# Guidance note:
# Distribution of breeding birds in relation to upland wind farms

## December 2009


### *Summary*

- Impacts of wind farms on bird populations can occur through collisions, habitat loss, avoidance/barrier effects, disturbance displacement or exclusion, *e.g.* from breeding grounds or foraging areas. This information note details work by Pearce-Higgins *et al.* (2009)[1] investigating whether there is reduced occurrence of breeding birds in upland areas of Britain close to wind farm infrastructure (turbines, access tracks and overhead transmission lines).

- The study collected data from 12 upland wind farms in the UK, and is thought to be the first such multi-site comparison examining effects of wind farms on the distribution of breeding birds. Several analytical approaches were applied to establish whether correlations occurred by chance, but they failed to find any evidence of statistical bias that may have affected the results.

- Levels of <u>turbine displacement</u> observed suggest that breeding bird densities may be reduced within a 500m buffer of the turbines by 15–48%. **Curlew** (-42%), **golden plover** (-39%), **snipe** (-48%), **meadow pipit** (-15%) and **wheatear** (-44%) were all affected. Given that avoidance by **curlew** extended to 800 m, reductions in density for this species were also calculated over a 1km radius, and estimated to be 30%. Flight activity of **buzzard** and **hen harrier** were reduced by 41% and 53% respectively within 500m of wind turbines.

- Significant <u>avoidance of tracks</u> was shown by five species - **buzzard**, **golden plover**, **kestrel**, **snipe** and **wheatear**, but could not be separated from turbine avoidance.

- Only **stonechat** was found in significantly lower numbers in proximity to <u>power lines</u>. Breeding birds avoided wind turbines more often than tracks, and showed no consistent avoidance of power-lines.


### *Methodology*

- Twelve wind farms located within unenclosed upland habitats (moorland, rough grassland or blanket bog) were surveyed, nine in 2006, and a further three in 2007. The sites included most of the existing large (>10 turbines), upland wind farms in

Scotland and northern England. At each wind farm, the core survey area extended to a maximum of 1km from the turbines. Areas of enclosed grassland, forest and felled forest were excluded.

- Bird distribution was assessed using regular surveys during the breeding season within wind farm sites and at slightly smaller control areas located within open ground close to each wind farm. Control sites were carefully selected to be as similar as possible in terms of terrain and habitat to the wind farm sites.

- Six survey visits were made to each wind farm (control sites were visited three times) at around 12 day intervals from mid-April to the end of June. Weather conditions in which surveys were conducted matched standard protocols (Brown & Shepherd, 1993)[2]. Observers walked transects 200m apart across each site and plotted the locations of all moorland breeding birds. Meadow pipits and skylarks were surveyed separately in 250m x 250m subplots by walking transects at 50m intervals, based on a known detection function (Buchanan *et al*., 2006)[3].

- Generalized Linear Models were constructed for 12 species for which there were more than 50 sightings. These were used to test for effects of wind farm infrastructure on bird distributions, whilst controlling for the effects of confounding variables such as those related to vegetation, topography, proximity to roads etc. Reductions in breeding densities (or raptor flight activity) within 500m of the turbine array were modelled, assuming habitat usage is proportional to breeding density.

***Results in detail***

- Levels of displacement from the area close to wind turbines suggest that breeding bird densities (and raptor flight activity) may be reduced within a 500m buffer around the turbines by 15–53%. The predicted values for **buzzard, hen harrier, curlew, golden plover, snipe and meadow pipit** are presented in Table 1. The apparent level of avoidance by **curlew** across an area of 1km radius was estimated to be 30.4% (CI 3.0 – 52.1%). The 95% confidence intervals (CI) mean that we are 95% certain that the values for reduction in density fall within the stated ranges; 3-52% in the case of curlew within 1km of the wind turbines. The table also shows the maximum detected displacement distances for each species. There was additional evidence for marginal impacts on **skylark** and **kestrel**. The remaining species - **red grouse**, **lapwing** and **stonechat** - did not show significant responses to wind turbines.

- Hötker *et al*. (2005)[4] have previously reported minimum disturbance distances for **meadow pipit** (41m+/-53m), **curlew** (212m+/-176m), **golden plover** (175m+/-167m), **snipe** (403m+/-221m) and **buzzard** (50m+/-53m). All of these distances relate to non-breeding birds except for **meadow pipit**. These figures are in broad agreement with those reported by Pearce-Higgins *et al*. (2009)[1] for **snipe** and **golden plover**. However, the larger disturbance distances for breeding **curlew** and **meadow pipit** as well as foraging **buzzard,** observed by Pearce-Higgins *et al*. (2009)[1] might suggest greater sensitivity of these species during the breeding season. Curlew might be particularly vulnerable to displacement during this period.

**Table 1. Predicted reductions in breeding density/flight activity and displacement distances for those species significantly affected by turbine proximity**

| Species | Reduction in breeding density/flight activity (%) | 95% confidence interval (%) | Displacement distance from turbine (m) |
|---|---|---|---|
| **Buzzard** | 41.4 | 16.0 – 57.8 | 500 |
| **Hen harrier** | 52.5 | -1.2 – 74.2 | 250 |
| **Curlew** | 42.4 | 3.4 – 72.8 | 800 |
| **Golden plover** | 38.9 | 4.3 – 59.0 | 200 |
| **Snipe** | 47.5 | 8.1 – 67.7 | 400 |
| **Meadow pipit** | 14.7 | 2.7 – 25.1 | 100 |
| **Wheatear** | 44.4 | 4.9 – 65.2 | 200 |

- Significant avoidance of tracks was shown by five species - **buzzard**, **golden plover**, **kestrel**, **snipe** and **wheatear** (wheatear at the 0-200m scale only). Because all turbines occurred close to tracks (these being part of the wind farm infrastructure), it was not possible to disentangle this from turbine avoidance, although avoidance of highly disturbed tracks and footpaths may be apparent at very high levels of use (Finney *et al*. 2005[5]; Pearce-Higgins *et al*. 2007[6]). In contrast, the numbers of **red grouse** significantly increased in close proximity to tracks.

- Significant effects of proximity to overhead transmission lines were apparent for **skylark**, **stonechat** and **wheatear**. Whereas stonechat were found in lower numbers close to power lines, skylark and wheatear were more likely to be found in close proximity. However, the ability to detect change in bird distribution close to overhead transmission lines may have been limited given that they were present at only seven of the 12 wind farms.

- Wind farms are generally located on shallow slopes or hill-tops and so their distribution in the landscape is non-random. Thus, there was a risk that significant correlations between bird occurrence and turbine proximity might reflect species' habitat preferences rather than the presence of turbines. Therefore, a conservative analytical approach was used. Firstly, bird occurrence was modelled as a function of habitat, and only then were additional effects of wind farm proximity examined.

There was no evidence for systematic bias in the likelihood of detecting significant effects.

- Levels of displacement from turbines were greater than from tracks, whilst there was no overall displacement from overhead transmission lines. Displacement was detected at a fine spatial scale (10s and 100s of metres): lower bird densities close to turbines were thus not an effect of the (coarse-scale) planning process having resulted in wind farm development being consented at sites less good for birds than nearby controls.

***Guidance***

- Calculating the impact of wind farm developments on upland breeding birds:

  1. Survey an area using a minimum of three visits during the breeding season.

  2. Use the maximum number of individuals recorded within a 500m/1km buffer around the turbines to estimate breeding abundance (for curlew the mean number of individuals should be used[7]), applying the appropriate correction factor where necessary to convert this into the number of pairs.

  3. Apply the appropriate reduction factor from Pearce-Higgins *et al.*[1] to estimate likely reductions in bird density within a 500m buffer around the turbines (or 1km buffer for curlew).

  Note – this method is not recommended for estimating impacts on breeding raptors although the information supplied may be used to calculate loss of foraging area for buzzard and hen harrier.

- These results should help improve estimates of impacts by wind farms on the species included in the analyses and lead to more robust environmental impact assessment for these birds. They offer a sound basis from which to assess the need for mitigation and habitat enhancement measures where concerns are raised about displacement of breeding birds or foraging raptors.

- For raptors, the displacement highlighted by this research is likely to represent reduced foraging opportunities, and therefore can be used to help inform the likely amount of mitigation required to offset negative impacts.

- Where pre-construction monitoring indicates high densities of breeding upland birds, further detailed surveys of bird distribution, using a three or more visit protocol, would be very valuable, both in terms of assessing likely impacts and as a baseline for post-construction monitoring. Increasing the number of surveys to five (or more) would give an index of breeding success, and more accurate data on habitat usage[7].

- Post-construction monitoring. Best-practice would follow what is usually requested under Section 36 of the Electricity Act; monitoring in years 0, 1, 2, 3, 5, 10 and 15, with an appropriate reference/control site. Regular review should be implemented to assess study outputs and, if necessary, adjust study protocols and/or mitigate impacts.

- It is worth emphasising that the Pearce-Higgins *et al.* (2009)[1] study did not investigate any mechanism(s) underlying their findings. In addition, collision risk may affect populations across a wider area than indicated by the displacement distances given above and therefore should be treated separately. Collision may be a risk to both local residents and to birds passing through the turbine area from further afield: although the effects of collision and displacement may be mutually exclusive to individual birds at a given point in time, their effects on populations can be additive.

- This information is intended for guidance only. Each case should be treated individually, considering factors such as: topography; local, regional and national population sizes; trends and conservation status; whether existing populations will be fragmented by the wind farm; and cumulative effects of wind farms at the regional and national scale.

***References***


1. Pearce-Higgins, J.W., Stephen, L., Langston, R.W., Bainbridge, I.P. and Bullman, R. (2009) The distribution of breeding birds around upland wind farms. *Journal of Applied ecology*, **46**: 1323-1331.

2. Brown, A.F. and Shepherd, K.B. (1993) A method for censusing upland breeding waders. *Bird Study*, **40**: 189–195.

3. Buchanan, G.M., Pearce-Higgins, J.W. & Grant, M.C. (2006) Observer variation in estimates of meadow pipit *Anthus pratensis* and skylark *Alauda arvensis* abundance on moorland. *Bird Study*, **53**: 92–95.

4. Hötker, H., Thomsen, K.-M. & Jeromin, H. (2006) *Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats - facts, gaps in knowledge, demands for further research, and ornithological guidelines for the development of renewable energy exploitation*. Michael-Otto-Institut im NABU, Bergenhusen.

5. Finney, S.K., Pearce-Higgins, J.W.& Yalden, D.W. (2005) The effect of recreational disturbance on an upland breeding bird, the golden plover *Pluvialis apricaria*. *Biological Conservation*, **121**: 53–63.

6. Pearce-Higgins, J.W., Finney, S.K., Yalden, D.W. & Langston, R.H.W. (2007) Testing the effects of recreational disturbance on two upland breeding waders. *Ibis*, **149**: 45–55.

7. Grant, M.C., *et al.* (2000) Estimating the abundance and hatching success of breeding Curlew *Numenius arquata* using survey data. *Bird Study*, **47**: 41-51.