Whitfield, D.P. and M. Madders. 2006. A review of the impacts of wind farms on hen harriers *Circus cyaneus* and an estimation of collision avoidance rates. Natural Research Information Note 1 (revised). Natural Research Ltd, Banchory, UK.

Abstract: Assessment of the impacts of proposed wind farms on hen harriers is often hampered by an apparent paucity of available information from studies of impacts at operational wind farms. To a large degree this is because few studies are readily or obviously accessible, and so the purpose of this review was to utilise those studies which could be accessed (primarily reports posted on websites) to examine the evidence for the susceptibility of hen harriers to the two main impacts of terrestrial wind farms on birds: displacement/disturbance and fatality through collision with rotating turbine blades.

At least eight studies of hen harrier displacement effects have been conducted, using several study designs, in USA and continental Europe. Only one study documented good evidence of displacement and it was reasonable to conclude that although further studies are highly desirable, if displacement of foraging occurs then it will likely be limited to within 100 m of wind turbines if it occurs at all. In keeping with most other studies of raptor displacement, therefore, it appears that foraging hen harriers have a low sensitivity to disturbance at operational wind farms. Persecution of some UK hen harriers may make such populations more susceptible to disturbance, however. Displacement impacts on nest site selection are more poorly studied, and preliminary results from Scotland and Northern Ireland indicate that birds will nest 200 – 300 m from turbines.

At least 10 wind farms where hen harriers occur have been subject to research on collision fatalities. Deaths were recorded at three sites with only a single study, involving searches over 7,500 turbine-years, recording more than one casualty, and no collision victims were recorded at seven sites. Against expectations, documented mortality was not positively related to harrier activity since wind farms with recorded deaths were those with the lowest harrier activity levels. The cause of this apparently counter-intuitive result was not obvious, with the height of rotor blades (since harriers typically fly at low altitudes) and an index of risk exposure not offering satisfactory explanations. It was apparent, nevertheless, that hen harriers do not appear to be susceptible to colliding with turbine blades and that collision mortality should rarely be a serious concern.

Collision risk modelling under the Band Collision Risk Model (CRM) (Band et al. 2006) can be used to estimate predicted mortality rates at proposed wind farms. Avoidance rates under the Band model (the extent to which birds avoid colliding with rotor blades) were estimated from eight wind farms in USA: estimates were 100% (at six sites), c. 99.8% (at one site) and 93.2% (at one site). For the six sites with 100% avoidance, harrier activity levels were relatively high so this could not explain the absence of any fatalities and at two of these sites searches were conducted at 50 to 150 turbines over several years. At the remaining four sites with no fatalities a combined 101 turbines were searched for four years in total. All eight studies accounted for search biases due to observer efficiency and corpse removal. Thus, there was no evidence of any deficiencies in the methods employed at the sites where avoidance was 100%. It is suggested that harrier collisions are relatively rare events and probably subject to stochastic or accidental conditions and hence sampling may produce occasional relatively low avoidance rate estimates while most estimates are substantially higher. Unbiased estimates may therefore require studies at a substantial scale and duration which are probably impractical and difficult to justify cost-effectively. Combining results from several smaller scale studies may thus provide an appropriate solution and for the 'non-Altamont' USA studies a 99% avoidance rate predicted a combined number of harrier fatalities very close to the empirical measure. In conclusion, an assumption of 95% avoidance is likely to be overly cautious and an avoidance rate of 99% appears to be more realistic.