# Turbine height as a management tool for collision risk to birds at offshore wind farms


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The Scottish Government
Riaghaltas na h-Alba

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The Scottish Government has set challenging energy and climate change targets that include the development of significant offshore wind developments. However, offshore wind farms have the potential for significant interactions with seabirds through collision of birds in flight to such a degree as to adversely impact upon SPA populations. Recent refinements to the 'Band model' in combination with a synthesis of bird flight heights have highlighted the potential for management of collision risk for some seabird species through changes in turbine height above sea level.


## Background

Significant resources have been invested in the development of models to estimate the collision risk that birds may be exposed to from wind farm developments (e.g. the 'Band model'). It is clear that in some cases predicted collision rates may pose a significant risk to bird populations and therefore wind farm developments. Recently compiled information on flight heights (Cook et al 2012) and improvements in the 'Band model' (Band, 2012) provide the opportunity to examine in more detail the relationship between collision risk and flight height and explore methods in which potential risks may be 'engineered out' of developments.

## The Extended Collision Risk Model

Two important improvements in the application of the 'Band model' have recently been made:

1. flight height data from a large number of offshore wind farm surveys around the UK have been brought together, for a range of species, and this has enabled a generic flight height distribution to be generated for each species (Cook et al 2012)

2. the original Band collision model has been extended to enable such flight height distribution data to be used in the collision calculation (Band, 2012, see Figure 1)

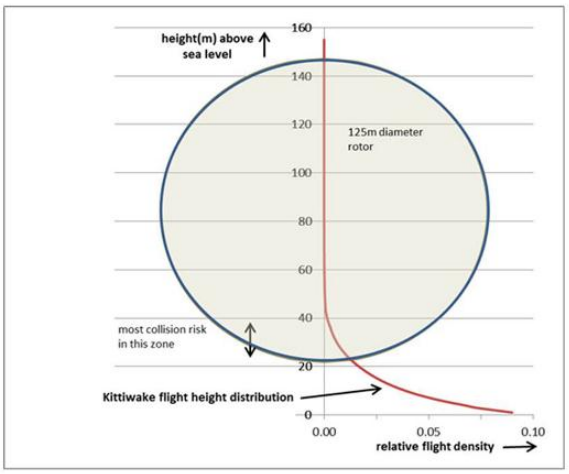


**Figure 1**: Generic flight height distribution for black-legged kittiwake.

The 'extended collision risk model' usually yields a significantly reduced prediction of collision risk for seabirds whose flight height distribution is skewed towards low altitudes (Figure 2). This is due to:

**(i)** the actual risk height presented by the rotors

**(ii)** the reduction in swept area towards the lower edge of the rotor

**(iii)** the decrease in collision risk of a single transit from the rotor centre to the rotor edge

**(iv)** the dependence on tidal state (bird flight height is relative to sea surface)

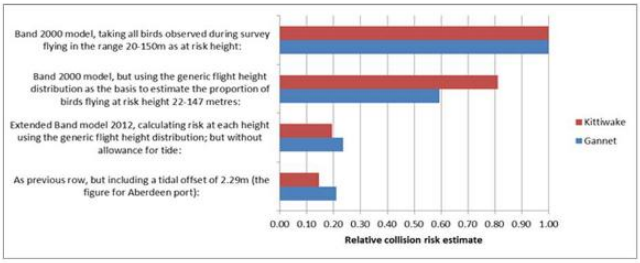


**Figure 2**: The effect of using the extended model on northern gannet and black-legged kittiwake. Both species exhibit a flight distribution skewed to low altitude.

## The Influence of Turbine Clearance

The application of the extended Band Model allows the influence of turbine clearance upon collision risk to be considered with both positive and negative change in collision risk resulting from increasing turbine clearance by 10m or 20 m (Table 1). For those species exhibiting a reduction in collision risk with increased clearance, significant changes may occur with relatively small increases in clearance (Figure 3).

**Table 1**: Example changes in estimated risk resulting from increasing turbine clearance by 10m or 20m above Highest Astronomical Tide (HAT)[1]

| | Turbine clearance above sea level | | |
|---|---|---|---|
| | minimum | +10m | +20m |
| clearance above HAT(m) | 22 | 32 | 42 |
| hub height above HAT(m) | 84.5 | 94.5 | 104.5 |
| **Species** | **Collision risk relative to risk at minimum clearance** | | |
| Northern gannet | 100% | 130% | 183% |
| Herring gull | | 71% | 57% |
| Black-legged kittiwake | | 25% | 7% |
| Northern fulmar | | 53% | 26% |
| Great skua | | 79% | 61% |
| Sandwich tern | | 49% | 17% |
| Red-throated diver | | 66% | 46% |
| Common guillemot | | 142% | 136% |
| Shag | | 9% | 3% |

*[1]Based on 5MW wind turbines with rotor diameter of 125m, a maximum blade width of 4.3m, an average blade pitch of 15 degrees, mean rotor speed of 9.9 rpm, hub height of 84.5m and turbine clearance above sea level of 22m.*

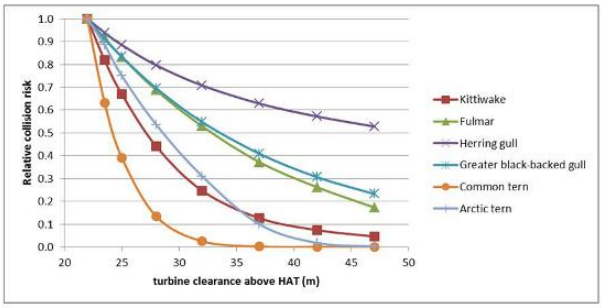


**Figure 3**: Relative collision risk as a function of turbine clearance for a subset of bird species

## Conclusion

Whilst problems still exist in the accurate measurement or estimation of bird flight heights during surveys and appropriate bird avoidance rates are still being determined, adjustments to turbine clearance height may provide opportunities to manage collision risk for a range of bird species.