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Windfarms and Birds :
An analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues

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on behalf of the Bern Convention
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Executive Summary

1. This report was commissioned by the Council of Europe for the Bern Convention as an update of the one commissioned by them last year and presented to the 22nd meeting of the Standing Committee for information. Its remit is to '*analyse the impact of wind farms on birds, establishing criteria for their environmental impact assessment and developing guidelines on precautions to be taken when selecting sites for wind farms'*. This revised version has, as an additional annex (Annex 2), a draft recommendation for consideration by the 23rd meeting of the Standing Committee.

The Impact of Wind Farms on Birds

2. A review of the literature identified the main potential hazards to birds from wind farms to be:
• Disturbance leading to displacement or exclusion, including barriers to movement
• Collision mortality
• Loss of, or damage to, habitat resulting from wind turbines and associated infrastructure
3. There have been few comprehensive studies, and even fewer published, peer-reviewed scientific papers. Many studies suffer from a lack of before and after, or wind farm area and reference area comparisons, or a total lack of assessment of relevant factors such as collision/collision risk, differences in bird behaviour between night and day, or are of inadequate duration to provide conclusive results. In some cases, the reason for the short timescale is that studies are in their early stages and so there may

be further information available in future.
4. It is clear that there is a need for robust, objective baseline studies to inform sensitive siting to minimise
deleterious effects on birds, other wildlife and their habitats, and a need for post construction monitoring at consented installations where there are environmental sensitivities. There is clearly a distinction to be made between effects of a temporary versus a permanent nature. There is also a need to put into context the potential impacts to determine the spatial scales at which they may apply, eg: site, local, regional, national and/or international.

Disturbance

5. The effects attributable to wind farms are variable and are species-, season- and site-specific. Disturbance can lead to displacement and exclusion from areas of suitable habitat, effectively loss of habitat for the birds.
6. There are several reliable studies indicating negative effects up to 600m from wind turbines, ie a reduction in bird use of, or absence from, the area close to the turbines, for some species (eg whooper swan *Cygnus Cygnus*, pink-footed goose *Anser brachyrhynchus*, European white-fronted goose *A. albifrons*, Eurasian curlew *Numenius arquata*). In a large wind farm, even this relatively small exclusion area around an individual turbine, may amount to a cumulatively significant exclusion area, or area of reduced use, even within a single wind farm.
7. The scale of such habitat loss, together with the extent of availability and quality of other suitable habitats that can accommodate displaced birds, and the conservation status of those birds, will determine whether or not there is an adverse impact.
8. Habituation may occur, *cf* observed differences in behaviour between residents and migrants in some studies, but studies over several years of eagles in California provide little indication of habituation and
few other studies have been of long enough duration to demonstrate whether or not habituation occurs.
9. Disturbance potentially may arise from increased human activity in the vicinity of the wind farms, eg
during construction, maintenance visits, facilitation of access via access roads, often in areas of little human activity before the arrival of a wind farm. The presence/noise of turbines may also deter birds from using the area close to turbines. Few studies are conclusive in their findings, often because of a lack of well-designed studies both before and after construction of the wind farm. Furthermore, very few studies take account of differences in diurnal and nocturnal behaviour, basing assessments on daytime only, which is inadequate for those species which are active during darkness and which may behave differently at night compared with during the day.

10. There is some indication that wind turbines may be barriers to bird movement. Instead of flying between the turbines, birds may fly around the outside of the cluster. Whether this is a problem will depend on the size of wind farm, spacing of turbines, the extent of displacement of flying birds and their ability to compensate for increased energy expenditure. The cumulative effects of large wind farm installations may be considerable if bird movements are consequently displaced. This may lead to the disruption of ecological links between feeding, breeding and roosting areas.
11. Wind farm design may alleviate any barrier effect, for example allowing wide corridors between clusters of turbines. Research and post-construction monitoring at several pilot sites will be necessary to determine whether and where this is an acceptable solution.
12. The wind energy industry is in its infancy offshore and, consequently, there has been little research into
the impacts on birds. Nonetheless, there are useful studies underway, especially in The Netherlands and Denmark, indicating a variable response that is both site- and species- specific, just as onshore. The proposals for large wind farms in shallow sea areas may conflict with the feeding distributions of seabirds, notably seaducks, if these are displaced due to disturbance and consequently excluded from their main feeding areas. The potential cumulative effects of multiple installations are a particular

concern.

13. Collision Risk and Mortality

14. The majority of studies have quoted low collision mortality *rates* per turbine, but in many cases these
are based only on found corpses, leading to under-recording of the actual number of collisions. Even where collision rates per turbine are low, this does not necessarily mean that collision mortality is insignificant, especially in wind farms comprising perhaps several hundreds or thousands of turbines. Even relatively small increases in mortality rates may be significant for populations of some birds, especially large, long-lived species with generally low annual productivity and slow maturity, notably so when already rare.

15. Relatively high collision mortality rates have been recorded at several large, poorly sited wind farms in
areas where large concentrations of birds are present (including Important Bird Areas (IBAs)), especially migrating birds, large raptors or other large soaring species, eg Altamont Pass in California, USA, Tarifa and Navarra in Spain. In these cases, actual deaths resulting from collision are high, notably of golden eagle *Aquila chrysaetos* and griffon vulture *Gyps fulvus*, respectively.

16. Collision mortality at poorly sited wind farms may have population level effects, and cumulative mortality from multiple wind installations may also contribute to population declines in susceptible species. Making projections of the potential magnitude of wind turbine-related avian fatalities is problematic because of the frequent lack of objective information.

17. The weight of evidence to date indicates that locations with high bird use, especially by species of conservation concern, are not suitable for wind farm development (eg in Spain, regional recovery plans prohibit wind farms in areas important for breeding and feeding imperial eagles *Aquila heliaca*). Site selection is crucial to minimising collision mortality. The precautionary principle is advocated where there are concentrations of species of conservation importance. It is therefore very important that alternative locations are proposed for the potentially most hazardous wind farms.

18. Wind speed and direction, air temperature and humidity, flight type, distance and height, time of day
and topography all influence the risk of collision, as do species, age, behaviour and stage of the bird's annual cycle. All these factors need to be incorporated in collision risk assessments. Collision risk is greatest in poor flying conditions, such as strong winds that affect the birds' ability to control flight manoeuvres, or in rain, fog, and on dark nights when visibility is reduced. In these conditions, the flight height of migrating birds tends to be greatly reduced. Lighting of turbines has the potential to attract birds, especially in bad weather, thereby potentially increasing the risk of collision.

19. Few studies attempt observations in poor weather and visual observations are limited in such conditions. However, remote techniques can be used to extend observations beyond the visible spectrum, eg radar, thermal imagery and, at the very least predictions of the likely frequency of the weather conditions that increase collision risk can be used to inform the risk assessment.

20. Most studies have been of small turbines, often in small clusters; the implications of newer, larger turbines and larger wind farms may be different. The importance of wind farm location and layout in determining the risk of collision by birds with wind turbines is apparent from studies both onshore and offshore.

21. Collision mortality arises as a result of collision with turbines, meteorological masts and power lines.

Thus, assessment of bird collision risk and mortality, arising from collision or electrocution, needs to include wind turbines and associated structures, including overhead power lines transporting energy from the wind farm. It is recognised that the actual rate of collision is likely to be under-recorded, owing to the limitations of the study techniques, particularly corpse searches, so it is essential that calibration is undertaken at each site to enable correction factors to be applied to produce more realistic estimates of collision mortality.

22. Collision risk models provide a potentially useful means of predicting the scale of collision attributable
to wind turbines in a given location, but only if they incorporate actual avoidance rates in response to fixed structures and post-construction assessment of collision risk at wind farms that do proceed, to verify the models. Population models provide a means of predicting whether or not there are likely to be population level impacts arising from collision mortality. Again, they require post-construction verification at consented wind farms to test the validity of the predictions and the models.

23. Habitat Loss or Damage

24. Loss of or damage to habitat, resulting from wind farm infrastructure, is not generally perceived to be a
major concern for birds outside designated or qualifying sites of national and international importance for biodiversity, depending on local circumstances and the scale of land-take required for the wind farm and associated infrastructure. The cumulative loss of or damage to sensitive habitats may be significant, especially if multiple, large developments are sited in such locations, eg on sandbanks in shallow waters or on peatlands. Furthermore, direct habitat loss may be additive to disturbance exclusion.

25. Onshore infrastructure including turbine bases, substations and access roads etc will involve direct habitat loss. This is generally fairly small scale, but could affect local hydrology in sensitive habitats and, again, the effects will be dependent on the size of the wind farm and especially the extent of any road network required.

26. Offshore, direct habitat loss is generally small-scale, primarily for turbine bases and cables at sea. However, increasingly large wind farms, especially on feeding areas such as sandbanks in shallow waters, may give cause for concern and habitat change or damage may be significant.

27. Other Issues

28. Turbines may offer roosting or nesting sites for birds. However, research needs to be undertaken to assess the extent of bird use. In the offshore environment, there may be adverse effects on birds as a result of disruption to, or encouragement (collision risk for birds feeding among turbines) of, avian food
resources such as benthos and fish populations, for example as a consequence of the effects of electromagnetic fields around under-sea power cables. These aspects require further study to clarify whether or not there are significant issues of concern.

29. Environmental Assessment and Site Selection Guidelines

30. Criteria for Environmental Assessment

31. All wind farm developments require screening and those that have the potential for damaging effects on
wild birds or the wider environment, or in areas where there is uncertainty as to the potential effects, require a robust environmental impact assessment (EIA[1]). This needs to include comprehensive environmental impact assessment for individual projects and an assessment of the cumulative impacts arising from each wind farm proposal (including associated infrastructure onshore and offshore, such as new roads, power lines and under-sea cabling) in conjunction with other projects (both other wind

[1] In EU states, by reference to the selection criteria set out in Article III of Directive 85/337/EEC on the *'Assessment of certain public and private projects on the environment'*, as amended by Directive (97/11/EC), or the
use of similar criteria in countries where this is inappropriate.

farms and other relevant projects).

32. There is considerable support for wind energy as an environmentally benign source of energy. Nonetheless, stringent environmental assessment is just as important for wind energy as for other developments to ensure that it is sited optimally and to avoid or at least minimise any adverse impacts.

Poor quality EIAs, or lack of information, must not be permitted to lead to planning approval on the

grounds of no demonstrable effect.

33. Standardised study methods, to ensure comparability, are essential, as is consistency in their application
before, during and after construction, in the wind farm area and a reference area (BACI - Before-After Control-Impact). It is recommended that a minimum one-year baseline field study should be undertaken to determine the use of the study-area by birds and to identify which, if any, species may be adversely affected by wind farm construction. Post-construction monitoring needs to enable short- and long-term effects and impacts to be distinguished and provide the information to enable them to be satisfactorily addressed.

34. On the basis of the literature review, species' conservation status and more than 10 years collective experience by the BirdLife partners, the following species groups and example species are considered to be particularly sensitive, or potentially so, to wind farms (disturbance displacement, barriers to movement, collision, habitat loss or damage), although in many cases there is a lack of impact studies to date. Thus, they are likely to be focal species for detailed environmental assessment and research. This list is indicative rather than comprehensive. There are many species for which there is either no information, or no conclusive information, to date. Focal species are likely to be site and issue specific
and may change in the light of further research or change in conservation status.

Species group (eg species)	**Disturbance displacement**	**Barrier to movement**	**Collision**	**Direct habitat loss/damage**
Gaviidae, divers (redthroated diver *Gavia stellata*)	√	√	√	
Podicipedidae grebes	√			
Sulidae gannets & boobies			√	
Phalacrocoracidae (shag *Phalacrocorax aristotelis*)			√	
Ciconiiformes herons & storks			√	
Anserini, swans (whooper swan *Cygnus cygnus*) and geese (pink-footed goose *Anser brachyrhynchus*, European white-fronted goose *A. albifrons*, barnacle goose *Branta leucopsis,* brent goose *B. bernicla*)			√	√
Anatinae, ducks (eider *Somateria mollissima*, long-tailed duck *Clangula hyemelis*, common scoter *Melanitta nigra*)	√	√	√	√
Accipitridae raptors (red kite *Milvus milvus,* whitetailed sea eagle *Haliaeetus albicilla*, lammergeier *Gypaetus barbatus*, griffon vulture *Gyps fulvus*, imperial eagle *Aquila heliaca*, golden eagle *A. chrysaetos*, Bonelli's eagle	√	√		

Hieraetus fasciatus)
Charadriiformes waders
(European golden plover
Pluvialis apricaria, blacktailed
godwit *Limosa*
limosa, Eurasian curlew
Numenius arquata)
√√
Sternidae terns √
Alcidae alcids/auks
(guillemot *Uria aalge*)
√√√
Strigiformes owls √
Tetraonidae (black grouse
Tetrao tetrix, capercaillie *T.*
urogallus)
√√√
Gruidae cranes √√√
Otididae bustards √√√
Passeriformes especially
nocturnal migrants
√

35. Precautions for Site Selection of Wind Farms

36. There is a strong consensus that location is critically important to avoid deleterious impacts of wind
farms on birds. There should be precautionary avoidance of locating wind farms in statutorily designated or qualifying international (eg Natura 2000 – SPAs & SACs, 'Ramsar sites', Emerald Network and Important Bird Areas (IBAs)) or national sites for nature conservation, or other areas with large concentrations of birds, such as migration crossing points, or species identified as being of conservation concern. The favourable conservation status of habitats and species in these areas is a central tenet to their designation, requiring demonstration of compatibility with this aim by any proposed development. The weight of evidence to date indicates that locations with high bird use, especially by protected species, are not suitable for wind farm development.

37. Adverse impacts on wildlife must be avoided by full evaluation of suitable alternatives, appropriate siting and design.

38. Recommendations

39. There is an urgent need for statutory marine protected areas to be identified and designated.

40. Research and monitoring should be implemented by national governments and the wind energy industry, in consultation with relevant experts, to improve our understanding of the impacts of wind farms. This will be an iterative process that will inform decision-making, appropriate site selection and
wind farm design. The results of research should be published in international scientific journals, including a summary, preferably in English, to ensure wider dissemination.

41. Research and monitoring requirements encompass the following: effects and potential population level
impacts on birds of disturbance displacement, barriers to movement, collision mortality and habitat loss
or damage; effectiveness of different wind farm layout and turbine design to provide mitigation.

42. National governments must undertake Strategic Environmental Assessment (SEA)[2] of all wind energy
plans and programmes that have the potential for an adverse effect on wildlife in their country. If there are potential trans-boundary effects, then international co-operation with other governments should be sought when undertaking the SEA. The scale of SEA should be determined by consideration of the likely biological scale of impacts as well as jurisdictional boundaries.

[2] As set out in Directive 2001/42/EC of the European Parliament and of the Council, 27 June 2001 '*on the assessment*
of the effects of certain plans and programmes on the environment'.

43. Specifically, these SEAs should include indicative mapping of bird populations, their habitats, flyways
and migration routes and an assessment of the plan's probable effects on these, to aid decision-making.

44. As part of effective regional planning, there is a need to identify species and areas of concern, to map
potential and no-go locations for wind energy development on the basis of nature conservation concerns, for example avoidance of focal points for migration crossings. This may require the collection of additional information, especially offshore.

45. There need to be incentives to ongoing technological development to maximise efficiency of wind turbines and to reduce dependency on the limited shallow water habitats offshore.

46. There is a need for best practice guidance on standard study methods, to inform the EIA process.

47. This report has not looked in detail at individual case studies to evaluate examples of conflict resolution, case law, or trends in casework throughout the Council of Europe area. This may be a useful subject for further study.