

Understanding the impacts of wind farms on birds

An update on recent BTO research



THE BTO

The British Trust for Ornithology (BTO) is the UK's leading independent research organisation studying birds and their habitats, with considerable expertise in the design, implementation and analysis of a range of projects, from intensive studies to extensive surveys. The BTO has been providing advice about the potential ornithological impacts of renewable energy schemes since the 1980s, both within the UK and overseas. This has included leading work to assess the impacts of proposed tidal schemes on the Severn and Mersey estuaries.

More recently, wind farms, both onshore and offshore, have been a focus of our work. This has involved working closely with government, industry and other stakeholders in order to build a robust evidence base with which to assess the impacts of wind farms on birds. In addition to applied research, the BTO carries out Impact Assessment work through its commercial arm, Combined Ecology.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

BTO was responsible for the ornithological EIA for the recently consented projects within

the Dogger Bank Offshore Wind Farm Zone. At present, this is the largest area of wind development planned anywhere in the world. As such, the site presented some unique challenges for impact assessment. To solve these, the BTO developed a novel analytical approach, combining data from digital aerial surveys and more traditional boat surveys in order to generate robust population estimates for the suite of species using the site (Johnston et al. 2015).

RESEARCH-BASED EVIDENCE

Collision Risk Modelling

Wind farms may impact birds through multiple effects, including by posing a barrier to movement, displacing birds from habitat and through collision. Predicting the number of birds at risk of colliding with wind turbines is a core component of the impact assessment process and the BTO has played an important part in developing the evidence base for this. A particularly important project has been a review of avoidance rates (Cook et al. 2014), one of the key parameters in collision risk models. The selection of appropriate avoidance rates has been a

key source of debate between industry, developers and other stakeholders. The report produced by BTO was well received by all involved in the process and has been of significant value in moving this debate forward. BTO is also undertaking a literature review and meta-analysis of collision rates of birds and bats with wind turbines globally, as part of a wider collaborative project led by BTO that considers the potential impacts of renewable energy upon biodiversity.

The BTO has also been involved in reviewing and developing collision risk models. An important development in recent years has been the so-called "extended" Band collision risk model, which utilised BTO modelling of flight height distributions of birds based on data collected from boat-based surveys. Previously, birds in flight had been assumed to be distributed evenly across the rotor-swept area of a turbine. This assumption was known to be unrealistic and likely to result in an over-estimate of the number of birds at risk, as most birds fly at relatively low heights.

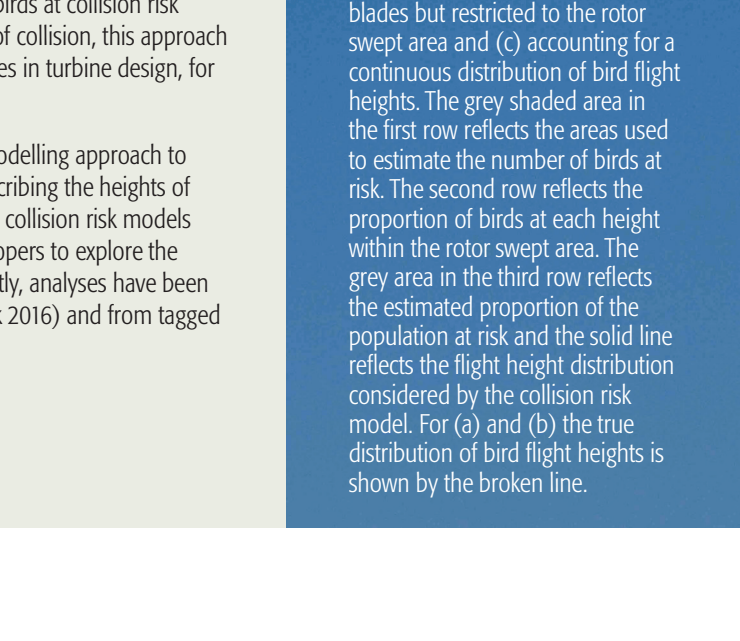
The BTO developed a novel modelling approach to produce continuous distributions of bird flight heights to be incorporated

THE IMPORTANCE OF SEABIRD FLIGHT HEIGHTS FOR UNDERSTANDING COLLISION RISK

Research by the BTO helped has helped to highlight the importance of understanding the height at which birds fly when assessing the risk of collision with wind turbines. The riskiest part of the turbine is the centre of the rotor-swept area where the gap between the blades is at its smallest. One assumption of many collision risk models is that birds are distributed evenly throughout the rotor-swept area of a turbine. However, we know from observational data that this is unlikely to be the case and that birds are likely to be most abundant towards the lower, less risky, part of the turbines. Consequently, by assuming birds are evenly distributed across the rotor-swept area, collision risk is likely to be over-estimated.

In boat-based surveys, the flight heights of birds are usually assigned to a series of bands (e.g. 0-10m, 10-20m, >20m) and these data are then used to estimate the proportion of birds at collision risk height. In addition to potentially over-estimating the number of birds at risk of collision, this approach has the additional disadvantage of not being able to take into account changes in turbine design, for example changes to the height of the turbine.

Using data collected for 25 species at 32 sites, the BTO developed a novel modelling approach to take data collected during surveys and produce continuous distributions describing the heights of flying birds (Johnston et al. 2014). These distributions can be incorporated in collision risk models where they produce more realistic estimates of collision risk and allow developers to explore the value of altering turbine height as a possible mitigation measure. Subsequently, analyses have been undertaken using data collected from digital aerial surveys (Johnston & Cook 2016) and from tagged birds (Ross-Smith et al. 2016).



Approaches to estimating the number of birds at collision risk height; (a) assuming birds are evenly distributed between the upper and lower tips of the turbine blades, (b) assuming birds are evenly distributed between the upper and lower tips of the turbine blades but restricted to the rotor swept area and (c) accounting for a continuous distribution of bird flight heights. The grey shaded area in the first row reflects the areas used to estimate the number of birds at risk. The second row reflects the proportion of birds at each height within the rotor swept area. The grey area in the third row reflects the estimated proportion of the population at risk and the solid line reflects the flight height distribution considered by the collision risk model. For (a) and (b) the true distribution of bird flight heights is shown by the broken line.

into models and so generate more realistic estimates of collision risk (Johnston et al. 2014). This approach has subsequently been extended to data collected using digital aerial surveys (Johnston & Cook 2016) and from birds fitted with GPS tags (Ross-Smith et al. 2016).

Tracking

Boat, aerial or digital aerial surveys are extremely valuable for understanding the distributions of birds in and around proposed or operational wind farms. However, to better understand how birds may interact with wind farms, movement data need to be collected at a much finer scale. The BTO have been collecting tagging data from gulls, skuas and gannets at colonies across the UK, many of which are of national or international importance, in order to investigate how the birds using these colonies may interact with wind farms. This work has revealed daily, seasonal and annual variation in space use and in the heights birds fly at, and provided understanding of movement and behaviour within operational wind farms, thereby informing the risks posed to gulls from offshore wind farms (Thaxter et al. 2015, Ross-Smith et al. 2016).

Population Modelling

It is important to understand the consequences of any impact arising as a result of the presence of a wind farm at a population level. As a result, population models are a key part of the assessment process. The BTO has been working closely with governmental advisors in order to develop robust approaches for population modelling (Cook & Robinson in press). These approaches have been at the level of the individual wind farm and also cumulatively for multiple wind farms.

Our work has resulted in changes being made to the way in which the population level consequences of wind farms are assessed in the UK. A key outcome from recent BTO work has been highlighting the importance of how density dependence is considered in population models (Horswill et al. in press). For a number of species, there is evidence that as population size declines, population growth rates also decrease. If wind farms have a significant effect at a population level, this density dependent mechanism may cause populations to decline faster than previously expected.

REFERENCES

Cook A. S. C. P., Humphreys E. M., Masden E. A. and Burton N. H. K., 2014. The avoidance of collision between birds and offshore turbines. *BTO Research Report No. 656*, Thetford, UK

Cook, A. S. C. P. and Robinson, R. A., in press. Towards a framework for quantifying the population-level consequences of anthropogenic pressures on the environment: The case of seabirds and wind farms. *Journal of Environmental Management*.

Horswill C, O'Brien S. H. and Robinson R. A., in press. Density dependence and marine bird populations: are wind farm assessments precautionary? *Journal of Applied Ecology*. doi: 10.1111/1365-2664.12841.

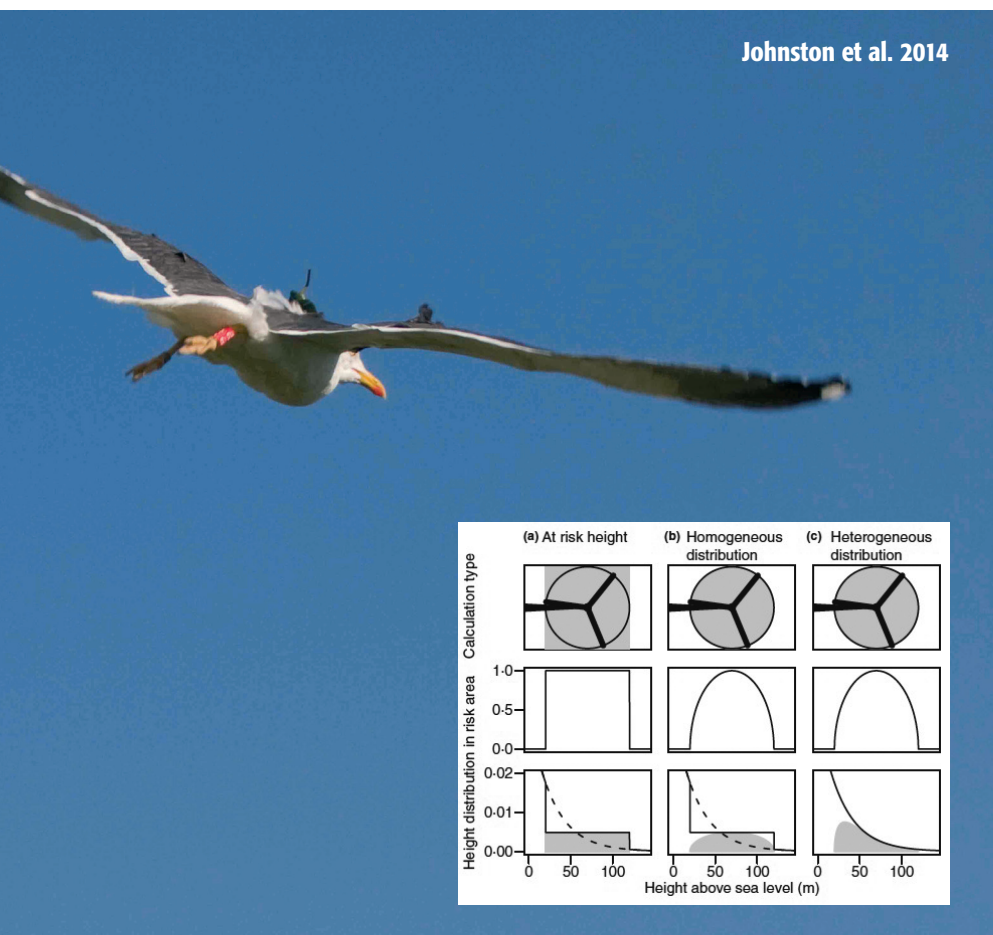
Johnston, A., Cook, A.S.C.P., Wright, L.J., Humphreys, E.M. and Burton, N.H., 2014. Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. *Journal of Applied Ecology*, 51, pp.31-41

Johnston, A., Thaxter, C.B., Austin, G.E., Cook, A.S.C.P., Humphreys, E.M., Still, D.A., Mackay, A., Irvine, R., Webb, A. and Burton, N.H., 2015. Modelling the abundance and distribution of marine birds accounting for uncertain species identification. *Journal of Applied Ecology*, 52, pp.150-160.

Johnston, A. and Cook, A. S. C. P., 2016. How high do birds fly? Development of methods and analysis of digital aerial data of seabird flight heights *BTO Research Report No. 676*, Thetford, UK.

Ross-Smith, V.H., Thaxter, C.B., Masden, E.A., Shamoun-Baranes, J., Burton, N.H.K., Wright, L.J., Rehfish, M.M. and Johnston, A., 2016. Modelling flight heights of lesser black-backed gulls and great skuas from GPS: a Bayesian approach. *Journal of Applied Ecology*, 53, 1676-1685.

Thaxter, C.B., Ross-Smith, V.H., Bouten, W., Clark, N.A., Conway, G.J., Rehfish, M.M. and Burton, N.H.K., 2015. Seabird-wind farm interactions during the breeding season vary within and between years: A case study of lesser black-backed gull *Larus fuscus* in the UK. *Biological Conservation*, 186, 347-358.





Understanding the impacts of wind farms on birds

Wind farms are seen as a key component of attempts to reduce reliance on fossil fuels and mitigate the impacts of climate change. However, concerns remain about their impact on the environment, particularly in relation to birds. BTO scientists have been working to improve our understanding of the impacts of wind farms on birds in order to help minimise any negative effects. This short BTO Research Note highlights key projects that BTO scientists have been involved in which have helped to improve our knowledge of the interactions between birds and wind farms.

The BTO is the UK's leading independent research organisation studying birds and their habitats, with considerable expertise in the design, implementation and analysis of a range of projects, from intensive studies to extensive surveys. Combined Ecology delivers practical, science-based solutions for sustainable development. The BTO has been providing advice about the potential ornithological impacts of renewable energy schemes since the 1980s, both within the UK and overseas, now through its commercial consultancy arm Combined Ecology. This has included leading work to assess the impacts of proposed tidal schemes on the Severn and Mersey estuaries.

More recently, wind farms, both onshore and offshore, have been a focus of our work. This has involved working closely with government, industry and other stakeholders in order to build a robust evidence base with which to assess the impact of wind farms on birds. In addition to applied research, the BTO carries out Impact Assessment work through Combined Ecology. The BTO has also been working as part of the Movetech Telemetry Partnership to develop low cost GPS tracking devices for a range of species.

Contact details:

For more information about the BTO's work on wind farms: aonghais.cook@bto.org

For information about Combined Ecology's Impact Assessment work: info@combinedecology.com

For information about Movetech tags: movetech@bto.org