This paper forms part of the proceedings from the BOU conference ***Climate Change and Birds****.*
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Whooper Swan *Cygnus cygnus* migration in relation to offshore wind farms

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Background

Installation of wind farms has increased rapidly across Europe over the last two decades, as governments seek to reduce the greenhouse gas emissions associated with climate change and secure energy supplies through greater use of renewable resources. Although there is increasing evidence for climate change having a deleterious effect on avian populations (Bright *et al*. 2006), there is also concern that wind farms may have direct negative effects on the birds through collision mortality, decreased landscape function (barrier effects) and displacement from feeding areas (Drewitt & Langston 2006). Accurate assessment of potential cumulative impacts from multiple wind farms along a flyway is a major challenge as it requires detailed information on the birds' migration routes. Where there is evidence of potential risk at one or more sites, specific research projects should be undertaken in order to support conclusions made within Environmental Impact Assessments (EIAs) for each development.

One such project is the satellite-tracking of Whooper Swan *Cygnus cygnus* migration between Great Britain and Iceland, undertaken in 2009 by the Wildfowl & Wetlands Trust (WWT) in association with COWRIE Ltd (Collaborative Offshore Wind Research into the Environment). Several of the offshore wind farms planned for Great Britain are likely to coincide with the flight paths of Icelandic-breeding swans and geese that winter in this country. There is particular concern for Whooper Swans because their large size makes them less manouvrable than other smaller species, raising the risk of them flying into the turbines; flying accidents are known to be a major cause of death for these birds (Brown *et al*. 1992). Moreover, as Great Britain receives 42% of the Icelandic Whooper Swan population each winter (Worden *et al*. 2009), it has a particular responsibility for the conservation of these birds. The study therefore aimed to provide detailed information on the swans' migration routes and flight heights in relation to current and proposed offshore wind farm sites, particularly in relation to the large Round 3 zones identified for the North Sea and East Irish Sea.

Methods

Forty 70-g solar-powered GPS satellite transmitters were fitted to Whooper Swans at three sites of international importance for the species in winter 2008/09: 20 at Martin Mere, Lancashire; 15 at Welney, Norfolk; and five at Caerlaverock, Dumfriesshire. The tracking of swans from Martin Mere and Welney provided detailed information on the routes taken from the southern part of their wintering range. A further 10 transmitters were fitted to swans caught in Iceland in summer 2009 to provide additional data on their autumn migration. The transmitters provided hourly data on the swans' locations between 18:00 and 11:00 h in spring (8 March–15 May), and every 2 h between 06:00 and 20:00 h in autumn (15 October–29 November).

Swan location data downloaded from the ARGOS satellite and weather data from British weather stations were imported into a GIS. Generalized linear mixed models were used to determine which environmental variables (particularly weather conditions) had a significant influence on the swans' onward movement (Griffin *et al*. 2010).

Results

Whooper Swans tracked from wintering sites in western Britain (Martin Mere and Caerlaverock) all migrated along the west coast of Britain and 95% departed the country over the Outer Hebrides. Swans from southeast

England (Welney) were more likely to migrate along the east coast of Britain, with 11 (73%) passing over the Firth of Forth and nine (60%) continuing via the Moray Firth to depart for Iceland from northern Scotland, but four (27%) crossed from southeast to northwest Scotland to depart over the Hebrides (Fig. 1).

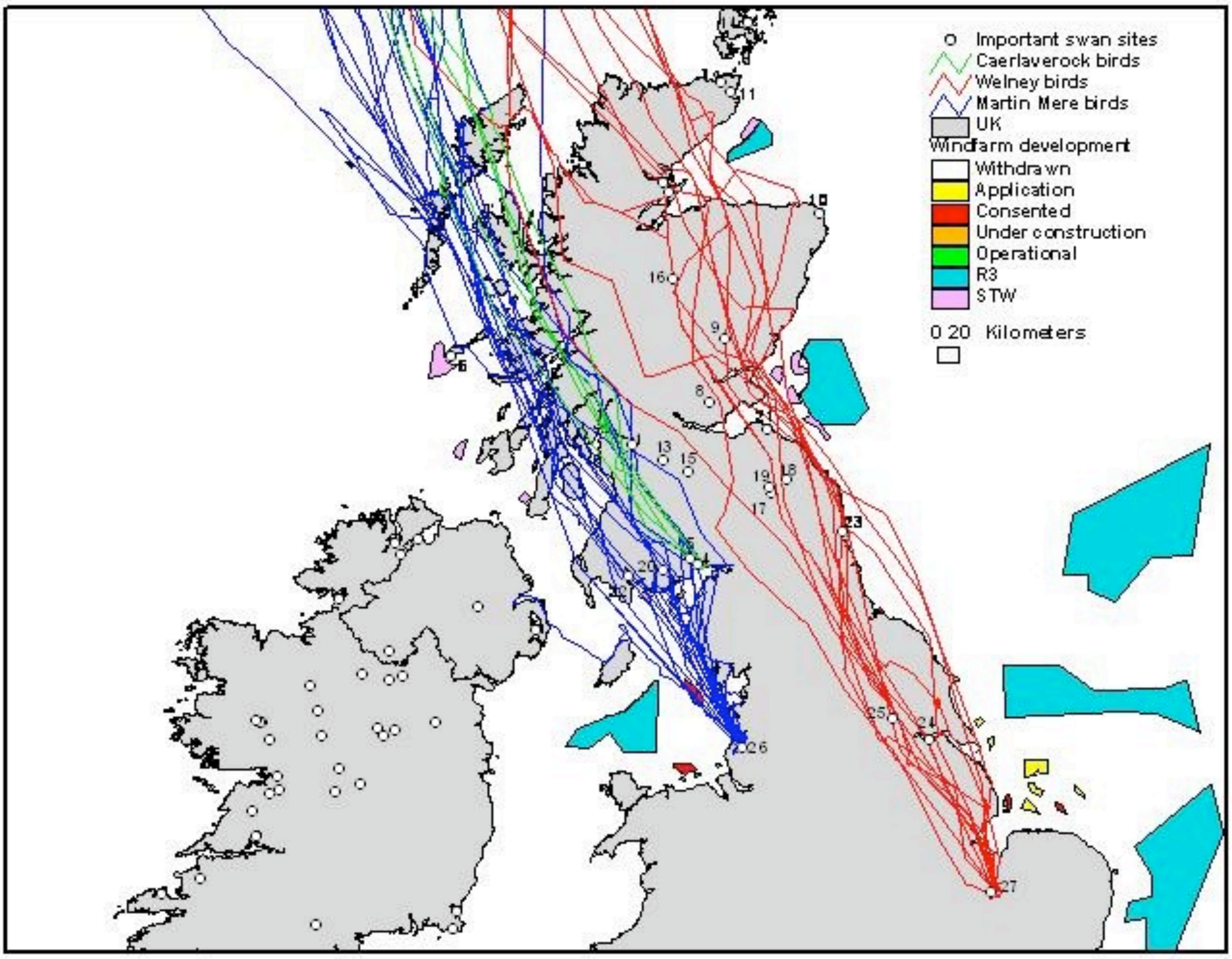

Figure 1. Migration routes in spring 2009 of Whooper Swans fitted with satellite transmitters, in relation to sites of national or international importance for the population. (Important Whooper Swan sites as reported in Robinson *et al*. 2004.)

Of 19 swan tracks in the East Irish Sea, seven (37%) passed across or immediately adjacent to existing or consented wind farm sites (Barrow, Ormonde, Walney and West Duddon), and a further eight (42%) passed <5 km from these sites, but none passed across the proposed Round 3 East Irish Sea zone. On crossing the Solway Firth, 50% of these swans passed across or adjacent to the existing or proposed sites of Wigtown, Solway Firth and Robin Rigg, with two more (10%) passing <5 km from these sites. Meanwhile, none of the Whooper Swans following the east coast of Britain passed across wind farm locations; all 15 tracks passed either over land or within the inner areas of the Wash, thus avoiding overlap with proposed Round 3 wind farm zones in the North Sea. Overall, 16 (40%) of the 40 swans tracked on spring migration passed across at least one offshore wind farm site and three birds (8%) passed across two sites (Fig. 1). This represented 75% and 15%, respectively, of the 20 Whooper Swans tracked from Martin Mere.

The swans migrated by day or night but were significantly more likely to continue migration during the day than under moonlight or dark conditions. As expected, Whooper Swan migration was also more common on tail winds than side winds, with little onward movement on head winds. The swans mostly travelled under conditions of high and rising atmospheric pressure, which may reflect its association with improved weather and lighter winds. Variables that were non-significant in initial analyses included the swans' wintering site, whether the birds were migrating over land or water, temperature, visibility, precipitation and fog (Griffin *et al*. 2010).

Conclusions

The study noted that detailed local studies, notably radar studies, should be conducted at wind farm locations on Whooper Swans' migration routes, both before and after construction, to advise on the positioning of the turbines and to assess whether the installations have any impact on the birds. Priority should be given to key passage areas, such as the Cumbrian coast, Solway Firth and the North Channel in western Scotland. Satellite-tracking studies should be used to determine the migration routes of swans and geese, to inform future offshore wind farm EIAs. We recommend that a high level of information exchange between all parties be maintained, to facilitate the increase in use of renewable energy sources whilst ensuring that any negative impact on Whooper Swans and other species is kept to a minimum.

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CITATION: Griffin, L., Rees, E. & Hughes, B. 2010. Whooper Swan migration in relation to offshore wind farms. *BOU Proceedings – Climate Change and Birds*. http://www.bou.org.uk/bouproc-net/ccb/griffin-etal.pdf

