also be explained by changes on wolf population size and number of livestock heads.

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Is Germany much more Beautiful than France? International Comparison of Assessments on Wind Energy's Impact on Landscape Scenery. Need for a European Approach.

The impact of wind energy turbines on landscape scenery is seen as one of the most important obstacles relating to social acceptance of wind energy. In Germany the various federal laender have a multitude of approaches for assessing impairment of the landscape. In Germany landscape scenery must be considered according to the Federal Nature Conservation Act as well as according to the European Environmental Impact Assessment Directive (85/337/EEC). In Germany these differing methods are currently creating very different forms of monetary compensation. Monetary compensation is obligatory to pay when physical compensation within the impacted ecosystem, or landscape, is not possible. In this investigation, the author attempts to compare the way Germany deals with landscape impacts with the way other countries (e.g. France, Sweden, Denmark Spain or UK) handle this conflict. To investigate the differences, literature research and case studies of wind farms in the different countries are conducted, as well as interviews with international experts. Different methods are presented and assessed. Not only is the method of the assessment, as a part of the Environmental Impact Assessment, examined, but also both the integration of landscape matters within the planning process and public consultations are investigated. In conclusion, the author proposes some essential considerations for creating a standard method of wind energy landscape impact assessments. This includes further development, and a simplification of the overly sophisticated assessment as it is currently done in Germany. Further recommendations for Germany include an attempt to standardize the different methods of impact regulation under nature protection law. The author's proposed essentials for an international approach are based on a geographic information system (GIS) which accounts for the height and number of turbines, the value of the natural beauty of the surrounding environment, and last but not least, the visibility of the wind turbines. This visibility is analyzed by a GIS including such factors as topography or land cover and vegetation. The method can be adapted internationally without expensive, specialised soft ware or expert knowledge. Both the EIA Directive and the European Landscape Convention could be the legal basis for such a standardized "European View" of the "European Landscape".

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Impacts of wind turbines on bats: results of a large-scale study in the UK.
Wind energy generation is expanding rapidly and the impacts on bats are poorly quantified in most countries. Our study used search dogs to locate bat carcasses at 26 wind turbine sites distributed in a range of habitat types across the UK. We also monitored bat activity using acoustic detectors in the nacelle and at ground level. We will present evidence on the scale of the impact of wind turbines and bats, and consider whether there are likely to be implications for the conservation of local bat populations. We will also present preliminary evidence on the usefulness of bat activity data in predicting casualty rates.

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Mitigating wind-turbine induced avian mortality: audible, optical and biomechanical constraints and options

Because of the fast rate of wind-power development in Europe it will become a challenge to verify impacts on birdlife and construe ways to minimize these. Birds colliding with wind turbines are generally perceived as one of the major conflict issues for wind-power development. Although impacts of offshore and onshore wind energy production may differ, there are several similarities regarding tools for monitoring and assessment of mitigating measures. Development of concrete and practical tools / measures / products to reduce bird mortality related to offshore and onshore wind power is therefore paramount to avoid any delay in consenting processes. Here we review the expected efficacy of various post-construction mitigation measures for wind-turbine induced avian mortality with regard to audible, optical and biomechanical constraints and options of birds.

The efficacy of mitigation measures to reduce collisions of birds with wind turbines can be expected to be species-specific. Species-specific sensory (vision, hearing) faculties limit the ability to observe a wind turbine in a given circumstance. Their consequent cognitive perception of the "stimulus" may depend on the possibilities for associating wind turbines with risk, and discriminating these from other sources. Last but not least, perceived risks –in the form of a wind turbine– may only be evaded when their aerodynamic, locomotive physiology (e.g. wing load, wing aspect) enables them to do so in due time. In order to be able to identify and construe functional mitigation measures these aspects need to be taken into account. Measures eliciting a series of intermittent strong stimuli that are variable in frequency may limit habituation effects; these should only be elicited specifically to mitigate imminent collision. Thus measures either adjusting turbine operation or warning/deterring birds approaching turbines are expected to be most functional. Warning signals may either be based on optical or audible stimuli; however, birds' hearing is inferior to humans while their visual acuity and temporal resolution is higher, but with great differences among species.

Implementing effective mitigation measures could reduce the general level of conflicts with birdlife and thus enable both the development at new sites, at sites that have been declared having too high conflict levels, and utilize the wind resources better at specific sites without increasing the conflict levels.

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Landscape analysis, environmental knowledge and wind power planning

Landscape analysis can be seen as a particular kind of environmental knowledge, employed as a tool in decision making about the location of wind power. It is used to identify environmental values, to characterize a landscape, and enhance communication on how development could take place. Heavily resting on maps and plans, physical landscape traits, montages and expert knowledge, landscape analysis has a rather strong air of objectivity, rationality and scientific detachment. Moreover, landscape analysis tends to be well-adapted to the needs of local and regional authorities and their need to focus on officially recognized environmental values, such as cultural heritage, recreational spaces, and natural assets. As a result, attention to non-expert interpretations of landscape often remains weakly developed or at best seen as a secondary dimension of landscape analysis. This privileging of a particular form of expert environmental knowledge is problematic for several reasons. In wind power literature, it is widely recognized that non-expert interpretations about the local environment often influence opinion about wind power to a substantial degree. One way to deal with the weak position of lay knowledge in the planning process would thus be to widen the scope of landscape analysis. This paper explores ways to enhance and develop a dimension of landscape analysis, which is crucial for acceptance: to create an arena for dialogue between locals, officials, politicians, project managers and other actors. Empirically, the paper is based primarily on interviews and the analysis of documents from three Swedish case studies. It covers cases from three distinct regions (high mountains, open landscape and forest), as seen through the lens of international experiences and the wider context of communicative planning theory. Working its way from this theoretical and empirical material, the paper argues on a more practical level for a more thorough recognition of the importance of dialogue around the public's environmental knowledge in the planning process.

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Stakeholder engagement – crucial for successful wind projects

Effective stakeholder engagement is the way of working at Vattenfall Renewables. Vattenfall's aim is to be one of the leading companies in renewable energy and wind power can not be met without stakeholder engagement and involvement from the whole organisation. For us, it is of great importance that we are considered a reliable player and partner and we need to understand our stakeholders as well as their needs and concerns. We deliver accordingly in all relevant aspects of wind development and operations.

Stakeholder engagement is crucial for successful wind projects and to ensure long-term commitment locally also after the construction is finalized. Dialogue and good relations with decision makers, neighbours, organisations and other local stakeholders create possibilities for wind power acceptance long-term which will imply benefits for further development and opportunities. At the same time, building trust enables "license to operate". A well seen operator can contribute to high level acceptance in the local community and proud employees.

The level of activity varies for each wind farm and depends on different local conditions, size and environment. Onshore projects have different stakeholders than offshore wind farms which affects strategy, plan and choice of local activities.

Vattenfall has experience from various projects, from onshore projects in the north of Sweden to one of the largest offshore project in the world. How do we succeed with engaging stakeholders and reaching stakeholder engagement in our projects? Experience from several projects in different countries point to similarities as well as differences in how stakeholders want to be engaged.

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Radar monitoring of migrating pink-footed geese – behavioural responses to offshore wind farm development

In the context of growing demand for offshore wind energy production in recent years, much effort has been made to determine the collision risk that offshore wind turbines pose to birds. Currently only limited species-specific data on migrating birds' avoidance rates and associated mortality at offshore wind farms exist.

During a four-year study, bird detection radar was used to monitor behavioural responses and flight changes of migrating pink-footed geese in relation to two offshore wind farms during and after construction. Radar recorded a total of 979 goose flocks migrating through the whole study area, of which 630 were visually confirmed as 43,249 pink-footed geese *Anser brachyrhynchus*. Overall, we calculated that 97.25% of all flocks recorded by radar, in 2009 and 2010 combined, migrated without any risk of additional mortality associated with the constructed wind farms. We identified a growing tendency of geese to avoid the wind farms and calculated that, for 2009 and 2010 combined, avoidance was exhibited by 94.46% of the original 292 flocks predicted to enter the wind farms.

This study demonstrated that migratory geese responded to offshore wind farms by adopting strong horizontal and vertical avoidance behaviour. For the first time, wind farm avoidance rates have been recorded for this species, these rates will allow more robust impact assessments to be undertaken both of this species and waterfowl in general. Remote sensing techniques should be used to undertake long-term impact assessments at offshore wind farms to provide evidence-base for assessing the mortality risk for migratory birds.

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Effects of Small Wind Turbines on birds & bats and correlates of mortality

The development of renewable energy technologies such as wind turbines forms a vital part of strategies to reduce greenhouse gas emissions worldwide. Although large wind farms generate the majority of wind energy, the small wind turbine sector (SWT, units generating <50kW) is growing rapidly. In spite of evidence of effects of large wind farms on birds and bats, effects of SWTs on wildlife have not been studied and are likely to be different due to their potential siting in a wider range of habitats.

In this talk, we present the first study in the world to quantify (i) the effect of SWTs on bird and bat activity, (ii) the extent of variation in bird and bat mortality among SWT sites and (iii) any correlates of levels of such mortality.

First, using a field experiment, we show that bird activity is similar in two distance bands surrounding a sample of SWTs in the UK between 6–18m hub height) and is not affected by SWT operation. At shorter distances from operating turbines (0–5m), bat activity (measured as the probability of a bat "pass" per hour) decreases from 84% (71–91%) to 28% (11–54%) as wind speed increases from 0 to 14 m/s. This effect is weaker at greater distances (20–25m) from operating turbines (activity decreases from 80% (65–89%) to 59% (32–81%)), and absent when they are braked.

Second, using a combination of field observations and owner questionnaires, we show that although bird and bat mortality does occur at SWT sites in the UK, levels of mortality are generally low and vary widely across sites.

We conclude that (1) although reported at some SWT sites, levels of bird and bat mortality across SWT sites in the UK are low, (2) bats avoid operating SWTs but this effect diminishes within 20m. Irrespective of direct collision mortality, such displacement effects may have important consequences especially in landscapes where suitable habitat is limiting. By contrast, we did not show bird avoidance of operating turbines at the relatively small spatial scale studied.

Planning guidance for SWTs is currently lacking. Based on our results we recommend that they are sited at least 20m away from potentially valuable bat habitat.

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Wind power effects on land use and reindeer herding practices

Wind power activities in Northern Finland's reindeer husbandry area are increasing rapidly. But still, there is a lack of research on impacts of wind mills on reindeer behavior and reindeer herding practices. Environmental impact assessments are now done only based on assumptions on what are the direct and indirect impacts of wind farms on reindeer herding.

The concept of ecosystem services (ES) can offer an approach to prevent ecological problems caused by human actions, such as wind power installations. The goal of environmental impact assessments is to minimize these problems. In ideal situation wind power as one ES can be utilized in a matter that it doesn't endanger other benefits (ESs) that nature provides to humans. Value of reindeer grazing habitats that new wind farms will be built on might decrease, which leads increasing grazing pressure elsewhere or need to increase supplementary feeding. Changes in reindeer behavior may also be to associated biodiversity: e.g. in Malla Nature Park in Finland "optimal" reindeer pressure has positive impact in biodiversity (vascular plants, some insect taxonomy etc.) (Jokinen *et al* 2005). Shift of reindeer grazing areas may have wider ecosystem impacts.

There has been a controversial debate about land use in Lapland for a long time. The main participants of this complicated issue are forestry people, reindeer herders, mining companies and tourism actors, but also other local people and conservationists are relevant stakeholders. With emergence of wind power utilization, a new player entered the scene, causing new claims and new impacts. There might be some influence especially for the concept of cultural services & various stakeholders.

We have studied Hirvasniemi herding district that is encountering four wind farms in coming years. Altogether the number of mills will be 46 maximum. We used remote sensing, geographical information systems (GIS), statistical analyses and interviews to build up an effect area estimation maps. GIS and remote sensing data used was CORINE, topographical data base (National Land Survey Finland) and Landsat TM images. The determination of ES was based on current ecological literature and interviews of people, whose livelihood has been dependent on nature's properties.

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Methods for environmental assessment of wind power policy and plans

In order to combat climatic changes, renewable energy is of highest policy concern today, promoted by e.g. the EU Renewable Energy Directive. Other policy goals concerning for example environmental issues may though be in conflict with the desired high levels of renewable energy supply. For example, while implementing renewable energy systems, environmental impacts may occur, which conflict with designated habitats and species protected by the EU Birds and Habitats Directives as well as with the European Landscape Convention, promoting human perspectives on landscapes. In Sweden, the Governmental environmental quality objectives should be considered in policy and planning. Landscape related environmental objectives for archipelagoes, forest and cultural landscapes, among others, may however conflict with future implementation of e.g. wind power technology and associated infrastructure. In this context, assessment of environmental impacts of renewable energy options calls for development and application of methods that can take into account impacts on landscape and regional levels, in order to find sustainable solutions. The overall aim of the currently ongoing study is to develop methods for exploring opportunities for and environmental impacts of large-scale renewable energy systems in Sweden.

For planning as well as for policy discussions, strategic environmental assessment can be applied, involving a structured process for assessing environmental impacts. Within this process, methods for analysis and assessment of planning and policy alternatives include Multi-Criteria Decision Aid (MCDA), which can be applied in Geographic Information Systems (GIS) in order to catch the spatial dimension as well as other issues and interests. In this way, renewable energy options involving wind power are driven by assumed energy demands and technological opportunities in an initial suitability study. Major environmental impacts concerning ecological and social impacts on landscape level are thereafter localized and quantified. Among these impacts are cultural landscapes, visibility and sound impacts, as well as biodiversity impacts that are modeled concerning habitat and migration routes for birds and bats, together with potential impacts of infrastructure such as grids and new roads on ecological networks. The MCDA methodology can integrate these disparate criteria in a systematic way. Preliminary results are quantified impact assessments, while the GIS-based methods allow for iteration of the initial suitability study for integrating environmental aspects in a final set of alternative options. These results are used for a final evaluation of strategic choices in relation to the main environmental objectives in an integrated sustainability appraisal, as part of the strategic environmental assessment.

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Aliens in wind farms – preventing and monitoring impacts on vegetation

Wind farms' effects on flora and vegetation are often poorly assessed within Environmental Impact Assessment (EIA) studies. Although direct impacts over rare plant species or habitats are most of the times taken into consideration, impacts regarding invasive alien plant species are frequently neglected. The invasion by alien species being one of the main threats to the world's biodiversity, it is evident that invasive flora has been overlooked at wind farms, with little being done to prevent, measure and control its spread.

In Portugal increasing awareness about the invasive plants has motivated a better address of this problem in the EIA process. Bio3 is monitoring several wind farms in central Portugal and, in cooperation with farms developers, is implementing actions to control the spread of alien plant species.

In Serra da Lousã wind farm, located at a Natura 2000 Site, the presence of aliens *Acacia dealbata* and *Acacia melanoxylon* is well-known. The monitoring program began in 2006, before the construction of the Wind Farm, and a large number of individuals of both species were identified at that time, including adults and seedlings. After construction we monitored the wind farm area twice (2009 and 2011) and followed the evolution of alien plants cores. This monitoring plan allowed us to realize that *Acacia spp*. were spreading along wind farm roads and wind turbines platforms, with an increasing number of individuals and new invasion cores. Due to the evolution of the situation, a Control and Eradication Plan is going to take place in the wind farm area, which includes the use of herbicides.

In another Portuguese wind farm monitored by Bio3 the initial situation found was very different from the one in Serra da Lousã. In Pampilhosa da Serra wind farm no invasive species were present and only few individuals of *Acacia dealbata* were found in the surrounding area. The potential propagation of alien species was then followed up and, two years after the construction, we identified four new invasion sites with *Acacia delabata* seedlings, inside the wind farm. The early identification of problem allowed the immediate implementation of simple control measures, compared to those used in Serra da Lousã.

Both case studies highlight the importance of performing a proper assessment and monitoring of the invasive plants presence. Only this way it is possible to implement site-specific mitigation/control measures in an early stage, in order to increase their success rates and reduce costs.

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Off-site mitigation and compensation measures for bats at wind farms

The development of wind energy facilities entails the risk of some negative impacts on wildlife. Bats are, among vertebrates, pointed out as one of the most affected group. This is due not only to direct mortality but also disturbance, barrier effect and habitat loss. Mitigation measures for bats have been implemented in several projects but, in some cases, they haven't been sufficient to achieve a no net loss status. In those situations, as a last resource, off-site mitigation and compensation are required.

In our presentation, we reviewed a set of practical measures that have potential to compensate the most affected communities/species by wind farms located in Mediterranean climate.

These measures were classified in two types: "off-site mitigation measures for direct wind farms' impact" and "compensation through the use of mitigation measures for other sources of impact". The first aimed at improvement of the ecological species requirements outside the affected area but inside their territory and the second ones had a social nature.

In the case of direct off-site mitigation, it seems that in the Mediterranean ecosystem, the increase of heterogeneity of habitat at a landscape and biotope scale is of major importance for bats. The main measures identified are mostly related to the maintenance of native forests and management of production forest in order to raise the availability of shelters, improve bats´ hunting micro-habitats, and diversifying monocultures.

Compensation through the use of mitigation measures for other sources of impact is mainly related to the reduction of other anthropogenic threats. This can be achieved by performing environmental education sessions for local communities, local stakeholder engagement, agreements and partnerships with local owners, among others.

Examples of both types of measures will be presented, with a special emphasis on a study about the best management practices in production forests to improve hunting habitat for bats.

This research is part of the R&D project, Wind & Biodiversity, co-financed by project is partially funded by the national program of incentives for the Portuguese businesses and industry (QREN), under the operational program "Mais Centro", and with the support of the European Regional Development Fund.

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Importance of coastal area on bat migration at the western coast of Latvia – implication for localization of wind farms

The NE-SW oriented coasts of the Baltic Sea as well as forelands and islands in Fennoscandia are considered to be intensively used by bats during spring and autumn migration, thus being critical areas concerning installation of wind turbines. It is confirmed also in studies on bat migration in Pape Ornithological Research Station, SW coast of Latvia. The studies were performed in August–September by systematic captures of bats by Helgoland trap (1985–1992, 2009, 2011–2012), observations and counts of bats by means of spot light (1986–1992, 2011) and ultrasound detectors (1993–2012) and acoustic bat activity recordings (2010). 16 bat species have been recorded, of which three long-distance migrating species – Nathusius' bat *Pipistrellus nathusii* (90% of all captures), noctule bat *Nyctalus noctula* (4.1%) and pigmy/pipistrelle bat *Pipistrellus pygmaeus/pipistrellus* (2.4%) – were frequently observed. The migration peak was observed between the second half of August and the first decade of September, although the latest migrants were captured in late October. The highest migration activity of bats was observed on relatively few nights each season and was wind dependent. The most intensive low-altitude migration was observed at eastern and southern winds (up to 6 m/s). During the nights of the most intensive migration at least 5000 Nathusius' bats are crossing the area of Pape Ornithological Research Station. The highest bat activity was observed in about 50 m zone over the dunes and gradually decreased as the distance from the sea increased. However, exceptionally high activity was also observed further inland at the feeding habitat near the lake Pape. Wind farm installation at the sea coast may pose a great threat to migrating bats and therefore must be avoided. Safe distance from the sea and important feeding habitats within the coastal area are to be carefully determined prior the installation and post-construction surveys are to be conducted to analyze the installation impact on bat migration.

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Stress effects of aircraft obstruction markings of wind turbines

Wind turbines (WT) with an overall height above 100 m are increasing in number. Consequently in Germany, the proportion of WT with obligatory aircraft obstruction markings is rising. However, recent residents' complaints hint that obstruction markings might cause acceptance problems. So far, whether obstruction markings cause stress effects or even substantial annoyance remained an open question. Therefore, based on the methodology of environmental and stress psychology the following topics were analysed:

1. comparison of three different types of day markings (xenon-lights, LED, colour-markings of the blades),
2. comparison of synchronised and non-synchronised markings,
3. comparison of day and night markings,
4. comparison of markings in simple (plain, low building density) vs. complex (forest, hills, high building density) landscapes,
5. comparison of markings with and without visibility regulation.

Overall, 420 residents of 13 wind farms with direct sight on WT of one wind farm participated in a questionnaire survey. The questionnaire included over 500 questions concerning stress effects, social acceptance of the local wind farm and renewable energies in general.

In sum, the findings reveal no evidence for substantial annoyance caused by obstruction markings but small stress effects on average. Indeed, in comparison residents were annoyed more strongly by the wind farms' noise and impact on the landscape. However, a differentiated analysis suggests specific stress conditions which infer need for action. First, at certain weather conditions, like cloudless nights, obstruction markings caused strong annoyance. Moreover, xenon-markings clearly caused more intense and multifaceted stress effects than LED or blade colour-markings. Additionally, xenon negatively affected the general acceptance of wind energy: residents of wind farms with xenon-markings reported significantly lower acceptance. Furthermore, synchronized navigation lights were less annoying than non synchronized lights at certain weather conditions.

Overall, visibility regulation proved to be advantageously. Residents without visibility regulation relatively more often used serious stress reduction procedures to cope with the obstruction markings. A further important result is that stress and annoyance during the wind farm planning and construction period augmented perceived annoyance by obstruction markings. Altogether, the interviewed residents voted for minor light intensity, synchronisation, and demand-oriented navigation lights.

To reduce stress caused by aircraft obstruction markings and to increase social acceptance of wind energy we suggest: abandon xenon-markings, synchronise navigation lights, apply visibility regulation, and create less stressful planning and construction periods. In the future, demand-oriented navigation lights should be permitted to foster wind energies' social acceptance.

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Noise stress effects of wind turbines

Despite adhered maximal permissible values residents of wind farms complain about noise of wind turbines (WT). The aim of our research project was to analyse the noise problems of a wind farm exemplary and to give recommendations for noise reduction. The study design based on the methodology of environmental and stress psychology in combination with noise measurement and audio recordings.

211 residents of a wind farm (nine WT, Enercon E-82, 2 MW and 150 m total height) in Lower Saxony were interviewed using a standardised questionnaire with over 450 items. As stress indicators were used annoyance responses, psychological and somatic symptoms, distraction by noise and coping responses. Additionally, we assessed several personal and wind farm features as moderators of noise annoyance (e. g. noise sensitivity, health indicators, distance between the respondents' residence and the proximate WT, number of WT visible from the residence). Furthermore, the respondents were asked about a typical situation with noise annoyance. We used items to characterize the noise conditions (e. g. kind of noise, time of day, weather conditions, coping responses). After the interview the respondents received short answer sheets with the same items as for the typical situation for applying in the case noise annoyance occurred. The residents were provided with audio equipment to record annoying noise. The recordings in combination with operating data of the wind farm were analysed by the German Wind Energy Institute (DEWI).

To evaluate the results of the single wind farm we compare the results in central variables with those of an earlier study with 13 wind farms concerning stress effects of aircraft obstruction markings of WT.

Because the presented study is ongoing the results and conclusions are preliminary:

73 (35 %) of the respondents rated WT noise at least as moderate annoying. 20 subjects of this group reported psychological or somatic symptoms which they attribute as noise induced. Frequently specified symptoms were related to reduced performance, fatigue, negative mood, irritation and disturbed sleep. The correlation between WT annoyance and distance to the proximate WT was small ($r = -.28$). Typically, annoying noise occurred by moderate or strong west wind, at the evening or at night. Frequently, the residents felt disturbed by recreation, leisure activities and sleeping.

In conclusion, the results lead to a better understanding of annoying WT noise conditions and their impact on residents.

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No net loss of biodiversity and the development of wind energy: can we have our cake and eat it, too?

Rapid and large scale wind-energy development challenges our ability to anticipate and subsequently verify impacts on biodiversity and ecosystems from wind-power plants and their related infrastructure (e.g. transmission lines) over large areas. In this context, decision-makers require improved tools and methods to guide them in balancing ambitious wind-energy targets and no less ambitious targets for biodiversity conservation.

The headline objective of the EU's Biodiversity Strategy is to halt the loss of biodiversity and the degradation of ecosystem services by 2020, and to restore them as far as feasible. In this context, the European Commission announced an initiative to ensure there is no net loss (NNL) of ecosystems and their services. Determining what this actually entails will be critical to assessing how wind-energy development can or cannot be reconciled with European nature conservation goals.

Building on existing policies across Europe, we discuss what NNL of ecosystems and their services could mean, and how it might apply to wind-energy planning and project design. We specifically investigate two overarching challenges regarding wind energy and the environment:
The first is to identify w*hich levels of wind-energy generation can be reached without going beyond social or ecological tipping points with respect to ecosystems and their services*. With this in mind, we consider framing NNL as the long term capacity of ecosystems to deliver services, and we discuss our ability

to identify thresholds in the underlying ecological processes, and to anticipate likely impacts through spatially-explicit projections of alternative wind-energy scenarios.

Given that in some areas wind energy goals will most likely exceed these thresholds, the second challenge is *identifying mitigation options for making wind-energy targets socially and ecologically acceptable, and at what cost.* These include targeted measures for avoidance, reduction and offsetting or compensating of impacts which are at the heart of many existing NNL policies in Europe. We investigate the scientific and governance hurdles raised by the design and implementation of innovative policy and planning tools that could emerge from the EU's NNL initiative.

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The Dilemma of the Planner – How to handle birds and bats in the planning process of wind farms – examples, problems and solutions from Germany

European and national nature conservation legislation demand a thorough consideration of birds and bats in the course of finding, planning and realization of sites for wind energy turbines. Broad experiences show that there are still lots of obstacles in the different planning levels in adequately dealing with these protected species, which lead to many struggles and court cases. Examples from Germany illustrate some of the problems which can be encountered in the current planning procedures.

The key approach which might prove as a solution for these problems is the concept of the SSS-specificity (site-species-season). It focuses on the one hand on the actual impact of wind turbines on certain bird and bat species and asks on the other hand for the necessity and availability of the relevant data at the respective planning level. Examples demonstrate how the growing scientific knowledge contributes to the applicability of this internationally already known concept.

The presentation looks at three different planning levels:

1. The regional level: What kind of data normally exist on this level – without being able to do comprehensive bird and bat surveys – and what are the consequences for the challenge of identifying either positive or negative areas for the development of wind energy?
2. The community level: What kind of data have to be gathered in order to choose the most suitable areas for wind energy and to fulfil the demands of the European legislation for the protection of birds and bats? What are the consequences for the methodological concept of the respective surveys?
3. The individual project level: Depending on the survey efforts on the superior planning levels – what still has to be done with regard to pre- and post-monitoring when it comes to the final decision of approval for the erection of individual turbines?

The approach of the SSS-specificity enables the planner to identify the requirements for data and survey effort with respect to the different planning levels in the individual planning case. The result is a target-oriented and effective focussing on the actual necessities for birds and bats data as well as the respective methodologies and efforts. Practical examples from Germany illustrate benefits and problems of this approach.

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DTBird® a tool for bird monitoring and bird mortality reduction in wind farms

DTBird® is a seft-working bird detection system with the capacity to perform real time actions to avoid bird collisions with wind turbines, like stopping a wind turbine or emission of warning and dissuasion signals.

DTBird® is based on artificial vision, technique used in military applications. In a standard configuration 4 sensors analyze and record all the movements of bird in collision risk areas around individual wind turbines.

DTBird® has 4 modules available; each one has a specific function:

- DTBird® *Detection*, continuously monitors surveillance area and detects flying birds in real time.
- DTBird® *Dissuasion* emits warning/dissuasion signals to birds flying in collision risk areas.
- DTBird® *Stop control*, sends a stop control signal to the wind turbine according to collision risk of birds.
- DTBird® *Collision control*, detects and records potential collisions of medium to big size birds with the wind turbines.

Videos, environmental data and DTBird® actions of every bird flight in collision risk areas can be checked in DTBird® *Data Analysis Platform*, daily automatically updated.

The Platform also provide Automatic Service reports, summarizing Service profile, Bird flights, DTBird® actions, and Collisions detected in selected periods.

The access to the Platform is done through www.dtbird.com, with 2 access right levels: Administrator (total access, data editing, export data and videos, and allows to request automatic reports) and Reader (without data editing).

DTBird® is a flexible system, with different features depending on the setup:

- Detection of birds in real time from a few meters up to more than 1 km.
- Emission of warning/dissuasion signals adjustable to environmental conditions.
- Wind turbine stop adjustable to objective birds, reducing the loss of wind energy production.

First installation of DTBird® in a wind turbine was set up in March 2009 in Spain, and currently is operating also in Italy and Norway, in onshore and offshore projects.

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The cumulative impact of wind farms on bats: a regional landscape approach

Wind farms are steadily growing across the whole European territory, with potentially serious detrimental effects on wildlife. Besides considering their local effects on sensitive wildlife, impact assessment should look the so far neglected cumulative impacts. We developed a regional scale analysis in the Molise Region, an area of central Italy that is currently undergoing a large-scale development of wind farms. We implemented Species Distribution Models (SDM) based on foraging habitats for two bats especially exposed to wind farms impact, *Nyctalus leisleri* and *Pipistrellus pipistrellus*.We i) developed sensitivity maps by overlaying SDM maps for the two species with turbines location; ii) assessed the fragmentation and loss of foraging habitat determined by wind turbines at regional scale; and iii) identified highly vulnerable areas where wind farm construction would be especially harmful to bats. SDMs were statistically robust (AUC = 0.80 for *P. pipistrellus* and 0.83 for *N. leisleri*), and revealed that 41% of the region is suitable for foraging for both species. Over 50% of existing and planned wind farms fell in these areas. Foraging habitat loss at regional scale for both species accounted for ca. 1% of suitable habitat deriving from both existing and planned wind farms. Loss of habitat is accompanied by an increase of fragmentation evidenced by an increase of number of patches for 8% and a decrease of their mean area for 10%. The western part of the region was the most suitable to both species, and will deserve careful consideration for future wind farm planning to avoid unsustainable impacts on bats.

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Wind power and the transformation Saami indigenous landscapes: consultation practices and impact evaluation in a struggle for ecological democracy.

For most persons concerned with climate change, the wind turbine has become the symbol of clean energy. Although many hoped that that the wind business offered an alternative to more environmentally disruptive forms of energy production, wind power has become government subsidized profitable business that have inherently significant physical, social and cultural impacts and therefore generates environmental conflicts like any land based activity involving resource exploitation that preceded it. The rapid expansion of large scale wind power industries in the north of Sweden has resulted in an inequitable environmental burden on indigenous Saami herding communities, whose livelihood depend on accessing the same areas for herding purposes. In their view the corporations acquire land according colonial methods, through unequal negotiations, where the local communities are not given enough information or options, and are offered poor deals. However, most socio-environmental and cultural impacts of wind power expansion on Saami pastoralist communities remain invisible to wind power companies, state authorities and the public at large as consultation and impact assessment processes continue to exclude Saami voices and thereby undermine Saami indigenous rights.

This presentation will build on ethnografic research focusing on consultation processes between Saami communities and developers with an emphasis on risk assessment and issues of uncertainty. It will be shown that Environmental Impact Assessments have been used as a central tool in decision making, however due to the lack of integrated approaches to environmental, cultural and economic concerns in a single analysis, a tendency to reduce the scope of analysis to broad technical frameworks and general descriptions, instead of clarifying the plurality of specific consequences, and a general lack of implementation guidelines, Saami concerns remain excluded from the evaluations of impacts. As it stands there are no concrete state measures on how to use and manage natural resources in the best interest of the Saami population in Sweden, nor are there guidelines for compensation for damages suffered by reindeer herders. As the integration of decision making is not clear, reindeer herders often become the subject to the authority of several agencies, leaving them with inconsistent regulation, without effective protection and ultimately with unresolved claims. Sustainable development policies continue to conflict with Saami perceptions and knowledge, which is categorically excluded and replaced with rational resource management policies with strong links to the world market, thereby reinforcing social inequalities and ultimately excluding Saami from sharing in the leadership of the environmental movement.

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Still controversial even though main problems have been removed: A case study of Zenibako Wind Power Plant in Japan

In Japan, main reasons for the opposition to the wind power plant are bird strike, landscape destruction, and concerns for health hazards of low frequency wave by wind mill. Zenibako coast in Hokkaido prefecture is an ideal place because the above points are not an issue here; the coast holds little endemic species and lies far enough from residential areas.

However, opposition movement has occurred for other reasons. Some residents, who have the attachment to the place, claimed that there is a scarce coast vegetation. Another group, living at the nearest residential area, claimed the impact of low frequency wave, though they live more than two kilometers away from the site.

The environmental assessment was carried out, in which all the issues above are included. Then, the results of the assessment were evaluated by the third party committee. They concluded that there is little possibility that the wind power plant has negative impact and noted the needs for long term monitoring. Even after this process, the movement did not settle down.

In short, it became difficult to build a consensus only through stakeholder process. In such a case, it would be constructive to consider the citizen participation program involving the general public as valued consultants. Before implementing the program, it is important to know the distribution of opinions of the general public. This study looked at people's attitudes towards the Zenibako case: the importance of relevant values, their estimation of each stakeholder's behaviors, for or against building Zenibako Wind Power Plant, and their willingness to participate in public decision process.

To examine how people think about the Zenibako case, a mail-out survey was sent in February 2012 to 900 random samples of residents living in 4–8 km distance from the site. Among these samples, 430 valid responses were obtained (the response rate of 47.9%).

The results showed that people have little trust in all the stakeholders: the wind plant company, those who oppose, and the local government. Although many people approved for promoting wind power plants in general, they also estimated the value to deliberate every point of issues. Nevertheless, they do not want to be involved in the discussion and decision process even if they have an opportunity to join it. Overall, people are fed up with this controversy per se.

The difficulty of consensus building and the way to achieve consensus will be discussed.

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Do offshore wind farms influence soft bottom communities – results after three year operation of "alpha ventus"

The first German offshore wind farm has been in operation since 2009. Benthic data have been sampled continuously from 2008 (baseline survey) until 2012 (third year of operation) always in spring and autumn. Investigation of the macrofauna communities (in- and epifauna) have been carried out according to the standard for the Investigation of the Impacts of Offshore wind turbines on the Marine Environment (StUK 3) issued by the German Federal Maritime and Hydrographic Agency (BSH).

The results show significant alterations over time and between the OWF and the reference area for the in- and epifauna community.

The results of the study will be used to identify possible weaknesses of underlying methods and moreover they provide a valuable basis for impact assessments of future offshore wind farm projects.

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The effect of wind farm generated sound on fish

Wind farms in operation are known to generate underwater noise. During their lifetime substantial areas will continuously be covered with noise. This becomes extra problematic with the advent of Terra Watt wind farms, which will cover large offshore areas. It cannot be ruled out that these establishments will give rise to harmful effects on the marine environment that will exist for long time. The size of Utgrunden and Lillgrund wind farms can be classified as small and medium, respectively. The experience and knowledge that were gained at these sites have been invaluable for the understanding of the characteristics of wind turbines generated underwater sound and reused in other studies.

The results from Lillgrund and Utgrunden show that the noise spectrum is dominated by two tones found in the frequency intervals 100 to 150 Hz and 400 to 500 Hz, where the frequency increases with increasing wind speed. It was observed that the maximal sound level was generated at low wind speeds, possible due to non-optimal operating mode of the turbine. However, in normal operation the highest sound levels were found as expected at high wind speed. Measurements at Lillgrunden indicated that the noise field could be divided in three regions namely: near to a turbine, the intermediate distance to the park and long distances to the park. Near to the noise from the individual turbine dominates but already in the intermediate region it was observed that the park effect came into play and has accordingly to be accounted for. Hence a park model was developed that was used to establish hearing distance for some fish species as well as for comparison with ship generated noise. In the study of Utgrunden the focus was on the second component of sound that is particle motion. For this purpose a novel instrument was developed to measure particle acceleration. The results showed that the particle acceleration were lower than the hearing thresholds at a distance of 10 m from the foundation of the wind turbine. The talk will focus on the two studies but will also give examples of investigations that were realized as the results of the Vindval's investments in underwater acoustics.

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Using pellet-group counts and position data from GPS-collars to illustrate changes in reindeer habitat use in relation to wind power development

In the track of ever-expanding new infrastructure, such as wind power, roads and power lines, it becomes increasingly important to map and understand how free-ranging animals and wildlife respond. In Malå community in northern Sweden two mountains have been built with wind power parks containing 8 and 10 power plants, respectively (Storliden and Jokkmokksliden). Semi-domesticated reindeer use the area during calving and summer. Reindeer use and behavioral responses to existing and new infrastructure were determined using reindeer pellet-group counts during four consecutive years and using data from 9–16 GPS-collars fitted on female reindeer during three consecutive years including pre- and post-development. To illustrate the reindeer activity we have further analyzed reindeer step length in relation to the same parameters as above together with several weather parameters. Preliminary results suggest an obvious avoidance of the new roads and the power line constructions, leading to the wind power park. Reindeer furthermore increased speed and activity in proximity to the roads and the park. While windmills are often placed at higher altitudes, the developing associated infrastructure including power lines and access roads in valleys and low-lying terrain may impact migrations routes and connectivity of forest patches used for grazing in an already fragmented landscape.

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Key issues facing the development of large-scale wind: Results from the TCU-Oxford-Nextera Wind Research Initiative

Wind energy is one of the fastest growing sources of power generation in the world. In the U.S., wind has grown 25%–50% per year between 2005 and 2010 and now supplies approximately 2.5% of annual U.S. electricity consumption. However, the dramatic growth in wind power development has raised a number of challenges for the industry. These include concerns over potential impacts to wildlife, particularly birds and bats, visual and noise impacts on communities, issues relating to siting, and the ability to more clearly identify the system-wide environmental and emissions impacts from wind energy. This paper presents major findings from the first four years of work on the TCU-Oxford-Nextera Wind Initiative, a multi-year, multi-institutional research collaboration between several universities. Several key questions have emerged from the research, including:

1. Can wind power coexist with thriving bird and bat populations? Specifically, can we predict when and where high fatality bird and bat events will occur and what can we do to mitigate against them?
2. What are the relative roles of various environmental impacts from wind turbines on public attitudes?
3. What natural and social conditions influence public attitudes and what role (if any) does proximity have in influencing public attitudes?
4. What are the life-cycle emissions from clean generation technologies such as wind relative to other generation technologies?

We address these questions in the two most important states for wind development in the U.S., Texas and Iowa. The overall goal of this initiative, and this paper, is to better understand the ecological impacts of, and public reactions to, large-scale wind developments as a step toward more widespread use of renewable energy resources.

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Predicting Collision Hazard Zones to guide Repowering of the Altamont Pass Wind Resource Area

The 580-MW Altamont Pass Wind Resource Area (APWRA) caused the deaths of 1,100–2,200 raptors per year over the past 30 years, including the annual deaths of 38–72 golden eagles (*Aquila chrysaetos*), 196–311 red-tailed hawks (*Buteo jamaicensis*), 316–635 American kestrels (*Falco sparverius*), and 467–960 burrowing owls (*Athene cunicularia*). Repowering the APWRA could reduce these fatality rates while also doubling energy generation by replacing the thousands of old, small wind turbines with many fewer modern wind turbines. In one recent repowering project, each new turbine replaced 23 old turbines, resulting in a shift in the height domain of the rotor planes and much more open airspace between the turbines. Repowering brings the opportunity to carefully site the turbines to minimize collision risk to bird species of greatest concern. We used geo-referenced bird observations collected over 2 years at 15 stations, and over 6 years at another 77 stations to develop fuzzy logic models of suspected hazardous flight behaviors performed by golden eagles, red-tailed hawks and American kestrels. Some hazardous flight behaviors included hovering, kiting and contour-flying, but these needed to be related to the landscape and to where on the landscape wind companies might install wind turbines. Using GIS, we related raptor flights to wind conditions and to slope measurements that we derived from a digital elevation model of the APWRA. Significant associations contributed to fuzzy logic models that predict collision hazard levels, which we then translated into map-form. Our collision hazard maps are being used to guide turbine siting in repowering. As planning proceeds, we are testing our models in two repowered projects so that we can improve the models in advance of repowering the rest of the APWRA. Three years of monitoring at a 38-MW repowering project revealed fatality reductions of >50%, and another 80-MW project is undergoing fatality monitoring.

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Exploring the potential for cumulative effects on marine mammals from pile driving during offshore wind farm construction

As part of ambitious renewable energy targets, the UK aims to develop marine renewable energy resources; as part of this, a number of relatively large offshore windfarm developments have been proposed within or around the 12 nm territorial waters limit. Concerns have been raised over potential impacts of underwater noise during construction (pile driving) on marine mammals, and in some areas multiple, simultaneous developments are planned, leading to the potential for cumulative effects. We computed sound propagation loss models for a pulsed sound source (pile driving), and coupled this with spatially explicit animal density surfaces, to assess sound exposure for a range of marine mammal species under different spatial and temporal configurations of development using the SAFESIMM software. SAFESIMM provides a risk assessment of the proportion of animals likely to experience auditory injury based on published recommendations of injury thresholds (Southall et al., 2007). The scenario was representative of a development at 12 nm from the coast with a number of marine mammal species in the area and used empirical information for sound source and animal density. Three models of behavioural responses to sound were considered when predicting levels of cumulative exposure to noise; no response (a random walk model), movement towards and movement away (biased random walk models). Even under the simplest scenario of one source producing sound, results showed individuals were predicted to experience sound exposure levels higher than auditory injury thresholds. Differences in accumulated sound exposure levels (SELs) between the behavioural response models was evident; furthermore, proximity to the coast by individuals had an impact on their levels of exposure due to the fact that animals could become effectively "trapped" by the coast when moving away from the sound. Results from multiple sound sources highlight the importance of considering the cumulative exposure from multiple developments over longer time periods, and differences depending on the response movement model highlight the importance of understanding behavioural responses by animals to pile driving. The interactions between predicted effects, the location of piling and the predicted density of animals highlighted the importance of incorporating spatially explicit models of animal density in predictions. The total magnitude of impacts under cumulative piling scenarios varied significantly depending on the spatial and temporal patterns of simultaneous and concurrent piling events, suggesting that simulations can be carried out to determine the optimal balance to minimise overall impact.

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Impact on fish abundance and distributions patterns from Horn Rev I Offshore wind farm in the North Sea

Deployment of offshore wind farms (OWF) is rapidly expanding these years. A Before-After-Control-Impact (BACI) approach was used to study the impact of one of the world's largest off shore wind farms (Horns Rev Offshore Wind Farm) on fish assemblages and species diversity. Fish were generally more abundant in the Control than the Impact area before the establishment of the OWF. Eight years later fish abundance was similar in both the Impact and Control area but the abundance of one of the most frequently occurring species, whiting, was much lower as compared to 2001. However, the changes in whiting reflected the general trend of the whiting population in the North Sea. The introduction of hard bottom resulted in higher species diversity close to each turbine with a clear spatial (horizontal) distribution. New reef fishes such as goldsinny wrasse, *Ctenolabrus rupestris*, viviparous eelpout, *Zoarces viviparous*, and lumpsucker, *Cyclopterus lumpus*, established themselves on the introduced reef area.

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Foraging activity of bats around artificial light source and possible usage for conservation

The wind power still raises issues for conservation biologists and therefore it is important to search for means of minimizing its impact on aerial fauna. Using the fact that insectivorous bats tend to aggregate around different light sources for foraging, we want to find out if there is a possibility of drawing the bats away from wind turbines by setting up additional lighting infrastructure. We are monitoring activity of bats on fields near Jadwisin, SW Poland, where we had observed strong foraging activity of bats around a searchlight, mounted on the top of a silo at the small concrete factory site. In the course of the project, an additional tower has been erected on the field, 900 meters from the existing light source. We have changed the lighting pattern by placing the light source on the tower, while turning off the previous one. The ultrasonic detectors are set at both sites and also in the field with no illumination. We analyze the recordings and distinguished between fly passing and foraging events. Although it is an ongoing project, the preliminary results show increasing activity around the new source of light and decreasing activity around the factory with the advance of the season. We did not take temperature factor into account in the beginning, and that could be the case why activity at factory site is still considerable. More long-term studies are needed to investigate the subject. The conclusions indicate a possibility of controlling bat activity around wind power plants with use of light, which could have implications for conservation biology.

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Wind power in open landscape, forest, mountain and sea – an interdisciplinary study

In Sweden, a major expansion of wind power is taking place, supported by national targets for renewable energy. For developers and local authorities it is a challenge to identify sites suitable for wind power, not least by avoiding potential conflicts of interests. The overall hypothesis of this project is that the *response* of people to a proposed wind power project may be explained by various local conditions – *physical environment*, *social environment*, *activities* and *individual conditions*. To reflect different physical environments, four different types of landscapes – open landscape, forest, mountain and sea – are studied.

The project is interdisciplinary, including sociology, environmental psychology and economics, with three empirical studies approaching the hypothesis with varying degrees of abstraction and different methods of data collection. The *sociological* part is a qualitative study focused on the perceptions and arguments of the local population. This includes their reasoning about wind power as a threat to local qualities or as a contribution to the local economy and society, their reasons for opposition or support and their general concerns. Using in-depth interviews with local stakeholders, developers, local politicians and professional planners a nuanced understanding of the local response and context is provided. In the *environmental psychological* part the objective is to obtain a better understanding of how factors identified in the sociological part of the study, jointly contribute to the individual's feelings towards (e.g. core affect) and response to (e.g. actively object, passively object, passively support or actively support) a proposed wind power projects in the local environment. Using a postal questionnaire distributed to persons living within 30 kilometres of the planned wind power projects the actual response of the locals is captured. Structural Equation Modeling (SEM) is employed to identify the relations between environmental, social and individ-

ual factors behind the individual's response. In the *economics* part focus is on the public's response to a choice between hypothetical wind power projects. The projects are characterised by a number of important and relevant attributes chosen to reflect local conditions. They include type of landscape, ownership, participation in the planning process, transfer of revenues to the local society in a pre-specified way, and monetary costs in terms of the electricity certificate fee. Data is collected through a web panel survey and analysed in a choice experiment framework.

It is found that Swedes in general prefer wind power located offshore, but dislikes wind power in mountainous areas, in comparison with wind power located in forests. The results also suggest that Swedes are rather sceptical to wind power establishments in areas (landscapes) they use for recreational purposes, but this scepticism is not present for areas (landscapes) where they live permanently. The results on a general level also point to the importance of *how* wind power is established; e.g. concerning ownership, participation and local revenues. On the local level, results reveal similarities in local responses in the different environments, indicating that there is not one environment more suitable for wind power than others. The results point to the importance of considering the different conditions (physical environment, social environment, activities and individual conditions) in each local context in order to improve understanding of the local response to a proposed wind power project.

For the *physical environment*, the results show the importance of reliable visualizations and noise calculations and, not least, to have a dialogue about the subjective experiences of these. For example, an unbroken horizon or pristine nature may be crucial for a certain experience, and the threat to this that wind power might involve, need to be clarified and discussed.

With regard to the *social environment*, a strong trust and local participation throughout the planning process is needed. It should include anyone who feels concerned by the establishment, to inform continuously about the process (even when nothing is happening) and to engage in a dialogue about the views expressed. Results suggest that Swedes are willing to make monetary trade-offs to ensure that the local population is involved in the planning process. It is also important to be aware of that a wind power project may have implications for the local social interaction, such as neighborly relations and the perception of each other.

For *activities*, the results suggest that it is important to learn about local development potentials and interests, to identify local qualities and to engage in dialogue about the possibility of coordinating the wind power project with other interests. For example, existing activities may be dependent on silence for their existence, which places considerable demands on how wind power may be integrated in the local context.

With regard to *individual conditions*, the results show that it is essential to have proper statements of benefits and costs associated with a wind power project, environmentally and economically. People's experience of wind power,

the expected impact on the local community and ownership of the turbines are important for the attitudes towards a planned wind power project.

In order to understand the *response* it is also a question of identifying local people with different attitudes towards a proposed wind power project and work to reach and include them all. It is essential to be aware of people's response being partly emotional.

In conclusion, there is support for the development of wind power, but also uncertainty about how the landscape and local qualities will be affected. To find the right location for the establishment, it is necessary to identify and consider the specific physical and social environment, activities, and individual conditions and to understand the local response this causes. The significance of local participation in the planning process and opening of a comprehensive and inclusive dialogue with all concerned is supported by all three sub studies.

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Best practice ecological analysis methods for UK offshore wind farms: Robin Rigg, Solway, Scotland and the integrated approach of Marine Environmental Monitoring Programs (MEMP)

Robin Rigg in the Solway was Scotland's first commercial scale offshore wind farm development, operational from April 2010. This presentation will provide specific details of the long-term ecological monitoring, analysis (circa 10 years) and key results for the renewable industry from the Marine Environment Monitoring Program (MEMP).

In particular, this presentation will discuss the implementation of the MEMP and the key ecological monitoring results from a comparative analysis of the baseline-construction and post-construction monitoring. Density surface modelling approaches with leading statistical techniques have been utilised to enable comparative analysis between the phases of development for a range of ecological taxa (benthic communities, birds, marine mammals and fish).

Specific discussion around the consideration of potential impacts of the construction phase from the monitoring results to a range of key species (e.g. benthic communities, guillemot *Uria aalge*, razorbill *Alca torda*, gannet *Morus bassanus*, red-throated diver *Gavia stellata*, cormorant *Phalacrocorax carbo* and harbour porpoise *Phocoena phocoena*) are considered. The first 2 years of operational monitoring will also be considered in relation to any further changes or return to pre-construction conditions.

This integrated and comprehensive approach is the most holistic in the UK to assess the potential ecological impacts. The results from this approach to monitoring and analysis provides considerable improvements in certainty around potential impacts, this ultimately allows the potential impacts to be understood in greater detail.

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A Critical Review of the Effects of Tall Structures on Birds

As technology and energy development increases, undeveloped land and land traditionally used for agriculture now host structures not part of the historical landscape. These structures (e.g., communication towers, transmission lines) are taller than many objects in natural landscapes. Concerns have been raised regarding the effects of tall structures on birds, primarily functional habitat loss due to avoidance. Two hypotheses have been advanced to explain observed patters of birds near tall structures and include increased perceived predation risk – birds avoid tall structures because they could provide a perch for raptors – and neophobia – birds avoid tall structures because they are unfamiliar. We examined the literature and used a vote-counting methodology to determine how tall structures affect birds and if the fact that the structure was tall could be isolated from other aspects of development. We examined the author's conclusions to determine if they proposed a causal mechanism for the observed pattern and if the data supported the proposed causal mechanism. Generally, a structure's "tallness" could not be isolated from other factors associated with development such as human disturbance. We did not detect any consistent response to tall structures, nor did we find evidence to support the hypothesis that birds avoid tall structures because of a perceived predation risk or the novelty of the structure. The study of bird responses to tall structures to date has focused on identifying patterns, and in general causal mechanisms have not been tested. Understanding causal mechanisms is important for management and conservation because observed effects might not be related to the tallness of the structure but to other factors that could be managed such as timing of construction. Our results suggest that the effect of tall structures on birds is not well understood, and focused studies that examine before-and-after effects and specific causal mechanisms are needed to support effective project siting and conservation planning.

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Safety in Ignorance: the Wind Industry, Bats and the EU Habitats Directive

One of the most intriguing environmental issues associated with wind power is the extent to which it impacts on bats. Although we now have reasonable confidence that this is an issue that can be managed effectively and a good general idea of the best approaches to mitigation, we still do not understand it well enough to be sure how best to address it at the individual site level. Nevertheless it seems increasingly clear that restricting turbine operations at night (under certain weather conditions at those times of year when bats are attracted to turbines) is more effective than relying on turbine placement alone.

However, in the UK at least there has been considerable reluctance on the part of the wind industry to acknowledge the need for this type of mitigation – or indeed to accept that there is a bat issue needing mitigation at all. This is rooted in a fear of how Article 12 of the EU Habitats Directive, which requires member states to apply strict protection measures to, amongst others, all species of bats, is being (or might be) interpreted by the courts. The fear is that rather than wind turbine collisions being regarded as 'incidental' deaths to be monitored to ensure that they do not have an adverse impact on bat populations, they will be regarded as illegal 'deliberate' killings – because in the light of publicly available information they are to be anticipated as an inevitable consequence of operating wind turbines. In the latter case the concern, despite government reassurances to the contrary, is that if a wind turbine is shown to have killed a single bat the operator could be prosecuted and / or forced to suspend all operations at night.

Thus, despite agreement in principle in 2007 between the UK government and the UK wind industry on the need for a co-operative monitoring study of operational wind farms to establish the scale of the bat issue in the UK, it has taken until 2011 for fieldwork to start, and it is proving very difficult to get sufficient wind farms to monitor. In practice, many individual operators are drawing the conclusion that their interests are best served by evading the issue rather than by supporting its investigation.

Therefore, in the UK at least, EU legislation intended to protect species is actually impeding progress in understanding and mitigating the impact of the wind industry. It is important to understand if this problem is unique to the UK, to bats and to the wind industry, or if it is having similarly unhelpful effects in other countries, on other species and in relation to other industries. Is the emphasis in the Habitats Directive on the strict protection of individuals of protected species actually a serious impediment to the effective conservation of their populations? And if so, do we need to refine or reform the law to rebalance animal welfare and biodiversity conservation?

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Mitigating the potential negative effects of tall wind turbines on bats: vertical activity profiles and relationships to wind speed

Wind turbines represent a novel source of hazard for bats, especially through collision with rotor blades. Tall turbines have their rotor at high elevation (≥ 50 m above ground) but there is hardly any quantitative data about which bat species forage and commute at that altitude. We therefore investigated the vertical activity profiles of the bat community occurring at a site where a wind farm equipped with tall turbines is planned in the Upper Rhone valley in SW Switzerland (Valais). A specific focus was on mouse-eared bats (*Myotis myotis* and *M. blythii*) and European free-tailed bats (*Tadarida teniotis*), three rare species occurring locally that might be impacted by this new infrastructure. We also studied the relationships between bat activity and wind speed.

In July – October 2011 and May – June 2012 bat activity was monitored with automatic ultrasonic and upper sonic recorders (Batloggers®). In order to measure bat activity profiles, the devices were installed during several nights at different elevations up to 70 m above the ground, along cables spanning vertically from the top of a crane-truck to the ground. To identify potentially critical turbine locations within the planned wind farm, the devices also recorded bat community structure and activity at 6 different foreseen sites. Bat call sequences were analysed with Batscope®, in an attempt to attribute each sequence to a given bat species or species aggregation.

Vertical activity analysis showed that most bat species are little active at higher elevations (> 50m). The species more often recorded were *P. pipistrellus* and *H. savii*. Mouse-eared bats (*M. myotis* and *M. blythii*) were rarely recorded, being mostly active at low level: they seem to be out of risk of collision with the rotor blades. *Tadarida teniotis* shows a more evenly distributed vertical activity profile, being often active at rotor level, which puts it at risk. Bat activity generally declines with increasing wind speed: most bat activity occurred below a wind speed of 3.5 m/s, a threshold we suggest as a reference basis to fix the cut-in speed for operating turbines. These recommendations are likely to decrease the potential negative impacts of such tall wind farms on the local bat community.

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Prediction of the future fatalities: Bats and wind energy in Ukraine

The rapidly growing wind energy in Ukraine could be fatal for eastern European bat populations. The south of Ukraine and the steppe (prairie) part of Crimea are territories with active development of wind energy. At the same time the annual bat migration from the breeding zones (in the North – the woodlands of Ukraine, Russia and Belarus) to the hibernation places (in the South – Mountain of Crimea, Caucasus and Balkans) occurs across these regions. There is no concrete data collected for migration, but it is known that thousands (even one million) of bats of 7 species move through this area.

We conducted an investigation which was targeted to estimate the impact of the wind energy turbines on migration bats in the open steppe area of the southern Ukraine in 2010–2011. It was the first pilot project in this research area in Ukraine. We ascertained that the socioeconomic situation doesn't stimulate the wind energy business in our country. There are four basic problems: 1) non-competitive conditions in power market; 2) lack of free land market; 3) problems with "green tariff" (feed-in tariff) in the past (before 2011); 3) electricity glut. The last point means that Ukraine generates electricity for internal needs and export by the hydro and atomic power stations. In the nearest future the situation will change. 2011 was the critical year, when the wind energy started to develop again after 7 years of intermission.

We estimated the current impact of wind energy on bats in Ukraine as minimal (up to ten bats per year). Only one Novoazovskaya wind station (21,975 MW) works at present. The main danger in the future will be the development of wind energy on a big scale. New wind stations are going to be built in an area that we recognize as a potential high-way for bat migration between steppe area and Crimea Mountains.

The main problem of bat conservation in Ukraine is a low level of technical and financial equipment of local zoologists.

Thus the main future steps in bat conservation on the territory of Ukraine will be fundamental investigations of migration activity and migration routes of bats. The territories of the steppe part of Ukraine need special attention of bat-specialists and at least long-term monitoring.

Ukraine is a developing country and the traditional decision of such questions as wildlife conservation and investment processes which are based on the conflict of interests hasn't been formed yet.

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The catchment area of German wind power facilities: A plea for international regulations

Wind turbines are increasingly established throughout Europe and North America with often fatal consequences for wildlife, most importantly bats and birds. Yet, it is often unknown over what geographical distances wind farms are affecting animal populations. Based on stable hydrogen isotopes in fur and by developing an isoscape origin model, we assessed the geographic provenance of bats killed in summer and autumn at German wind power facilities. We found that killed *Pipistrellus nathusii* originated from Estonia or Russia, and *P. pipistrellu*s from more local populations. Noctule bats (*Nyctalus noctula*) and Leisler's bats (*N. leisleri*) were of Scandinavian or Northeastern origin. Our isotopic geo-location reveals that wind power facilities kill bats not only of sedentary local populations but also of distant populations, thus having potentially a negative impact beyond political borders; an observation that calls for international regulations for implementing mitigation measures to prevent large-scale detrimental effects on endangered bat populations.

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Effects of wind farms on breeding and migratory populations of Short-toed Eagle

The Strait of Gibraltar is considered one of the most important points in the world for migrating birds. It is a connection point between Europe and Africa for Western Europe migratory birds. In the case of Short-toed Eagle, Baltic, Italian, French and Iberian populations are forced to use the Strait on their annual migratory movements, and these migratory birds, together with dispersal eagles and floaters, bind to local breeding birds in our area, making up an interesting study case in which it is difficult to specify the effect of wind farms on local population. The aim of this study is to determine to what extent wind farms affect a migratory raptor that is also common during the breeding season in the strait of Gibraltar. We analyse: 1) mortality data recorded in the wind farms from 2009 to 2012, 2) information concerning the dates at which young eagles initiate the period of independence, as well as the movements of immatures marked with GPS-PTT transmitters fitted when nestlings since 2009, 3) phenology of both autumn and spring migration of the species provided by Programa Migres (a monitoring program launched by Consejería de Medio Ambiente of Junta de Andalucia, and carried out by Migres Foundation, whose goal is a long-term scientific monitoring of migratory birds in the Strait of Gibraltar).

During the study period 21 short-toed eagles collided, 56.25% of the aged birds were adults, 37.5% juveniles, and the remaining 6.25% were immature. The temporal analysis shows how the collisions are concentrated mainly during the migratory periods, especially during the post-nuptial migration. This demonstrates that the effects of wind farms enclose consequences at long distances from where the collisions occur. Adults are distributed regularly throughout the migratory and breading seasons, between March and September; juveniles collide during September and October, when they leave the breeding territories and cross the Straits towards the wintering quarters in Africa, and immatures collide during the breeding season, when they visit the area and spend time on breeding territories. According to the collected information and life-history of the species at the Straits, we made a population viability analysis to estimate the risk for local eagles, and also the effect on migratory birds.

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Long term monitoring results of wintering Red-breasted Geese in the AES Geo Energy "Saint Nikola Wind Farm" and the Kaliakra region, NE Bulgaria

The hinterland of the western Black Sea coast, including Bulgaria, is the main wintering ground of Red-breasted Goose (*Branta ruficollis*) (RBG). Previous surveys have established that the area occupied by the Saint Nikola Wind Farm (SNWF), located approximately 40 km south of the main roosting area, can be used by feeding RBG and this could therefore create a potential risk of mortality through collision with turbine blades or a loss of agricultural feeding habitat through displacement. Study methods were similar in four winter seasons (2008 – 2012): the first season was before construction, the third and fourth were during operation. The wintering period of the geese is from mid- December to February. Greater White-fronted Goose (GWFG) was the most common species recorded, and the percentage occurrence of RBG varied between 0 % and 40 % within each winter. The duration of the winter stay was similar for both RBG and GWFG. However, there was a definite 'peak' period of activity with a concentration of over 90% of RBG being seen within 20 days; this concentration corresponded to the coldest period of each winter. The flight altitudes of geese observed crossing the area were most intensive between 50 and 100 m above ground level. Diurnal flight activity was most intensive in two periods: morning (7–9 h) and, to a lesser extent, evening (16–18 h). The main concentrations of geese in the vicinity of SNWF over the four winters have not changed as a result of the construction and operation of SNWF. There is no evidence for a disturbance effect due to SNWF displacing feeding geese. Monitoring of collision victims did not reveal any mortality of GWFG or RBG in SNWF. The results strongly suggest that previous collision risk models based on precautionary measures are overly pessimistic and that the ability of geese to avoid collision with turbines is very close to 100 %. Evidence suggests that increasing hunting pressure around important freshwater roosting sites to the north of SNWF will probably have an adverse effect far greater than SNWF.

Poster presentation abstracts

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Bat activity at different wind facilities in northwest Germany

We monitored bat activity in five different wind facilities (Cappel, Belum, Timmeler Kampen, LK Aurich and Varel) in northwest Germany. The wind facilities are situated in the same geographical region but differ with respect to distance to the coast line. Belum and LK Aurich were investigated from April to October, Cappel, Timmeler Kampen and Wulfendiek from mid-July to October.

In most of the projects we recorded bat activity with Anabats SD1 and SD2 (Tiltey Electronics, Australia), with the exception of Friesland where an Avisoft-System (Avisoft Bioacoustics, Germany) was installed. We measured bat activity at nacelle height and at LK Aurich and Timmeler Kampen also at ground level.

Our aim is to set the bat activity, species composition and phenology in relation to parameters such as weather conditions and distance to the coast line. Although all sites are situated in the same geographical region, we like to emphasize the differences and show that it is difficult to transfer the results from one wind facility to another.

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Bat fatalities at different wind facilities in northwest Germany

Northwest Germany is characteristically flat and a relatively open and the landscape is dominated by intensive agriculture. It is also known for strong winds, which has led to a high density of wind facilities. In this poster we show results from five wind facilities both at the coast but also more inland (ca. 30 km from the coast line). The wind facilities Belum, Timmeler Kampen, LK Aurich and Friesland were investigated quite recently, starting in 2011 or 2012, whereas the monitoring at Cappel took place in 2008/2009. In all cases we conducted carcass searches with carcass removal trails and search efficiency controls. Bat carcasses were searched every third day. In addition the bat activity was also monitored (see poster 2).

We compare the species composition and occurrence of bat fatalities in relation to the distance to the coast, structure richness and wind turbine height. We discuss whether the monitored activity was correlated with the bat fatalities.

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Modelling bat mortality risk: whole-year monitoring of 20 species on 10 meteorological masts in France

Stopping wind power plants during periods of high bats activity could contribute to limiting bat mortality. We developed predictive models of bat activity using recordings of bat activity collected during 2011 on 10 meteorological masts in contrasting settings (Mediterranean, oceanic and continental climates, forest, heathland and cropland ecosystems, on ridge, slope and flat ground landforms).

Each mast was equipped with an ultrasonic recorder (SM2BAT) plugged to 2 microphones, at heights of 5 and 45m. Bat passes were assigned to two height classes: over and below 25m, considered here as a threshold in terms of mortality risk.

In total, 138 448 bat passes were recorded and identified (95% to species level) and used to model the effects of hour, season, wind, temperature, site and their interactions on mortality risk. This was done for 20 of the 34 French species.

Our analysis showed very variable effects of wind, temperature and season, depending on sites and species. This underlines the need for locally adjusted data to appropriately model bat mortality risk.

Models of bat activity and mortality risks were fed into the CHIROTECH© software which is used to regulate wind turbines through the turbine's supervisory control and data acquisition software (SCADA). This allows the turbines to be remotely stopped and started according to modelled bat activity, whilst at the same time limiting losses of energy production.

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The extended seascape: submarine assessment of offshore wind farms

"Yellow submarines" may not necessarily stimulate consensus among those individuals who perceive them from outside. According to Alexander von Humboldt, landscape is the "total character of an area on Earth". However, so far impact assessments of changes in landscape caused by offshore wind farms have been entirely focussed on those landscape elements that protrude into the airspace. Both the German federal law and the European landscape convention claim the safeguarding of evolved landscapes and their specific characteristics. Yet, there are currently no systematic approaches, nor investigation standards, concerning structural changes of the submarine landscapes with their habitats. Here, for the very first time, we present a conceptual framework for the study of submarine landscape perception, building on established theory originally developed for urban environments – i.e. the "Rostock Modell". We will present first results of a 3D-analysis of submarine landscape structures and their perceptual consequences.

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Local effects of an offshore wind farm on the demersal fish community

The Lillgrund wind farm in Öresund, Sweden, was setup in 2007 as the world's third largest marine wind farm at that time. As part of its biological surveillance program, demersal fish communities were monitored in the wind farm area and two reference areas during four years before establishment and during the first three years of operation. Here, we present the main results of these studies with respect to effects on local fish abundance and fish community composition.

The results indicated no or minor effects of the wind farm on the fish communities. Changes in the abundance of some species were observed over time, as well as changes in community composition. However, similar changes occurred in parallel also in at least one of the reference areas, indicating that fish abundance in the wind farm was mainly driven by the same environmental factors as in surrounding areas, and to a lesser extent by any cumulative effects caused by the wind farm, such as increased habitat heterogeneity, noise and electromagnetic fields.

There were, however, effects on the spatial distribution of fish within the wind farm area. For several species, catches of fish were higher close to the turbines than further away. This aggregation pattern was seen already in the first year of operation, and was stable during all three years of study. The increased abundance of fish close to the turbines was probably related to an increased habitat complexity provided by the scour protection structures.

No general increases of fish in the wind farm area were observed in comparison to the reference areas. One clear result in the first years of the operation was an increased abundance of shore crabs. Shore crabs increased in all areas but with a higher rate in the wind farm area. However, during the third year of study, catches of shore crab were at the same level as during the baseline studies.

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Migrating birds and the effect of an onshore windfarm

Although a few studies have focused on the behaviour of migrating birds close to offshore wind power farms, the effect of large-scale onshore wind power farms on the behaviour of migrating birds is little known. The Hörnefors onshore wind power farm, south of Umeå in Northern Sweden, consists of 11 large wind power turbines and is located within a heavily used migratory route.

To study the behaviour of migrating birds near the wind power farm, counts of migrating birds have been conducted for two years before establishment of the turbines, during establishment and for two years after establishment. The study has also included searching for birds that have died due to collision with the wind power turbines. These searches have been assisted by bird-locating dogs and have been performed during the most important migration periods in spring and autumn.

Counts of migrating birds have mainly been conducted during spring (April–May) and autumn (August–October), but some counts have also been performed during summer and winter. Most of the counts have been performed during days with large numbers of migrating birds. Between 20,000 and 40,000 migrating birds were counted yearly. These numbers probably represent 15–30 % of the total number of migrating birds.

The results clearly indicate avoidance of the wind power farm by migrating birds. Wind power establishment has created a distinct boundary that birds choose to avoid rather than pass through. After the wind power establishment, many birds choose to fly more to the west or more to the east compared to the control surveys. Prior to construction an average of 40% of the registered birds flew through what is now the wind power farm and the area immediately surrounding it. This can be compared with 7% passing through the same area after establishment of the wind power farm. The change in flight paths was especially clear for Whooper swans, geese, corvids, pigeons and doves as well as for waders.

For gulls and birds of prey, a relatively large proportion of the migrating birds have continued to pass through the wind power farm. This applies especially to the Rough-legged buzzard. For these groups, and other birds that pass through the wind power farm in great numbers, the height of flight in relation to the risk zone around the turbine varies between groups.

The number of birds that have collided and been found on the ground is very low.

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Bird and bat fatality estimation: current approaches and new insights

A proper assessment of the impacts of wind farms on birds and bats entails the estimation of the number of fatalities that occur through direct collision with wind turbines or barotrauma (in case of bats). At onshore facilities the fatality estimation is generally based on carcass searches around wind turbines. However, estimators have to be used to adjust this observed mortality, since not all carcasses are detected by searchers or, given the time elapsed between searches, are available for detection. Over the years estimators tend to become more complex and demanding, in terms of field protocols and data analysis. Most of the reviewed estimators adjust the observed mortality by searcher efficiency, carcass removal and searched area. Occasionally other sources of bias are also considered. However different approaches are being adopted in what concerns the determination and inclusion of these correction factors, which will be explored in our presentation. Additionally, the recent developments of the on-line platform *Wildlife Fatality Estimator* will be presented.

This research is part of the R&D project, Wind & Biodiversity, co-financed by project is partially funded by the national program of incentives for the Portuguese businesses and industry (QREN), under the operational program “Mais Centro”, and with the support of the European Regional Development Fund.

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Do bats need to be considered in wind power planning and management in northern Sweden?

Bats have been shown to be vulnerable to wind power exploitation through habitat loss, collision and barotrauma. The last decade wind power has been prioritized as one major renewable energy source resulting in a rapidly increasing number and wider distribution of wind farms, which includes significant areas of northern Sweden. Discussions on to what extent bat fauna in the north of Sweden should be considered in for example environmental impact assessments (EIAs) has been proceeding without reaching any coherent conclusions since studies on bats have been very few. As the number of EIAs including bat studies has increased, the knowledge of the bat fauna of northern Sweden dramatically has improved. EIAs from northern Sweden are now being reviewed and examples of interesting findings are from an area north of Umeå in the county of Västerbotten, where 2011 three new species for the county were added to the three species previously found. These and other findings suggest that several bat species occur further north in Sweden than was known earlier. Hence, it is motivated to investigate potential impacts on bat fauna by wind power exploitation even in this part of Sweden. Further studies are needed to more accurately describe areas and conditions when impact on bats is a relevant issue to consider in wind power planning and management.

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Responses of harbour porpoises to pile driving on a temporal and spatial scale

The expansion of offshore renewables in the German EEZ has raised concerns over potential disturbance to marine mammals, in particular the harbour porpoise (*Phocoena phocoena*). Recent environmental impact assessment studies for offshore wind farms have generally identified noise emission during construction as the most influential disturbance having an impact on harbour porpoise populations. Specifically, high sound levels during pile driving can cause temporal displacement effects and may even inflict serious physical damage to their sensory system. However, our knowledge about the temporal and spatial scale of such disturbances is limited and current results do not reveal a coherent picture. During the construction of the first commercial German offshore wind farm "BARD Offshore 1", we investigated the temporal and spatial scale of behavioural responses of harbour porpoises to pile driving using passive acoustic monitoring devices (C-PODs) deployed in a gradient sampling design. Using porpoise acoustic activity (PAA) as a measure of abundance, we found that porpoises left the immediate vicinity of the wind farm during pile driving as PAA was reduced by almost 100 % up to a distance of 5 km. After pile driving PAA stayed below normal levels for on average 10–25 h, the amplitude of the effect and time period gradually decreasing with increasing distance. A small but still significant negative effect was detectable out to a distance of at least 18 km. Given the rapidly increasing number of wind farm construction sites in the North Sea, this information should be taken into consideration when assessing cumulative effects.

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Electrocution prevention as compensatory scaling: Offsetting white-tailed eagle (WTE) mortality losses at the Smøla wind-power plant, Norway

Environmental Impact Assessment allows for compensation of environmental injuries in the form of resource-based restoration projects. Given that compensation is a desired policy at a given site, this study suggests an interdisciplinary scaling method (Resource Equivalency Analysis, REA) that relies on a non-monetary bird-year (BY) metric to quantify and value the impact on human welfare from ecosystem service loss. The lost value associated with white-tailed eagle (WTE) turbine collisions at the Smøla wind-power plant (debit) are compensated through WTE electrocution prevention measures at nearby power lines (credit), scaled using the same BY metric. 172 actual and projected WTE turbine collisions (2005–2027) lead to a debit of 3,454 discounted BYs, which captures lost life expectancy discounted to present value. Field searches indicate that annual WTE electrocution mortality per pylon at Smøla ranges from .0022 to .0139 (2009–2011). The study finds that retrofitting between 348 and 2,209 pylons at a present value cost of 7.3 to 46.2 million NOK 2011 at 3% (1.2 – 7.8 million USD) may provide equivalent value and thus compensate the public for their welfare losses. Improved electrocution probability models will improve cost effectiveness of retrofitting as a compensatory measure. While REA may provide an approach for scaling a biodiversity offset, it cannot address the inevitable environmental trade-offs required in assessing the social profitability of choosing to compensate at a particular site.

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Reindeer area use before, during and after construction of the Fakken Wind Power Plant in Northern Norway

The Fakken Wind Power Plant (WP), with 18 turbines built on the Fakken peninsula on the south-east corner of the island of Vannøy, is presently Norway's largest WP. This WP was built within the Vannøy Reindeer Herding District's grazing lands, and is expected to be negative for their reindeers' area use on the island of Vannøy. Since 2006, we have been conducting ongoing field studies investigating the interaction between the Fakken WP and the Vannøy reindeers' area use. Field methods include monthly reindeer surveys using direct observations (began in 2006) and GPS-tagging of 14 adult female reindeer (began in 2009). This is a novel study with a considerable amount of "before data"; data gathered before modern infrastructure, such as a WP, has been built in an area, thus documenting the reindeer's use of the area before the potential disturbance factor is present in the reindeers' habitat. Before data provides a vital control for comparison with the ongoing and progressive stages of development, especially during construction and after the WP is operating. The monthly surveys provide a complete over-view of the reindeer area use at a medium (within 10 km) and close (within the WP and up to 2 km away) landscape scale. The GPS data compliments the surveys at these scales, and also contributes a systematic, larger regional scale, encompassing the entire range for the reindeer population on Vannøy. The Vannøy study area is also unique in that the reindeer remain on the island all year, providing a study of reindeer and WP interactions for every season, especially presumed sensitive season such as the calving period and winter. Additional data was gathered for habitat quality, elevation and other human development, such as roads, buildings and power lines. Preliminary results will be provided for comparisons between the time periods "before", "during" construction (September 2010 – July 2012) and the short period of "after data", encompassing when the WP began operating in July of 2012 and also our up-to-date data until the end of 2012.

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Bats and Offshore/Coastal Wind Farms in the North Sea – is there a conflict?

Recent studies and anecdotal evidence suggests that certain species of bat are migratory in the UK. The numbers of bats migrating and migration routes are unknown; the most likely routes would involve a relatively narrow sea crossing across the English Channel to south east England, but there is also anecdotal evidence (inferred from bat records on north sea oil rigs) to suggest a northern route from southern Scandinavia to Scotland or Northern England may also exist. The species for which most evidence exists of migratory behaviour in the UK is Nathusius pipistrelle. This is a species considered to be at risk of collision with on-shore turbines due to its flight behaviour. Given the recent expansion in off-shore and coastal on-shore wind farm development in and around the North Sea and the evidence from elsewhere that bats can be significantly impacted by wind turbines in some situations is there a potential for conflict? Recent feedback from Statutory Nature Conservation Organisations in the UK suggests an increasing awareness that this may be an issue that has to be considered by wind developers. Currently this is not being carried out in any consistent or standardised way. This presentation will review the current state of knowledge on bat migration across the North Sea to the UK and ask whether there is likely to be a significant risk to migratory bat populations, and if so what survey methodologies and what mitigation measures are likely to be appropriate or possible. Suggestions for further areas of research will be made and a call for collaboration between North Sea countries.

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Predicting griffon vulture flight trajectories to avoid mortality in wind farms using simulated wind currents

Wind farms have shown a spectacular growth during the last 15 years. Avian mortality through collision with moving rotor blades is well-known as one of the main adverse impacts of wind farms. In Spain, the griffon vulture shows the highest mortality rates at wind farms. As far as we know, this study is the first attempt to predict flight trajectories in order to foresee potentially dangerous areas for wind farm development. We analyse topography and wind flows in relation to flight paths of griffon vultures, using a scaled model of the wind farm area in an aerodynamic wind tunnel, and test the difference between the observed flight paths of griffon vultures and the predominant wind flows. Different wind currents for each wind direction in the aerodynamic model were observed. Simulations of wind streamlines in a wind tunnel were compared with observed flight paths of griffon vultures. No statistical differences were detected between the observed flight trajectories of griffon vultures and the wind passages observed in our wind tunnel model. Griffon vultures were moved by predominant wind flows in the area (i.e. they followed the routes where less flight effort was needed). We suggest using these kinds of simulations to predict flight paths over complex terrains and introduce certain criteria in the location of wind turbines in order to reduce soaring bird mortality.

Ruth de Silva, Kate Grellier, Sarah Canning, Chris Pendlebury & Nancy McLean

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Marine mammals – survey and monitoring techniques for impact assessment in areas of high marine mammal interest

The Moray Firth and the Firths of Forth and Tay support a number of Annex II (Habitats Directive) marine mammal species including harbour porpoise *Phocoena Phocoena*, bottlenose dolphin *Tursiops truncates*, harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus*. The requirements of the Habitats Regulations Appraisal (HRA) are such that in order to present data to support a robust assessment, a combination of baseline survey methodologies and assessment methods were developed.

The combined survey methods (including boat-based visual, passive acoustic monitoring and aerial surveys) were used to determine a density surface for these Annex II species. The numbers of animals that had the potential to experience the onset of auditory injury, significant disturbance or mild avoidance were calculated. A population level assessment for each species was undertaken in order to determine potential long-term impacts at a population level.

Drawing on experience from offshore wind projects proposed for the east coast of Scotland, we present the survey and monitoring techniques and the assessment framework that was developed to address these key consenting issues.

Steven Degraer, Robin Brabant & Bob Rumes (Eds.)

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Offshore wind farms in the Belgian part of the North Sea: Heading for an understanding of environmental impacts

To allow for a proper evaluation of the environmental impacts of offshore wind farms in the Belgian part of the North Sea, the environmental permit includes a monitoring program. This program targets physical (i.e. hydro-geomorphology and underwater noise), biological (i.e. hard substratum epifauna, hard substratum fish, soft substratum macrobenthos, soft substratum epibenthos and fish, seabirds and marine mammals), as well as socio-economical (i.e. seascape perception and offshore renewables appreciation) aspects of the marine environment.

Our first integrated reports focus on (1) monitoring strategy, (2) spatio-temporal variability and (3) early impact assessment.

(1) The monitoring approach consists of a baseline and a targeted monitoring. The baseline monitoring focuses on the a posteriori, resultant impact quantification and deals with observing rather than understanding impacts. The targeted monitoring upgrades the monitoring to a level of process understanding and focuses on a selected set of hypothesized cause-effect relationships of a priori selected impacts. This allows for linking environmental changes to an underlying cause-effect rationale, which is considered a prerequisite for an effective regulatory management.

(2) The marine environment is not stable, but shows a certain natural dynamic at various temporal scales (i.e. from tidal to multi-year cycles). This natural variability should be taken into account when aiming at the quantification or even detection and evaluation of anthropogenic impacts. A proper knowledge of the natural spatio-temporal dynamics is hence considered necessary for a future quantification of the anticipated impacts and for the evaluation of the significance of these impacts.

(3) While most impacts – both positive and negative – will only become established and detectable when more wind turbines will be installed (i.e. local cumulative effects) and/or after a certain period of time (i.e. time lag), some localized impacts are expressed from the early stages of the wind farm development onwards: (1) the establishment of hard substratum epifauna and fish as a consequence of the introduction of hard substratum, in an originally soft sediment environment (2) the enrichment of the soft sediment fauna, this is being expressed by e.g. the observations of larger fish in the wind farms, (3) underwater noise generated during pile driving drastically disturbs the harbour porpoises, but only for a short period of time, and (4) different species of gulls and terns are attracted to the wind farms, Gannets and Guillemots avoid them.

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The barrier effect impact, an issue for wind energy and wildlife conservation

Wind turbine impacts on wildlife are important issues for wind project acceptance. Different effects are associated with wind energy development:

- collision, when birds are killed
- habitat loss, when birds abandon for breeding or wintering the area because of a wind farm
- barrier effect, when migrating birds modify their flight paths to avoid a wind farm

If the two first impacts are relatively well known for the most part of the time, this is not the case of the barrier effect.

As a consequence of going around obstacles, migrating birds spend more time flying, which increase the amount of energy they need to achieve their migration, which in turn can reduce their survival and reproduction success. In theory, the development of wind farms all along the migration routes may have an impact on migrating bird individually but also for migrating bird populations. However, how much the barrier effect is responsible or not for the decline of migrating birds is unknown but need to be anticipated.

We present analysis on different species witch are representative from northern hemisphere avifauna and from different migration typology. Starting with those biological models we propose barrier effect impact quantification on bird populations and mitigation solutions combining industrials wind exploitation and environmental issues.

Our presentation starts with a transversally synthesis of what is known today in terms of flight energy costs, physiological flight adaptation, and migrating bird ecology. Examples are then used to:

- propose a quantification of the barrier effects and their impacts on bird populations,
- present practical and operational solutions to reduce the impacts of wind farms on migrating birds according the wind industry logical.

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Sensitivity analysis for wind farm collision risk models

Wind farm applications routinely apply avian collision risk modelling (CRM) as part of the Environmental Impact Assessment (EIA). The estimated mortality figures are used to assess the population level impact of wind farm development on a range of bird species. In the UK, use of the Band model for CRM is advocated by statutory agencies including Scottish Natural Heritage (SNH). SNH guidance for vantage point (VP) observations to provide input data for the model requires a minimum of 36 hours' flight input data from each VP, but the effect on model outputs of varying the number of hours' input data has not been tested.

There are also considerable unquantified sources of error associated with the collection and analysis of VP data which may reduce the magnitude of estimated mortality. Firstly, the data are based on point-counts to estimate flight activity within a particular radial sector (often extending over multiple km), and yet distance sampling is not used to correct for declining detectability with distance. Second, the focal-sampling method effectively ignores other individuals flying at the same time as the focal individual, automatically reducing the overall estimate of activity. Third, the estimate of avoidance is largely unquantified, variation in which can lead to a potentially substantial difference in estimated collision risk in the Band model. There remains considerable uncertainty for most species as to the extent of avoidance and limited quantitative information about collision risk and behavioural responses to turbines. Therefore a properly analysed assessment of the likely error associated with these assumptions will be a powerful tool for assessing wind farm EIAs.

Using VP data on flight activity of the white-tailed eagle *Haliaeetus albicilla*, collected at the 68-turbine Smøla wind farm in Norway, we test the following objectives:

1. The effect on the outputs of the CRM of varying the input hours of activity data;
2. Use distance sampling to correct for any likely fall-off in detection with distance;
3. Assess the effect of focal sampling on estimation of activity;
4. Attempt to quantify avoidance.

Testing of Objectives 2–4 is ongoing but results from Objective 1 suggest that variability in collision rate decreases predictably with increasing number of observation hours. However, at the asymptote in variability (about 62 observation hours) there is still considerable variability in predicted collision rate. VP watches are likely to be inherently variable, and collision rate predictions should assess the potential error associated with such results.

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Flight patterns of birds above the North Sea in prospective wind farms far offshore

As part of the wide-ranging Monitoring and Evaluation Program of the first Dutch offshore wind farm (OWEZ), flight patterns of seabirds and migrating land birds were studied from a gas platform (K14) 80 km northwest of the Netherlands. Fluxes (or flight intensities) of flying birds were recorded, differentiated to e.g. flight altitude, season, time of day/night and species (group) between March 2010 and March 2011. This allowed an assessment of the potential effects of new wind farms in this offshore region. It also allowed detailed comparison with results obtained at OWEZ (15 km offshore). We used a 25 kW marine surveillance radar with Merlin bird tracking software (DeTect Inc) to measure flux and flight altitude continuously. With visual observations additional data were collected on species composition and species-specific flight characteristics.

The number of birds recorded at K14 was lower than closer to the coast with a yearly mean number of bird groups of 45 per km per hour. Highest traffic rates were observed in the migration seasons (September and March). Overall, similar proportions of birds flew during daylight and in darkness, but during migration periods numbers during the night increased markedly. During migration, when bird numbers were highest, average flight altitude was higher as well. Thus, these migrant birds (mainly songbirds) generally flew higher than other birds such as (local) seabirds. Over the year, about half of the birds flew in the lowest altitude band (0–70 m) of which the majority during daylight. We quantified fluxes at the risk height of wind turbines, to be able to use these fluxes as baseline material in environmental impact assessments for future offshore wind farms. Combined with data on avoidance behaviour and collision risks, we have the necessary tools to model and thus predict consequences of prospected wind farms.

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Effects of repowering wind turbines on collision risk of raptor species

It is the aim of EU-member states to increase the share of energy by renewable sources. In Germany repowering of onshore wind-farms was defined as the most important measure to achieve this aim. To minimize the environmental impact there is a high need of information about possible effects of modern wind turbines (WTs) with high towers and large rotors on wildlife in general and raptors in particular, because some species are known to be susceptible to collisions with WTs.

In 2010 and 2011 we studied Red Kite (Milvus milvus), Black Kite (Milvus migrans) and Marsh Harrier (Circus aeruginosus) at eight wind-farms in the district of Soest (Germany). At each wind-farm horizontal and vertical distribution of these species were recorded. This data was used to calculate the theoretical number of collision victims per year by a collision-risk-model (Band-Model). We compared collision risks at exemplary wind-farms with two repowered scenarios each. As exemplary wind-farms we used old types of WTs with low hub heights, which were similar to the WTs of the studied wind-farms. For repowered scenarios we used modern WTs with a rotor-diameter of 101 m and hub heights of 99, 135 and 150 m. In the first repowered scenario we doubled, in the second we quadrupled the rated power of the wind-farms.

Collision risk was mainly influenced by hub height and rotor-swept area, which were both increased in repowered scenario. In general, the time Red and Black Kite as well as Marsh Harrier spent flying decreased with altitude. Due to higher altitudes of the rotor-swept area in repowered scenarios collision risk did not increase (but decrease in a number of cases) in comparison to exemplary wind-farms. Within repowered scenarios collision risk declined with increasing hub height when the rotor-swept area remained constant.

At first sight it is obvious that collision risk increases at modern WTs in comparison with old WTs because of the enlarged rotor. However, the lower rotational speed of the rotor, which lowers the probability of being hit when flying through the rotor, and the higher hub height can compensate for the enlarged rotor area.

Our investigation clearly indicates that repowering can lower collision risk of the studied species at certain sites. An increased collision risk can be prevented by high hub heights and / or a reduction of the area swept by rotors.

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Large-scale prediction and assessment of avian collision risk and mortality at wind turbines in northern Germany

Financed by the German Ministry of Environment (BMU), a joint project on the collision risk for birds at wind turbines has been commissioned to three consultancies BioConsult SH (Husum, leadership), IfAÖ (Broderstorf) and ARSU (Oldenburg). The large-scale study addresses the collision rate of birds with intensive and systematic searches for collision victims along defined line-transects. Upon completion of fieldwork in 2014, data from 54 wind farm seasons (time windows of 12 weeks) will form the basis of our analysis. Correction factors for detection probability and carcass removal in relation to varying crop coverage will be deduced from experimental trials. Systematic vantage point observations will provide values of avoidance rates (short range escape movements caused by rotor blades) as input for the BAND-Model (Band et al. 2007). The output of this model will be validated by the actual number of victims. The overall aim of the project is to bring together empirical field data and predictive model values for an advanced iterated cross-validation. Finally, the modeled number of victims will be used in species-specific matrix models to predict the consequences of additional mortality at the population level caused by the current and projected number of wind turbines in northern Germany. The project aims at giving objective and well balanced answers to the relevance of the impact of bird mortality at wind turbines. We will present the results of the first two field seasons, i.e., spring and autumn 2012.

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Are wind turbines in boreal forest in Sweden a threat to bats?

To achieve the EU goal for renewable energy production, more than 4000 turbines will probably be installed in Sweden over the next 15 years, most of them at relatively high altitudes in boreal forest. Data from USA and Germany suggest that wind turbines in such places are sometimes dangerous to bats, but there is no corresponding information from Sweden. In the province of Jämtland in the north-central part of Sweden, the expected increase in the establishment of wind power is particularly significant. There are approximately 100 turbines at present, but there are applications for another 1400 turbines. According to studies elsewhere, this increase might have an impact on the local bat fauna.

To evaluate the potential impact of wind farming on bats in northern Sweden, we initiated a survey in May 2012 at the wind farm Havsnäs with 48 extant wind turbines. Havsnäs is located in production spruce forest at ca. 720 m a. s. l. in northern Jämtland. To measure the bat activity at the turbines over the entire season, four automatic bat detectors (Pettersson D500x) were installed in the nacelle and at the base of two of the turbines, respectively. Insect sticky traps were also installed at the nacelle and at the base of the turbine. We also made inventories of bats along transects in the area around the wind farm. The results obtained so far (august 2012) indicate no bat activity and low insect abundance at the turbines, although bats occurred at lower elevations in the vicinity of the power plant area.

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Migrating Bats at a Wind Farm on the Åland Islands, Finland 2009–2012

On the Åland Islands in the southwestern archipelago of Finland two new wind farms are planned: one on the mainland at 800 meters from the coast line and the other one on a very small island offshore. The environmental authorities require a six-year study of both birds and bats at the proposed wind farm sites. Both wind farm sites have a common reference site – an existing wind farm southwest of the Åland Islands' mainland. It consists of six wind turbines built on four small islands in 2007. The bat studies, including studies of migrating bats, started in 2009 and will finish in 2014.

The aim of the bat studies is to determine if bats, and especially bat migration, occur at the existing wind farm so that the impact on bats (i.e. mortality) can be estimated. The results will help to set recommendations for possible mitigation acts for the two new wind farms.

Migrating bats have been studied with AnaBat bat detectors placed in weatherproof boxes equipped with an external battery. The bat detectors have been out in the field from April until October/November, which is the active period for bats in Finland. Systematical searches for dead bats under the existing wind turbines have not been done during 2009–2011, but will be conducted in the autumn of 2012. Since 2008, while searching for dead birds and during maintenance works of the wind turbines, only one dead *Eptesicus nilssonii* has been found.

During these studies six different bat species have been observed in the area of the wind farm. There are no bat colonies on the islands, although occasionally bats, mainly Eptesicus *nilssonii,* are present in the summer. Some migrating bats, mainly *Pipistrellus nathusii*, were observed in the spring, but the peak time for the observations of migrating bats were in the autumn from late August to early October. The most common migrating bat species is *Pipistrellus nathusii*, the other observed bat species are *Vespertilio murinus*, *Pipistrellus pygmaeus, Nyctalus noctula* and *Myotis sp*.

The results show that migrating bats can successfully fly through the wind farm. The hypothesis is that at this location bats fly at a low altitude, below the rotating wings, or between the turbines. In 2012, intense field studies will be conducted to determine both the height and the direction of the flights of the migrating bats at the wind farm.

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The impacts of wind power on terrestrial mammals – a review

We synthesized available knowledge on the effects of wind power development on terrestrial mammals (excluding bats). Presently, there is a rapid increase in wind farm development in Sweden, and most new wind farms are planned in the boreal forest region. Concerns are hence raised on the impact on forest wildlife and semi-domestic reindeer. Studies of terrestrial mammals in relation to wind power are however few, so the conclusions must to a large extent be extrapolated from research on related impacts, such as noise, disturbance from roads, construction work or recreational activities, and habitat changes. The review give at hand that ungulates and large carnivores may be disturbed by i) human recreation (including hunting and leisure traffic) facilitated in wind farms by the new road network, and ii) construction work (intensive but of short duration). Wind farms are often specifically targeted to hilly or rugged terrain far from human settlements; areas which often serve as refugia for large mammals, in particular large carnivores. Hereby, wind power development may despite a limited geographical extent have population level effects. We point out the importance of assessing the cumulative effects of multiple wind farms, and to establish scientifically sound monitoring programs to improve the knowledge base.

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The impact of Wind Power on Human Interests – a synthesis project

Wind power plants affect human interests in different ways, depending on peoples´ relations to the landscape. Land owners, tourists, permanent living or summer house owners react in different ways. In general, the attitude towards wind power is positive, but the closer the own house, the more negative attitudes. The aims of this project were to summarize, value and analyze research on wind power connected to *health*, e.g. noise, sleep disturbance, illnesses, shadows; to *economy and businesses,* e.g. jobs, tourism, properties, local ownership; to *landscape*, e.g. landscape analysis and planning, landscape perceptions, nature and culture environments, leisure and recreation, and to *acceptance and support*, such as attitudes and participation, planning and consultation, communication and dialogue in wind power processes.

Examples on successful projects on how to increase public participation are also presented. This project addresses authorities, planners and wind power managers, who might need compiled and analyzed research reports in their daily work. The report could also be used by the public. 18 researchers representing the above mentioned research areas are involved as authors of the project. International published research articles, reports from universities, authorities and from organizations etc., were valued and analyzed by the synthesis panel. The result showed small health effects, but some people are worried of noise effects from wind power turbines. Some people also reported sleep disturbance due to noise. Further research on connections between noise and sleep disturbance is recommended by the synthesis panel. Noise from wind power turbines and how wind power blend in into the landscape are the two most discussed issues connected to peoples´ interests. The synthesis panel also recommends a development of the existing method; landscape analysis. Social values, such as peoples´ perceptions and experiences of the landscape could be included in a more obvious way. All values should be included, according to the European Landscape Convention (ELC). People should be involved early in the planning process.

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An effect of high power ultrasound on bat activity – the implication for the protection of bats at wind farms

The mitigation means of bat mortality at wind power facilities are limited because bats are attracted to the wind turbines and intensively explore their vicinity. Therefore effective methods of deterrence or distraction of the animals are required. We developed a transducer which generates ultrasound waves of high intensity. An ultrasound beam was generated by a power sandwich type transducer with stepped flexular vibrating plate. The sound pressure level (SPL re 20 [uPa]) generated by the device was up to 146 [dB]. We tested the device in the field by broadcasting of the ultrasounds in the front of the cave entrance, where bats were active during the swarming period. The response of bats was recorded by using ultrasound detector and infrared video camera. The high intensity ultrasound emission significantly reduced bat activity within 15 [m] of the transducer. The results of this experiment are promising and could be applied in wind farms to prevent exploration of wind turbines by bats. The project will be continued in order to develop the system operating with different frequencies and effective on the big wind power parks.

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Habitat use and ranging behaviour of GPS tracked Golden eagles in northern Sweden

In Sweden, large scale wind energy development may pose a threat to the golden eagle (*Aquila chrysaetos*), a protected species which breeds throughout much of Sweden's northern forests. However, little is known about the habitat use and ranging behaviour of golden eagles in this region, which hinders environmental impact assessment. Twenty-nine adult and fourteen juvenile golden eagles were fitted with solar-powered GPS units in 2010 and 2011, which provide positions up to six times per hour. Dispersal, ranging behaviour and habitat use of juvenile and adult golden eagles will be presented, and used to discuss implications for wind farm establishment.

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Public and local acceptance of transmission lines

In several countries, such as Germany, the grid connection has become a needle hole for the expansion of wind energy. One severe barrier against a grid expansion is the social acceptance problems at the local level. To provide a deeper understanding how transmission lines are perceived in the public as well as at the local level we conducted an online survey using a standardized questionnaire. This questionnaire we constructed based on social psychological acceptance models. Beside the general attitude towards renewable energies and transmission lines we assessed specific positive and negative consequences attributed to transmission lines. Additionally, the participants rated their willingness to object or support transmission lines under certain conditions. Overall, 860 individuals participated in the survey. These participants were categorized in four groups: living close to an overhead transmission line (n = 212), to an underground cable (n = 182), to an overhead as well as an underground cable (n = 136), or not living close to either (n = 330).

Overall, as one might expect, the results show that participants living close to overhead lines evaluated transmissions line more critically compared to others. However, these differences are smaller than expected. Interestingly, visibility increase negative evaluations – participants with view on the transmission evaluated these more critically compared to neighbours without view. Additionally, overhead transmission lines are rejected more strongly compared to underground cables – at the public and local level likewise. However, the participants made a clear distinction between different areas: overhead and transmission lines were accepted to a comparable extend if they were located along existing lines, high ways or commercial areas. Moreover, the source of electricity to be transported by the transmission lines seems to have a crucial impact: if the participants can be sure that the transmission lines are needed to transport renewable energy, acceptance increases.

The results provided recommendations how to foster the acceptance of the grid expansion, such as to provide clear information on the positive and negative impacts, prove their necessity in regard to renewable energies, prefer existing lines and offer planning alternatives of the route.

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Using automatic measurements of bat activity to develop turbine-specific curtailment algorithms – a case study in two wind parks

On average, ten bats per wind turbine and year are killed in Germany, leading to an estimated total of 200000 bat fatalities annually. As all bat species in Germany are protected by European and German law, mitigation measures are necessary to prevent those frequent bat fatalities. For that, up to now curtailments of wind turbines are the only effective method. However, species composition, the total amount of bat activity and thereby the collision risk depend on the specific location of a wind turbine. To ensure the best compromise between bat protection and turbine efficiency it is vital to develop turbine-specific curtailment algorithms. Here, we present examples from our planning practice on how we use automatic activity measurements for the assessment of the collision risk and the development of turbine-specific curtailment algorithms.

To identify correlations of bat activity with wind speed, time of night and month, we installed automatic bat detectors with standardized calibration inside the nacelle of wind turbines in two wind parks in Northeastern and Southwestern Germany. Bat calls in the rotor-swept area were registered from July to October and May to October respectively. We used a statistical model based on a study at 70 wind farms in Germany to estimate the number of bat fatalities during sampling time. Furthermore, we adapted a second model from the same study for the estimation of bat activity from wind speed, time of night and month to the specific turbines. Both models were used to estimate the collision risk from these parameters. From this we calculated cut-off wind speed for combinations of time of night and month for certain tolerable numbers of bat fatalities per turbine.

In both wind parks the correlation of bat activity with wind speed, time of night and month was similar. However, there were big differences in species composition between the two wind parks. Furthermore, the total activity was much higher in the wind park in Northeastern Germany, leading to a higher estimation of bat fatalities. Due to this, much higher cut-off wind speeds were required in the park in Northeastern Germany to achieve the same tolerable number of bat fatalities. These results support the need for turbine-specific curtailment algorithms based on the specific activity pattern. A wide application of this method could ensure the ongoing fast growth of renewable energies while minimizing the impact on bat populations.

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A model based method to estimate bat and bird collision rates at wind energy turbines

Recent studies have shown that bats and birds can collide in large numbers at wind energy turbines. Wind power industry is showing a rapid growth. For an ecologically sustainable management of wind turbines, it is important to be able to estimate collision rate and to identify factors affecting collision rate. We, therefore, developed a hierarchical model that relates predictor variables such as wind speed, rotor diameter, acoustic bat activity or bird breeding density, respectively, to the number of carcasses that have been found during systematic searches. The model takes into account that the probability of finding an animal that has been killed by a turbine is less than one due to carcass removal, low detectability and only partly searchable area. The model allows estimating the number of collisions during the study period more precisely than the commonly used method of "correcting" the number of carcasses found by an estimate of detection probability because the model combines information in the predictor variables with the classically used information (i.e. the number of carcasses found and an estimate for carcass detection probability). Further, the model provides a tool to investigate relationships between potentially important factors such as type of turbine, wind speed, visibility, or types of mitigation actions on collision risk. As a result, it also provides a tool to develop turbine and site specific models that allow predicting collision risk from e.g. wind speed or other variables. Thus, the model itself can serve as a mitigation tool, e.g. when implemented in a stopping decision rule. We present an application of the model for assessing and mitigating bat collisions at wind energy turbines in Germany.

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Research on cost of environmental survey and mitigation measures in offshore wind farms

Research has been carried out on the potential environmental impacts of offshore wind farms. The main causes are well known and mitigation measures are already used to minimise effects on the local environment. Experience has shown that potential environmental impacts are species-, season- and site- specific. This study tries to assess what the costs of environmental surveys and mitigation measures are, and to what extent they influence an offshore wind farm project's costs.

The cost of equipment (e.g. systems to warn off marine mammals, or more silent piling techniques) and the costs connected to the extensive pre-, during and post-, construction surveys and monitoring were considered. The latter processes require vessels, personnel, aircraft and specialised equipment during long periods of time.

EWEA members and its Offshore Working Group Environmental Task Force contributed to the research by responding to interviews and filling in a questionnaire. The questionnaire focussed on environmental parameters critical to offshore wind projects (indicative delay factors: seasonal restriction due to spawning or migration period), and whether the latter were responsible for extra costs or delays. It also attempted to estimate whether environmental mitigation equipment and monitoring adds significant cost to the overall budget.

It is clear from existing literature as from expert surveys that the site-specific environmental conditions, the differences in legislation among countries, and the complexity of equipment result in difficulties in assessing environmental survey and mitigation (ES&M) costs of an offshore wind project. These parameters explain the cost range determined by the study. Developers spend on environmental impact mitigation around 1% of the project's capital expenditure which translates to a range from €3,740,000 to €5,900,000 for a 200 MW reference wind farm. The pre-construction period represents more than half of ES&M-related costs. It is during this period that nesessary surveys to define the impacts on flora and fauna are carried out. Ornithological and marine mammal surveys seem to be the most expensive. Assessing the potential impacts on birds and mammals is often a stochastic and long process

and requires expensive equipment, modelling procedures and specialised personnel which leads to high costs.

More work on understanding marine mammals distribution and behaviour is required in order to optimise construction work and avoid excessive delays and seasonal restrictions.

Joint environmental surveys between two or more offshore wind farms in the same area are also recommended in order to minimise ES&M costs per MW.

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Long term studies on biogenic reefs and implications for offshore developments

The Honeycomb worm, *Sabellaria alveolata* and the edible mussel, *Mytilus edulis,* can both form biogenic reefs. Both species can dramatically increase the biodiversity of an area, as the biogenic reefs they form create a multitude of habitats for other organisms. In addition, *M. edulis* beds are commercially important as a fishery. As such, both species are protected by both national and international legislation and the impact on these needs to be assessed as part of the Environmental Impact Assessments for offshore developments such as wind farms and wave and tidal deployments. However, the reefs formed by both species are subject to large variations in abundance and often form ephemeral beds.

The longevity of these biogenic reef features has been studied over 20 years on the Cumbrian coast (North West England) revealing complex dynamics, with one or other species becoming dominant at different times. Annual surveys carried out between 1993 and 2012 have shown apparently unpredictable, fluctuating patterns of abundance, with *M. edulis* displaying a spiralling decline, and *S. alveolata* slightly increasing in abundance over the study period.

Fluctuating populations of protected species pose problems for regulators and developers alike, due to difficulties in monitoring anthropogenic impacts against a background of constant change. More information is required in order to investigate the impact of climatic influences on these species, especially relating to long term environmental change.

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Socio-environmental changes with the construction of a Wind Farm in Brazil

The aim of this work is to identify factors that help, collaborate or participate to facilitate the acceptance or rejection of a wind farm located in the extremely south of Brazil. Some of the psychosocial assumptions that can contribute to the study of this theme are the concept of place attachment, and others like iniquity perception. This study is ongoing. Data were collected during the construction of the wind farm in the rural town of Cerro Chato. The 45 wind turbines are located in 24 properties of that town. We employed a semi-structured interview. Twenty-five subjects, that live the area, participated in this study. The sample was divided as follows: 1. farmers that will have wind turbines in their properties, 2. farmers that will not have wind turbines, 3. farmers that did not accept to have wind turbines in their properties, and 4. farmer staff that lives in the properties interviewed. The interviews have been recorded and transcribed; data is being analyzed employing content analysis: categories were created from the content of the interviews, and they were based in the literature about wind farms social impacts, as well as, concepts from environmental psychology. Preliminary results show differences in the place attachment between inhabitants: *place attachment* increase by 1. the symbolic value of the land after the construction was started; 2. the economic valuation of the lands and the economic benefits from the wind turbines in their properties. We also found a decrease in the *place attachment* in some inhabitants of Cerro Chato, who suffered changes in their town due to the construction of the wind farm, threatening the identity of the place already constituted (i.e. loss of calm due to the great movement of people during construction). There were also some people who expressed their wish of selling their houses. As a preliminary conclusion, we may argue that the construction of this wind farm involves both positives (economic profit; infrastructural improvements; positive visual impact) and negatives (loss of calm and privacy) effects on the welfare of the inhabitants. The present work is one of first that addresses this issue in Brazil. In that sense, these results may contribute by offering tools and concepts that may be employed in futures studies in the area.

Gillian Lye, Sarah Canning, Chris Pendlebury, Sally Shenton & Richard Walls

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Selection of mixed effects models for bird and marine mammal analysis undertaken for Robin Rigg offshore wind farm, Solway, Scotland

Robin Rigg in the Solway was Scotland's first commercial scale offshore wind farm development, operational from April 2010. This presentation will provide specific details of the analysis used for the long-term ecological monitoring (circa 10 years) undertaken as part of the Marine Environment Monitoring Program (MEMP).

In particular, this presentation will focus on the techniques used to determine the changes in bird and porpoise numbers and distributions at the site, comparing the situation pre-construction, during construction and then during the two years of operation. The key species that the analysis has been undertaken for are harbour porpoise *Phocoena phocoena*, guillemot *Uria aalge*, razorbill *Alca torda*, gannet *Morus bassanus*, red-throated diver *Gavia stellata*, and cormorant *Phalacrocorax carbo*.

The analysis techniques discussed by this presentation are mixed effects models. The aim will be to show how the models have been selected for each species.

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How to mitigate mass collisions of migrating birds at wind turbines?

Collisions at wind turbines are known for large (> pigeons) as well as for small migrating birds (< pigeons). Collision victims of large birds can be found with a higher probability than those of small birds. Hence, for small birds there might be a large number of unreported cases of collision victims. Usually, the approach to mitigate collisions of birds at wind turbines is based on single bird detection systems (radar, camera) aiming to avoid collisions of more or less large single birds. For those systems, the technical challenge is the identification of birds and to detect whether a bird is approaching towards a wind turbine or not. Furthermore, there is the difficulty that local birds usually being around in an area of a wind farm might lead to repetitive switch-off of turbines.

Another approach is to quantitatively measure the intensity of bird migration at site and to switch-off turbines after a certain threshold of bird migration intensity is reached. When the migration intensity is lower than the threshold, the turbines can be restarted. This approach is realisable by using simple fix-beam radar systems. This kind of radar system was developed by the Swiss Ornithological Institute and reveals automatically how many birds per kilometre and hour pass at a specific height interval (altitudinal distribution) in near real time. The echo signature patterns, which are recorded by the radar system, allow distinguishing between echoes of birds and non-birds, and more specifically between groups of birds (e.g. passerines, waders).

The main aim with this approach is to avoid catastrophic events of potential mass collisions of birds at wind turbines. The switch-off system is currently under development and is in discussion to be integrated as a mitigation measure into the new Swiss Manual for the Environmental Impact Assessment.

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Wind & Biodiversity project: integrated solutions for managing biodiversity in wind farms

The R&D project *Wind & Biodiversity* arises from the need of reconciling wind energy developments and biodiversity. As widely known, when inadequately located and designed, wind farms can be responsible for negative impacts on birds and bats. Although European Union Directives and regulations do not exclude the possibility of installing these projects inside Nature 2000 site, promoters must assure that they do not compromise the conservation objectives of these sites. In order to accomplish that, first it is mandatory to fully understand the real impacts and then to develop the best mitigation and offset measures.

Thus, the main goals of this research project are 1) to understand the ecology and the dynamics of bird and bat populations; 2) to accurately quantify and also understand the reasons beyond bird and bat mortality; 3) to develop equipments and technology to mitigate bird and bat fatalities; 4) to develop, adapt and validate compensation measures to implement in wind farms with high mortality rates; and ultimately 5) to develop integrated and sustainable management solutions/services adapted to wind farms, according to its engineering, performance and ecological context.

Started in February 2011, over the past 2 years much research has already been conducted, with emphasis for a better knowledge of how communities use wind farm areas, by using cutting edge technologies (e.g. radar) and for the development of mitigation/ compensation techniques. A great deal of work has also been performed in what concerns the development and optimization of the methods to assess bird and bat fatalities. So far, one of the main products of the project was the online platform *Wildlife Fatality Estimator*, which helps researchers and consultants to choose and apply properly the methods and estimators, when estimating bird and bat fatality at wind farms.

This 4-year project is lead by Bio3 in partnership with the University of Aveiro, (through the Center for Environmental and Marine Studies and the Institute of Electronics and Telematics Engineering). The project is partially funded by the national program of incentives for the Portuguese businesses and industry (QREN), under the operational program “Mais Centro”, and with the support of the European Regional Development Fund.

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Assessing cumulative impacts of wind-power development on birds: A spatially-explicit deterministic index for decision support

Knowledge on the cumulative impact of wind power is insufficient because research until now has primarily focused on species-specific effects associated with single wind-power plants. With a piecemeal development where each wind-power plant may in itself present little conflict, multiple wind-power plants may in sum, however, have serious impact on individual species or ecosystems as a whole. Overall planning can here contribute to improved legitimacy and accept for concession approvals. Internationally there has been signaled a growing need to establish common standards and methods of how issues related to cumulative effects of wind-power plants can be integrated in future research and monitoring practice. Here we propose a generic spatially-explicit deterministic impact-index that can be easily derived using standard survey techniques.

The proposed cumulative impacts index incorporates both direct (through collisions) and indirect (through reduced reproduction) mortality, in addition to barrier effects. The assessed impacts are related to the energetic 'footprint' of each wind-power plant by multiplying the dimensionless effect-sum by the impacted area per MW. To estimate the overall impact-index of a single wind-power plant across species, the species-specific relative impact-indices can be summed using a weighted mean based on species-specific vulnerability indices. Finally, in order to assess the cumulative impact of several wind-power plants within a geographic region these single impact-indices are summed while taking into account the effect of spacing of wind-power plants.

The cumulative impacts index is based on easily assessed pre-construction data, and may support consenting agencies for deciding on acceptable thresholds of cumulative impacts of wind-power development on birds within a geographical region.

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Methods to reduce the effects on wildlife in operational wind farms: experiences on a major migration bottleneck area

Although the benefits of wind as a renewable energy are evident, wind farms may have adverse consequences on flying animals as demonstrated in recent scientific literature. This is the main reason why assessing and monitoring the impact of wind farms on fauna is crucial if we want to achieve ecologically sustainable development of this renewable energy resource.

Until now environmental impact assessment studies have been principally based on observations of birds before the construction of wind farms, even though a weak relationship between those variables predicting risks from EIAs and recorded mortality have recently been found. This could be the main reason why there are wind farms causing high mortality levels worldwide.

It is already known that future risk assessment studies must be improved by finessing the scale of these studies, and also by integrating the physical characteristics of the entire area where the wind farm is planned, focusing also on the location of every individual wind turbine. Meanwhile, there are numerous already operational wind farms where action is needed to reduce and prevent wildlife accidents.

In this presentation we will explain the surveillance program, developed in close collaboration with the government and with wind energy companies, we conduct in southern Spain (Tarifa-Strait of Gibraltar), a water crossing of 14 km at its shortest distance, acting as a major migration bottleneck for Paleo-African soaring migrants (more than half a million raptors and storks cross to Africa every autumn and every spring). Before the implementation of the surveillance program some of the wind farms where we are working obtained some of the highest collision rates ever published for birds, raptors being the most affected group. This rate decreased very markedly after starting with the protocol, which could be applied to reduce the potentially undesirable effects of wind farms on flying animals internationally.

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Wind Energy in Forests – Are You Serious?

Onshore wind energy is a central component for the transformation of the energy system in Germany. Identifying and designating suitable sites is crucial to meet the ambitious energy targets. With more than 30 percent of Germany covered by woodland (in some Länder more than 40 percent), a large percentage of which located on low mountain ranges and ridges with outstanding wind conditions, there is a high potential for wind energy deployment in forests.

However, forests are considered sensitive habitats for various types of animals and plants, a place for recreation and an important element of the landscape scenery – in a nutshell a symbol for an intact environment. However especially forest monocultures under intense economic use can serve as an alternative location for wind energy plants (WEP). To develop more WEP without compromising the environment, we need to define criteria and standardised planning methods that allow the comparison of non-timberland with forests on the one hand and to define criteria that identify woodlands with low sensitivity to wind energy deployment on the other hand.

The contribution will be divided into three parts. The first part gives an overview on the current situation in Germany and other countries and focuses on some of the most urgent challenges when it comes to wind energy deployment in forests based on literature research and questionnaires. What are the pros and cons? What are the environmental impacts? What effects does it have on acceptance, recreation and the landscape scenery?

In the second part the author gives an overview on the current state of research on environmental impacts connected to wind energy deployment in forests. Among others, intermediate results of a currently running monitoring project to determine the impacts of wind energy projects on birds and bats funded by the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety will be presented.

The last part gives an overview on different planning solutions as far as forests are concerned. In Germany, the Länder implemented different strategies to consider forests in regional and local planning; other countries are developing criteria to standardise wind planning in forests. Which criteria can be used to designate areas for wind energy projects in woodlands? How and on which planning level do we need to steer the deployment of wind energy in forests? What kind of data do we need to define suitable areas? Can we standardise the process or do we need to focus on case-by-case approaches?

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Broadening horizons – the FMECA-NETEP Model

The permit application process for offshore wind farms (OWF) in Sweden conceivably requires a more comprehensive, transparent and quantitative complement within environmental impact and risk assessment. The NETEP framework (Navigation, Economics, Technology, Environment, Politics) has therefore been brought forward for academic scrutiny as a basis for the application of FMECA risk assessment methodology. FMECA (Failure Modes Effect and Criticality Analysis), particularly widespread within the aerospace and automobile industries, is a well-established, systematic method for the prediction of future failure in a product, part or process, to evaluate the consequences of the failure and to suggest possible measures to mitigate or eradicate the failure. Its use within attitude and acceptance, safety and environmental effect is however undocumented which creates the research gap for this study. Three Swedish OWF projects in the Baltic Sea area (Lillgrund, Taggen, Trolleboda) are evaluated using the proposed FMECA-NETEP method. Representatives (comprising the expert group) from government agencies and industry are briefed on the structure and use of FMECA and then attempt to use it to measure risk within their respective NETEP sectors in the three case studies. After this stage the model is refined, and the expert group work in unison on the evaluation of an unplanned site. The level of utilization of FMECA across the NETEP sphere is thereby evaluated. The expected results of the study are a transparent, holistic risk assessment methodology that could be used as a complement to OWF permit applications and which;

- illustrates cumulative effects and enables comparison between alternative sites with a more quantitative methodology than that used at present, and
- enables comparative study of similar potential OWF locations i.e. partly enclosed sea areas in or close to Natura 2000 areas (e.g. within the Baltic Sea, Mediterranean Sea).

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Surprised scavenger

Considering the increasing number of wind facilities around the world it has became fundamental to fully understand impacts on the populations of birds and bats killed by the wind turbines. Carcass removal (e.g. by scavengers or decay) is one of the criteria that must be accounted for when estimating bird and bat fatality, given the elapsed time between consecutive searches. With camera-trapping technology it is possible to improve knowledge about the scavenger community responsible for the carcass removal at wind farms, their specific richness, diet habits like carrion foraging, their response to different amounts of carcasses and activity patterns in a spatio-temporal context; which can also in turn provide a great contribute to an accurate estimate of the removal correction factor. Using this type of technology we conducted a study that aimed to characterize the vertebrate scavenger community and its role in carcass removal in two wind farms, located in Serra de Aire e Candeeiros Natural Park (Central Portugal).

Scavengers removal trials were conducted in spring and summer (two campaigns), covering two different activity periods in a total of 60 camera-stations (30 for each wind farm). Red-legged partridges (*Alectoris rufa*) and mice (*Mus sp.*) carcasses (total of 30 for each) randomly placed around the turbines were used. The number of carcasses placed at the same time was limited in order to avoid scavenger swamping.

The preliminary results revealed at least 7 species of vertebrate scavengers, which represent 4 orders: passerines, raptors, rodents and carnivores. Red fox (*Vulpes vulpes*) was the more frequent one. The garden dormouse (*Eliomys quercinus*) was an unexpected scavenger. Camera-trapping showed to be an appropriate non-time consuming methodology to community characterization and recording the exactly removal time of the carcasses. The use of these techniques in removal trials contributes not only to a better understanding of the carcass removal process at each wind farm, but also to the optimization of future trials design and definition of the ideal carcass search interval.

This research is part of the R&D project, Wind & Biodiversity, co-financed by project is partially funded by the national program of incentives for the Portuguese businesses and industry (QREN), under the operational program “Mais Centro”, and with the support of the European Regional Development Fund.

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Integrated Ecological Monitoring Plans (IEMP) for Offshore Wind Projects

A structured approach for ornithological baseline surveys for offshore wind farms has previously been proposed in order to build up an appropriate understanding of the site during the impact assessment process. As such an Integrated Ornithological Monitoring Program (IOMP) would use a selection of complimentary techniques targeted towards the range of species highlighted as being at potential risk. This approach is widened in order to incorporate other ecological taxa, including marine mammals, fish and benthic habitats. These techniques may include: boat-based and/or aerial surveys; complimentary remote methods such as radar, tracking studies and acoustic monitoring; and then modelling approaches such as collision risk, population viability analysis and cumulative impact assessment. The IEMP approach will be discussed using examples of offshore wind projects from the UK.

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Bat activity at wind turbine level compared to ground level

To explore bat activity at higher elevation over a forest landscape in south-western Sweden and compare it with ground level activity, an ultrasound microphone was placed at 100 meters in a wind mast and connected to a bat detector on the ground. A second recording set was placed below at ground level. Preliminary data do not indicate any activity of bats at the top of the mast. At ground level five species of bats have been recorded, three of which are considered as high risk species in relation to wind power plants. The collection of data is ongoing and the final results will be presented at the conference.

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Flight Activity and Breeding Success of Hen Harriers at Paul's Hill Wind Farm in North East Scotland

Paul's Hill Wind Farm, a 28 turbine (64.4MW) site in North East Scotland was built between 2004 and 2006 on upland moorland consisting predominantly of dry heath and blanket bog habitat. Baseline surveys completed between 2001 and 2002 identified a population of hen harrier, *Circus cyaneus*, utilising the proposed development footprint and surrounding area. At this time, hen harrier had been identified as one of the species most susceptible to collision and disturbance from wind farm developments.

As part of the planning consent, a detailed hen harrier monitoring programme, which includes flight activity, nest monitoring, collision monitoring and moorland management, was implemented in order to monitor the potential impact of the wind farm on this endangered European-protected raptor.

This presentation discusses the implementation of the monitoring programme, and the key ecological monitoring results obtained from 12 years of monitoring data, from baseline, construction and post-construction phases. Density surface modelling and generalised linear modelling analysis has been used to assess flight activity during all monitoring phases as well as assessing utilisation of the site by hen harriers.

Non-parametric correlation analysis and Monte Carlo simulations have been utilised to assess potential differences between the number of nesting pairs, nest locations and nesting success across all monitoring phases of the wind farm. Consideration is also given to the regional hen harrier population in comparison to the Paul's Hill Wind Farm population to assess potential differences in terms of productivity. The analysis also assesses the success of the moorland management being undertaken on site and the benefits it has had on the local hen harrier population.

The monitoring programme represents the longest data set for this species in relation to onshore wind farm developments in the UK. The analysis results put into context the potential risk to hen harrier populations in close proximity to onshore wind farms and allow the industry to have a greater understanding of the risk in the consenting, construction and operational phases.

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Land occupied for wind power farms in Västerbotten – how real measurements relate to what is stated in EIA documents

Construction of wind power farms occupies land areas for wind power turbines and access roads. Natural land is transformed to felled, excavated and paved areas. This can lead to the loss of natural environments or grazing land for Reindeer. Paved surfaces are generally a permanent loss of natural land, whilst other areas can eventually be restored. The consequences of this land alteration are often described in the environmental impact assessment (EIA). To make the impact assessment as credible as possible it is important that the land alteration described in the document is consistent with the actual situation on the site. An undergraduate degree thesis study examined land occupied for five wind power farms in the county of Västerbotten. Occupied land was measured in the field and compared with what was stated in the environmental impact assessment. Discrepancies between actual and estimated land occupancy was compared between the five wind power farms. The study covered road width (carriageway and roadside), land occupied next to roads (excavated land and felled woodland) as well as land occupied for the wind power turbines themselves (foundation, gravelled area, excavated area and felled woodland). Results show that field measurements of occupied land next to roads are to a great extent larger than estimates made in the EIA documents. There was also a variation both within and between wind power farms concerning road width, land next to roads and turbines. The study also shows that estimates of occupied land are not treated equally between EIA documents, in that measurements vary and are sometimes missing. There are also examples of areas that were excavated, when the EIA stated they were only to be felled. This makes the environmental impact more severe than in the document. Results show that road width within wind power farms is between five – six meters, occupied land next to roads is about 20 m and the total land area occupied for each wind power turbine is between 0.3 and 0.7 ha. The study also indicates how important it is that what wind power developer describes as commitments in the EIA document is followed up by the developer or authorities. What is described in permit applications must correspond to what is then done on the site.

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Field trial of acoustic survey methods to study bat migration at the German Baltic Sea

The fact that bats fly over the Baltic Sea during migration and foraging and that they are attracted by offshore wind turbines and might thus be killed has been shown in studies conducted at the Scandinavian Baltic coast. Solely in the German Baltic Sea about 1.000 wind turbines are projected. Reliable and comparable data on bat occurrence and phenology is urgently needed to allow bats to be considered during the authorization procedure.

We therefore started a pilot study at the German Baltic coast of Mecklenburg-Western Pomerania to contribute to the currently rather basic knowledge on bat migration over the southwestern Baltic Sea and to test methods to study bat migration offshore acoustically.

Acoustic surveys with direct ultrasound recording systems (time-expansion type) on geographic landmarks serving as potential departure points and on a small island show that bat migration takes place in the area. Migratory bat species like *Pipistrellus nathusii* and *Nytalus noctula* were registered in high numbers during the migration period. Furthermore, we found intermediate roosts occupied only during this period.

To test methods, different direct ultrasound recording systems (all time-expansion type) were installed at several coast locations and offshore (research platform, ferries, buoys). Contrary to expectations microphones resisted the rough conditions and recorded several bat calls including *Myotis daubentonii* and *Pipistrellus nathusii*. Available systems are clearly appropriate to study bat activity offshore.

On land ultrasound recording systems are applied as standard method for acoustic monitoring to quantify pre-construction bat activity and post-construction collision risk at wind turbines. To our opinion, there is no factual reason why a comparable acoustic monitoring procedure is not implemented offshore yet.

In addition to specifying the species-specific amount and phenology of bat activity offshore further study should concentrate on what factors might predict offshore bat migration peaks. The knowledge of the factors reliably predicting periods of exceptionally high fatality numbers is essential to prevent oversea-migrating bats from offshore wind energy related mortality by implementing turn-off-times – a possible solution meeting the demands of both bat conservation and renewable energy production.

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Short- and long-term effects of an offshore wind farm on three species of sandeel and their sand habitat

Offshore wind farms (OWFs) are being constructed at a high rate due to a high demand, both economically and politically, for sources of renewable energy. We investigated the short-term and long-term effects of an OWF situated in the North Sea off western Denmark (Horn Rev I; global position: 7.84° E, 55.48° N) on 3 ecologically important species of sandeel. Since sandeels display a distinct preference for sand habitats with a weight fraction of silt+clay <2%, we expected changes in habitat quality to provide a causal explanation for the potential effect of the OWF on the sandeel community. A Before-After-Control-Impact (BACI) analysis was applied. A baseline survey from March 2002 (prior to construction) was combined with surveys conducted in March 2004 (short-term effects) and March 2010 (long-term effects) plus an additional survey in September 2009. Sandeels were collected using a modified scallop dredge and sediment samples using a van Veen grab. The results from an analysis on all species combined revealed a positive short-term effect on the densities of both juveniles and adults, which was consistent with a reduction in the fraction of silt+clay. In the long term, a negative effect on juveniles was found; however, this effect was neither consistent with the additional survey in 2009 nor the silt+clay fraction. Subsequent analysis at the species level revealed that the effects detected were driven by Hyperoplus lanceolatus, which dominated the study area in all years. Habitat quality was high in both the affected and control area throughout the study period.

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Nocturnal migration during construction of an offshore windfarm: comparison of stationary and mobile radar detection

In the German EEZ numerous offshore wind farms are planned, but only few commercial projects are already under construction. Whereas during pre-construction ship based investigations have to be performed according to fixed methodological standards, using platforms is recommended during construction and operation. During the monitoring of bird migration in the construction stage of the first commercial German offshore wind farm "BARD Offshore 1" we used vertically rotating ship radars from a platform within the park and simultaneously from a vessels close to the construction site and compared nocturnal migration rates at the two close by sites. Migration rates correlated well at both sites and also altitudinal distributions were similar. However, in two nights with apparent mass migration measured from vessel, migration rates close to the platform were low. These nights were characterized by very low visibility (fog). Simultaneous visual observations and recording of flight calls from the vessel revealed an attraction of birds by the strongly lighted construction site. Attraction of birds is an important issue with respect to collisions of birds with windmills and structures related to the building of windfarms. The study shows that it is essential to operate close to the site of interest, that is, where construction activities take place. The advantages and disadvantages of stationary (platform) and mobile detection (from vessels) for construction and operational monitoring are discussed.

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Multi-site examples of effective control of Landscape level Hydrological risk from the construction phase for onshore wind farms in Upland Scotland

A structured and collaborative approach was established to assessing the impacts from construction of two onshore wind farms situated in upland environments in Scotland. The sites are situated within the catchments of rivers that are designated Special Areas of Conservations (SAC) on account of supporting healthy populations of Atlantic salmon (*Salmo salar*), river lamprey (*Lampetra fluviatilis*), sea lamprey (*Petromyzon marinus*), brook lamprey (*Lampetra planeri*), otter (*Lutra lutra*) and water-crowfoot (*Ranunculus fluitans*). To understand the effects of construction on the hydrological environment, specific programmes of water quality and fish monitoring via electro-fishing was undertaken at both sites. Locations for monitoring were chosen to either ensure complete coverage of the construction activities or were targeted to monitor water quality at key locations. Control locations were also chosen to understand how natural conditions can influence water quality. In conjunction with rainfall data, the chemical results indicate short term fluctuations in water quality, likely caused by the release of sediment into the hydrological environment during construction. The chemical patterns observed during the post construction monitoring period are similar to those observed during the baseline period, indicating that the wind farms have had no long term measurable impact on water quality. The electrofishing surveys that were carried out also corroborate the results of the chemical analysis and conclude that the construction activities associated with both wind farms have not produced a measureable effect on the local fish populations.

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