Offshore wind farms and birds: Round 3 zones, extensions to Round 1 & Round 2 sites & Scottish Territorial Waters

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Contents

Introduction

In December 2007, the government announced a third round of offshore wind farm development as a key component of delivering 15% of the UK's energy (electricity, heat and transport fuel) from renewable sources by 2020. On 4 June 2008, The Crown Estate (CE) first released their suggestions for potential Round 3 (R3) development zones, updated in September 2008 (Figure 1) pre-empting the outcome of the SEA process. CE 's intention was to accelerate the planning process by pre-qualifying interested developers and sharing the costs – and hence risks - of application, in readiness to move forward once the SEA consultation had taken place and the resulting government decision had been announced. A Strategic Environmental Assessment (SEA) was published in January 2009 (DECC 2009). The UK government's Renewable Energy Strategy was released on 17th July 2009. CE is now required to carry out an Appropriate Assessment of its R3 plan for offshore wind development. In addition to the proposed R3 zones, expansion of R1 & R2 sites is envisaged ("R2.5", CE 29 July 2009) (Figure 1), together with applications for test sites which, in theory, may be anywhere around the UK coast, but will not exceed 100MW per installation (CE September 2009).

In a parallel process, CE invited bids for offshore wind development in Scottish Territorial Waters (STW), and has now identified areas in which exclusivity agreements apply (Figure 1). An SEA for STW, was initiated in 2009 under the auspices of the Scottish Government.

This document focuses on seabirds and waterbirds in UK continental shelf waters, their coastal breeding colonies and non-breeding coastal and marine distributions. The purpose of this document is to identify those bird species which are most likely to be priorities for data collation and collection as part of the planned further development of offshore wind energy, and subsequent Environmental Impact Assessments (EIAs) for individual projects, especially in the areas mapped by CE as potential development R3 zones, R1 & R2 areas, and STW (Figure 1). The document also identifies knowledge gaps. This information will help to: inform the RSPB's responses to future wind farm proposals; encourage a consistent approach in dealing with offshore wind energy casework; provide advice to government, statutory agencies, CE and industry on monitoring and research requirements; and, hopefully, expedite the process by facilitating the targeting of effort where it is needed most.

Policy context

The RSPB believes that climate change is the greatest threat we face and that wildlife is likely to be the earliest victim. For example, science suggests that one third of land based species are threatened with extinction by 2050 unless action is taken to tackle climate change (Thomas *et al.* 2004). In addition, Huntley *et al.* (2007) suggest that;

- The centre of the potential range of the average European breeding bird is predicted to shift nearly 550 km north-east and is only 4/5 the size of the current range.
- For some species, the potential future range does not overlap with the current range at all. The average overlap is 40%.

- Projected changes for some species found only in Europe, or with only small populations elsewhere, suggest that climate change is likely to increase their risk of extinction.

The scientific consensus is that we need to prevent global temperatures rising by more than 2 degrees centigrade above pre-industrial levels and that global greenhouse gas emissions need to halve by 2050 with developed countries taking their fair share and reducing their emissions by 80 - 95% in this period. We continue to campaign for this scale of reduction, as part of the Stop Climate Chaos coalition, and are seeking this in the frameworks provided by climate change legislation across the UK.

Research that we have undertaken (IPPR, WWF & RSPB 2007) suggests that much more effort needs to be invested in reducing the amount of energy we use, in stabilising aviation emissions and decarbonising the electricity sector.

We need a revolution in the energy system which does not rely on the most polluting power stations such as coal fired power stations which do not have the capacity to store greenhouse gas emissions, but rather switches to investing in demand management, energy efficiency and renewable energy generation. This is why the RSPB supports the UK Government's plans to require a tenfold increase in energy from renewable sources (as obliged under the EU target for 20% of Europe's energy needs to come from renewable sources by 2020). Yet, we also want this energy revolution to take place in harmony with the natural environment. This is the core of our response to the Renewable Energy Strategy consultation and the RSPB's Climate Action Now campaign.

Bird distributions and movements in and around UK seas

Seabird breeding colonies

The UK is of outstanding international importance for its breeding seabirds (Figures 2 & 3), notably Manx shearwater (Appendix I gives Latin names of birds referred to in the report), northern gannet, great skua and lesser black-backed gull for which it supports over 50% of their respective biogeographical populations (Reid in Mitchell *et al.* 2004). As a consequence, the UK has particular responsibility under the EU Birds Directive to secure the conservation of its important seabird populations.

Since 2000, there has been a decline of 9% in the numbers of seabirds breeding around the UK, owing to a greater frequency of poor breeding productivity, notably in species that feed on shoals of small fish, such as sandeels (JNCC 2009). It is thought that food shortage leads to lower adult survival and reduced breeding productivity, as observed in black-legged kittiwake and European shag. Historically, over-fishing of sandeels was considered to be the main cause, but there is more recent evidence of a progressive increase in sea temperature affecting the availability of sandeels (Frederiksen *et al*. 2004; Wanless *et al*. 2007). Additionally, predation by non-native mammals, such as American mink, has contributed to reduced breeding productivity, although efforts are being made to control or eradicate these predators, notably from island colonies important for breeding seabirds.

Non-breeding distributions of birds at sea

European Seabirds At Sea (ESAS) data are acknowledged to be patchy in their coverage of UK waters, available at a fairly coarse spatial resolution, and now mostly in excess of ten years' old; many data are considerably older (Pollock & Barton 2006). Nonetheless, they represent the most comprehensive dataset available on the distribution and relative abundance of birds in UK waters (Stone *et al.* 1995; Camphuysen 2005, Kober *et al.*in prep.), reflecting both the need to determine how representative they are of current distributions and to plug gaps in knowledge to ensure that proposed marine SPAs really are the "most suitable territories" (EU Birds Directive). Survey coverage offshore has been particularly patchy in recent years, although there has been some limited resurvey of the outer Moray Firth, central North Sea and Dogger Bank for the Offshore Energy SEA (Batty 2008a & b, Cronin 2008 a & b, Leaper 2008).

For Round 2 offshore wind farm development, the RSPB was instrumental in encouraging DTI/BERR/DECC (Department of Energy & Climate Change) to develop a coordinated programme of aerial surveys, in conjunction with developers and the WWT, over the three strategic areas of NW England (Liverpool Bay), the Greater Wash and the Greater Thames (Hall *et al*. 2003, DTI 2006, BERR 2007, WWT 2009). This survey programme served the dual purpose of comprehensive coverage of large sea areas, providing contextual information as well as data for specific proposal sites for offshore wind farms, and more efficient deployment of scarce resources (skilled aerial survey ornithologists and suitable light aircraft). These aerial surveys were complementary to those carried out in targeted sea areas by the JNCC Seabirds at Sea team (e.g. Dean *et al.* 2003, 2004; Söhle *et al*. 2006; Wilson *et al*. 2006; Lewis *et al*. 2008), and those commissioned by CCW. Aerial survey coverage of inshore waters has been good in recent years, at least for the winter months, notably in 2004/05 to 2007/08 (Figures 4, 5a & 5b – NB there is overlap of some JNCC survey coverage in these figures).

Land-based surveys, mainly collected by the Wetland Bird Survey (WeBS) or local *ad hoc* seawatching surveys and data from bird observatories, extend only a short distance offshore into coastal waters, mostly ranging from 500m to 2km, depending on weather conditions (e.g. Musgrove *et al.* 2003; Austin *et al.* 2008). These data provide an indication of species present in coastal waters and potentially of distributions further offshore, including migratory routes.

Bird movements, foraging ranges, feeding concentration

Data from the UK ringing scheme provides information on origins and destinations for many bird species, through recaptures and recovery of dead birds, but provides little information about actual routes taken between breeding and non-breeding areas, (Wernham *et al.* 2002, BTO Migration Mapping Tool http://blx1.bto.org/ai-eu/). Information on migratory routes is sparse, although recent technological advances have provided useful tools for this application and our state of knowledge is expanding rapidly (e.g. Burger & Shaffer 2008).

Foraging ranges vary both within and between species, and within and between seasons. Food availability and distribution in any one year will influence foraging range, as does the stage of the annual cycle (e.g. Ratcliffe *et al.* 2000). Provisioning growing chicks is a particularly demanding stage of the breeding season and different species have different adaptations for dealing with these pressures. For example, terns generally make many short foraging flights to provide multiple deliveries of food, whereas shearwaters may be away on a single foraging trip of more than 24 hours when they are feeding chicks. For terns, this leads to elevated flight activity between the breeding colony and proximate feeding areas, although the locations of the latter may change as prey availability changes. In a bad year, they may have to make longer flights to find food for their chicks, and chick survival is likely to be lower in these years.

A wide range of seabird species has been recorded at increased densities at tidal mixing fronts, notably sub-surface and pursuit diving species such as northern fulmar, Manx shearwater, European storm petrel, northern gannet and auks. Various fish species concentrate to feed on plankton blooms associated with these seasonal fronts. Species such as northern fulmar, European storm petrel and Leach's storm petrel often forage at the edge of the continental shelf. Shallow waters around sandbanks attract foraging birds that feed on sandeels, e.g. terns, divers, shags, auks, northern gannets, black-legged kittiwakes (various authors cited in Ratcliffe *et al.* 2000). Currently, there is fairly limited, but increasing, understanding of the complex relationships between marine features and seabird foraging behaviour.

Understanding foraging associations with particular environmental features in the oceans is essential for identifying offshore feeding aggregations for marine SPAs and for risk assessment of offshore wind farms. It is likely that multidisciplinary approaches will be necessary, together with combinations of techniques. For example, surveys of distribution and abundance alone are inadequate to determine the importance of a feeding location without also knowing which colony or colonies are the sources of feeding aggregations. Several studies of northern gannets illustrate this well, as birds from Bass Rock forage in parts of the North Sea that are closer to other gannetries than that at Bass Rock (Hamer *et al.* 2000). SPEA and SEO BirdLife in Spain have used a combination of approaches to identify marine Important Bird Areas (IBAs; SPEA & SEO 2006, Ramirez *et al.* 2008). Models of habitat suitability integrated with tracking data are promising for identifying feeding areas (Skov *et al.* 2008).

Spatial prediction models were developed at Horns Rev, in Denmark, for divers and common scoters using landscape, topographic, hydrographic and prey data available for the entire study area (Skov *et al.* 2008a). The parameters used to predict the densities of the two species included current speed at surface, salinity gradient at surface, temperature gradient at surface, water depth, relief of sea floor, complexity of sea floor, distance to shipping lane, distance to coastline, distance to Horns Rev 1 wind farm, and modelled distributions of American razor clam *Ensis americanus* and the cut trough shell *Spisula subtruncata* (important prey items for common scoter). The hydrographic data were taken from the fine-scale hydrodynamic model set up for the development of models of the distribution of common scoter prey species (Skov *et al.* 2008b), which in turn were used as a substitute for data on prey. Distributions of divers (red-throated & black-throated) were correlated with the gradient zone between estuarine waters and the mixed marine waters of the North Sea and estuarine waters of the southern German Bight. The modelled distribution of common scoter fit well with the observed distribution in areas dominated by *Spisula subtruncata*, mainly east of Horns Rev I and close to Blåvandshuk (inshore), but not so well in central and western areas, including over Horns Rev II, where *Ensis* was prevalent. These models are a promising tool for interpreting and predicting spatial distributions in response to environmental change, but require further development.

Increasingly, novel technologies are being deployed to track birds, in particular to investigate foraging behaviour (e.g. Burger & Shaffer 2008). Radiotelemetry has been used to track birds over relatively short distances and short timescales, e.g. little terns from breeding colonies at Great Yarmouth North Denes and Winterton in relation to Scroby Sands offshore wind farm (Perrow *et al.* 2006), Manx shearwaters' rafting behaviour in the vicinity of several breeding colonies (Wilson *et al.* 2008, 2009). GPS data loggers offer the ability to track birds over considerably greater distances and time frames, but necessitate recovery of the data logger, or close approach for remote data download, to extract the information. Data loggers are useful for site-faithful birds marked and recaptured in breeding colonies, e.g. Manx shearwater (Guilford *et al.* 2008) and black-legged kittiwake (Daunt *et al.* 2002). Satellite tracking offers the greatest potential to follow birds over potentially huge distances and over extended time periods, up to several years if solar powered devices are used, but at present only for birds of large body size, such as northern gannet (Hamer *et al.* 2000, 2001, 2007). This technology has particular value for elucidating bird migration routes and there is considerable flexibility in terms of the frequency of obtaining positional information. COWRIE has commissioned a research project to satellite-track whooper swans migrating to and from breeding grounds in Iceland, to determine the routes they use, provide an indication of flight elevation, and contribute to a better understanding of collision risk in relation to wind farms in sea areas through which whooper swans migrate (Griffin *et al.* in prep., see also http://whooper.wwt.org.uk/whooper).

In terms of assessing risk associated with wind turbines, there is a need to distinguish the distance within which most foraging flights occur, rather than merely the extremes, as flight activity (number of flights, not necessarily number of individual birds) levels are influential in determining risk. BirdLife International (BLI in prep.) is in the process of reviewing foraging ranges for seabirds (Table 1), updating and incorporating Ratcliffe *et al.* (2000; RSPB 2000). However, BLI has not yet reviewed foraging ranges for gulls and petrels for which Ratcliffe *et al.* (2000) considered that most foraging was within 15 km for black-headed and common gulls, within 40 km for herring, lesser black-backed and great black-backed gulls and over 100 km for European storm petrel and Leach's storm petrel. Foraging range may vary for different breeding colonies and for some species is influenced by following fishing boats in search of discards.

Marine Protected Areas

At present, the main focus for work on marine protected areas for seabirds is the identification and designation of the Special Protection Area (SPA) network in the marine environment. This work will extend to nationally important sites as and when relevant national level marine legislation is enacted (Marine and Coastal Access Act 2009 for England & Wales; Marine (Scotland) Bill 2010).

Currently, nearshore marine extensions to seabird breeding colonies are the main focus of attention for designating marine SPAs. The proposed colony extensions currently apply to those species for which sample sizes are adequate to determine densities of birds engaged in maintenance behaviour in the waters surrounding breeding colonies, namely northern fulmar, Manx shearwater, northern gannet, common guillemot, razorbill and Atlantic puffin (JNCC, McSorley *et al*. 2003). These extensions are considered to represent concentrations of seabirds engaged in maintenance behaviours and do not necessarily reflect foraging ranges or main foraging locations, which will be the subject of separate SPA designations. Scottish Natural Heritage (SNH) has classified 31 colony extensions in Scotland, based on modelled bird densities (Appendix II).

For northern gannet, significantly higher predicted average densities of birds, engaged in maintenance behaviour, were found within 2 km of the breeding colony than at greater distances, both around Grassholm off the Pembrokeshire coast and around Bass Rock in the Firth of Forth (McSorley *et al.* 2003). Thus, diminishing densities are likely further offshore, at least within the limited 4-5 km range of assessment around colonies, except at offshore feeding aggregations. In the case of Manx shearwater, the greatest use of waters around breeding colonies, notably for rafts formed towards dusk, and during darkness, prior to visiting nests, was found to be 4 km around Skomer, 6 km around Rum, and 9 km at Bardsey Island (Reid & Webb 2005, McSorley *et al.* 2008, Wilson *et al*. 2008, 2009).

There are also informal proposals for marine SPAs in Liverpool Bay for wintering common scoters and red-throated diver (NE, CCW, JNCC 2009[1]; Webb *et al.* 2009a), and the Outer Thames Estuary for wintering red-throated diver (NE, CCW, JNCC 2009; Webb *et al*. 2009b), as part of the plan for SPAs covering inshore aggregations. [The RSPB considers several additional species qualify for SPA designation at these sites, including foraging terns and passage and wintering little gull]. Other locations that have been assessed for their potential qualification as SPA for inshore aggregations include Tay Bay (Söhle *et al*. 2007) and the Firth of Forth (Dawson *et al*. 2008). Assessment of SPAs for offshore foraging areas, the third strand of SPA designation, is in the early stages of investigation, is based primarily on spatial analysis of ESAS data, and has started the process of identifying areas that qualify for SPA designation (Kober *et al.* in prep.).

As part of its work towards establishing SPAs, JNCC is using boat surveys, visual tracking of foraging flights and radiotracking to identify foraging area extensions to SPAs for breeding red-throated divers. They are carrying out aerial surveys to produce distribution and abundance data for terns around

[1] http://www.naturalengland.org.uk/ourwork/marine/sacconsultation/default.aspx

key tern colonies, combined with visual tracking of foraging flights (L. Wilson pers. comm.). They are also collecting additional field data to identify feeding aggregations of seabirds throughout the year in UK continental shelf waters. It would be valuable for JNCC to re-survey sample areas for which they have undertaken spatial analysis of ESAS data to determine whether similar patterns of distribution and abundance occur now, notably areas for which apparent data deficiency constrains the ability to identify potential SPAs (Kober *et al.* in prep.). This would either increase confidence that the use of ESAS is fundamentally sound, or demonstrate that, on its own, it is a flawed approach for defining SPA boundaries. Inclusion of additional data, from other surveys and research programmes would make a valuable contribution to identifying SPAs.

Currently, it is unclear to what extent there will be overlap between offshore wind development proposals and future offshore marine SPAs. Earlier work by RSPB/BLI (RSPB 2000) recommended that extensions to seabird breeding colonies should encompass feeding areas such as the Minch, Smith Bank (Moray Firth), Wee Bankie and Marr Bank (Firth of Forth), which overlap with potential R3 or STW offshore wind farms.

Risk factors in relation to offshore wind turbines

The main potential risks for birds are collision; disturbance/displacement; barriers to movement of e.g. migrating birds, or disruption to functional links, for example between feeding and breeding areas; habitat change with associated changes in food availability; and the cumulative effects of these across multiple wind farms.

Location remains the most important risk factor, in particular distance offshore and the level of flight activity by species for which, or at times when, elevated collision risk is likely. The problem is that we know rather little about the locations of offshore feeding concentrations in UK waters, notably for birds from specific breeding colonies, but can begin to make some expert judgements about the likelihood of risk. There is a high potential risk of collision with wind turbines if they are located in areas in which there is a high level of flight activity by birds most likely to collide with turbine rotors or be affected by the associated turbulence. High levels of activity may be due to either feeding frenzies or high turnover of individuals using the area.

Risk level is a combination of distribution and behavioural characteristics of the species, which may vary seasonally and spatially as well as being age- and sex-dependent (Stienen *et al.* 2008). The evidence for terns is that they are generally manoeuvrable in flight, but flights occur within rotor swept height. Most tern collisions with the wind turbines at Zeebrugge coincided with incubation and chick provisioning and are likely to be attributable to the increased flight activity into and out of the colony and time pressures on the adult birds leading to them taking the most direct flights between breeding and feeding areas (Henderson *et al.* 1996, Everaert & Stienen 2007). The elevated collisions of male common terns were attributed to sex-biased variation in foraging activity during egg-laying and incubation (Stienen *et al*. 2008). When feeding chicks, they will generally forage closer to their breeding colonies unless failure of food supply forces them to forage further afield, so the collision risk for terns in several of the potential development zones for R3 offshore wind farms has to be reduced because of their distance offshore. Sandwich terns were observed to spend most of the time during foraging bouts at heights above 20 m, feeding by plunge-diving, whilst most foraging by common terns was observed close to the water surface owing to a predominance of surface-feeding (M. Perrow pers. comm.).

In the case of northern gannets, they plunge dive from 10-40 m above the water and fly within the rotor swept height but often forage over 100 km away from their breeding colonies and so easily within the range of R3 offshore wind farms. Understanding the relative importance and consistency of feeding aggregations will be key to assessing the level of risk for northern gannets. Studies of northern gannets from Bass Rock indicate linear relationships between foraging trip duration and, respectively, maximum distance from the colony (up to 440 km) and total trip distance (up to 1150 km), for foraging trips of up to 62 hours duration. Foraging trips of longer duration did not incur further increases in flight distance, indicating constraints on energy expenditure during flight (Hamer *et al*. 2007).

The height range of the rotor swept area will be critical to the risk of collision for birds offshore. Offshore swell affects wave height and hence flight elevation of species that generally fly close to the sea surface and wave crests, for example Manx shearwater. Whilst such species may be generally considered low risk in terms of collision with wind turbines, specifically in the case of the particular international responsibility that the UK has for Manx shearwater, any proposed wind farm development within the main feeding and loafing areas will require detailed assessment, in terms of collision risk and displacement/barrier effect, habitat and prey requirements, as most applicable to individual species of concern. Species whose flight activity currently extends to heights within the rotor swept area may have less overlap with the rotor swept area of the next generation of larger turbines, but the elevation of the lowest blade sweep is likely to be critical in determining risk. A precautionary approach will be necessary also for those species of which we know little about disturbance effects, but for which the UK has a special responsibility in terms of the populations that it hosts. These will require increased research effort.

Currently, there is limited practical experience of the effects of offshore wind farms on birds, but there are several useful studies from Denmark and Sweden. Radar studies at Nysted offshore wind farm, in Denmark, indicated a high degree of avoidance by large waterbirds during migration, mostly common eider *Somateria mollissima*, at least in fair weather (Desholm & Kahlert 2005). There was a significant reduction in migration track densities within the wind farm area post-construction (40.4% (n=1406) of flocks entered the wind farm area prior to construction of the wind farm (2000-2002) compared with 8.9% (n=779) during initial operation (2003) (χ^2=239.9, p<0.001). The birds' avoidance response was initiated at greater distance from the wind farm during daylight (≤ 3 km) than at night (≤ 1 km). A significantly higher proportion of migrating flocks entered the wind farm at night (13.8%; n=289), than during daylight (4.5%; n=378) (χ^2=17.1, p<0.001).

Aerial surveys of bird distribution and abundance and visual observations complemented the radar studies during daylight, and so at least partially compensated for the shadow effect of the wind turbines obscuring radar detection. Whilst flight activity is often depressed in poor weather, birds already migrating and caught in bad weather are likely to reduce their flight height. The frequency of weather conditions likely to affect flight behaviour, particularly for migrating birds, could be predicted from meteorological data.

Similarly, radar and visual observations at Utgrunden and Yttre Stengrund in the Kalmar Sound, Sweden indicated that most migrating common eider avoided flying close to these small wind clusters (respectively 7 and 5 turbines in parallel with the main direction of migration) (Pettersson 2005). This study provides a rare observation of collision by individuals in a flock of common eiders. A flock of approximately 310 eiders, in V-formation, flew past an outer turbine when several individuals in the outer flank, and therefore the rear, of the flock struck the rotating blade on its downward trajectory or were caught in the associated turbulence. Four birds were observed to fall into the water, of which at least two flew out and at least one was killed. This example illustrates the fact that turbulence around the rotors may pose a hazard and that birds do not necessarily have to be struck by the rotor blades for flight impediment or fatality to occur.

Experimental studies of wintering common eiders at Tunø Knob offshore wind farm in Denmark, involved placement of decoy flocks at different distances from the wind turbines, based on the principle that birds are more likely to settle where conspecifics are located (Larsen & Guillemette 2007). Nonetheless, common eiders were observed to reduce both the frequency of flights and landings on the sea surface at a distance of about 200m away from the turbines, indicating displacement.

Data from aerial surveys carried out before, during and following construction of the Horns Rev 1 offshore wind farm, in Denmark, were used to evaluate possible displacement effects of wind turbines on birds (Petersen *et al.* 2004). Distributional changes within the wind farm, the wind farm area plus 2km radius and the wind farm area plus 4km radius were assessed. Divers and common scoters showed almost complete avoidance of the Horns Rev 1 wind farm area in the first three years post construction (DONG *et al.* 2006). As proportions of the total numbers present, the displaced birds represented a relatively small proportion, but concerns were expressed about the potential for cumulative impacts of multiple wind farms along the flyway for these species. Subsequent surveys indicate that common scoters may now be utilising the sea areas within the wind farm in comparable densities within and outwith the wind farm. Changes in food availability, rather than the presence of the wind farm, may have led to the observed changes in distribution (Petersen *et al.* 2007).

Displacement from the wind farm area may result from disturbance due to the presence of turbines or increased levels of boat traffic, or helicopters, and maintenance crews, or result from changes to food supply that may, or may not, be a consequence of the wind farm. Seaducks and divers are noted for their susceptibility to disturbance and for forming "rafts" on the water surface of anything from a few individuals to several thousand (or even tens of thousands of) birds. Their predominant association with shallow waters ≤ 20 m restricts the likely overlap with Round 3 zones for wind energy development, albeit realistically most development will be located in shallower waters of less than 40-50 m initially. Extensions of R1 or R2 sites, test sites and sites in STW are likely to overlap distributions of these species (Appendix 1V & V).

The pressure to develop offshore wind farms in a relatively short timeframe prompted the production of a species sensitivity index for birds which was then applied to the German sectors of the North Sea and Baltic Sea (Garthe & Hüppop 2004). The species sensitivity index provides a useful measure to assist in prioritising bird species for assessing the risks applicable to the UK's offshore wind farm programme (Table 2). The modified scoring presented here for the UK is an initial assessment, and is not a substitute for updated baseline data collection (i.e. ESAS data), detailed EIA, targeted research and post-construction monitoring, but intended to make best use of available information until these sources improve that knowledge base. The relative importance of the UK for a species may mean that the cumulative impact score is high even for species thought to have low to moderate risk values because the consequence of any impact would be more likely to be significant for the biogeographical population. The sensitivity index has been revised for application to UK offshore wind farms (King *et al*. 2009) for a wider range of species than appeared in the original Garthe & Hüppop paper (2004), but would benefit from peer-review by a group of experienced ornithologists working together.

The ultimate test of impact, either for an individual development or cumulatively across multiple developments, is whether there is the likelihood of a decline in population size. There are two spatial scales at which this is relevant: SPA site condition assessment, in terms of assessing the effect on meeting the conservation objectives for the site, and the wider biogeographical population. Population models have some utility (Beissinger & Westphal 1998), but are heavily dependent on the available information, which is variable for different bird species (Maclean *et al*. 2007). The minimum requirements for running a Population Viability Model (PVA) are the starting population size, productivity, age-dependent survival and age of first breeding. Furthermore, assumptions have to be made that may or may not result in model outcomes that are realistic, see for example the population model for northern gannets at Troup Head in response to predicted collision mortality arising from the Beatrice pilot wind farm (Ratcliffe 2005). Specifically with offshore wind farms in mind, an attempt has been made to construct a PVA for Sandwich Tern on the North Norfolk coast (M. Perrow pers. comm.).

Priority species relevant to proposed areas for offshore wind

Species likely to be of particular concern in relation to offshore wind development and therefore priority for environmental assessment, have been identified here based on what is known of their distribution and ecology, notably their risk profile in relation to wind turbines, and conservation status in the UK (Table 2). Those species likely to be most relevant to the proposed R3 zones (Appendix III), proposals in STW

(Appendix IV) and areas encompassing R1 & R2 sites (Appendix V) are presented (Figure 1). Species lists will require refinement in the light of regional information and updates from further surveys and research.

Species have been identified, based on proximity to nearest major breeding colonies (most are SPAs) and likely foraging range for seabirds (RSPB 2000, Stroud *et al.* 2001, McSorley *et al.* 2003, Mitchell *et al.* 2004, Guilford *et al.* 2008) and, for non-breeding seabirds and waterbirds, based on the onshore SPA network, non-breeding offshore distribution, including marine IBAs (Stroud *et al.* 2001, Skov *et al.* 2005, Stone *et al.* 2005), and migration (Wernham *et al.* 2002). For reasons stated above, the nearest colony may not be the origin of a significant proportion of the birds recorded, but such distinction will be possible only following further investigation. In the absence of further research, there is a case to be made for including in the environmental assessment those SPAs within the likely main foraging range of the focal bird species (Table 1). The focus on major breeding colonies, those that are numerically most significant based on Apparently Occupied Nests (AON) or Apparently Occupied Territories (AOT) as per Mitchell *et al.* (2004), is an attempt to tease out areas and species of relatively greater biological significance from the UK coastline's almost uninterrupted conservation importance for breeding seabirds (Fig 2, supporting Excel spreadsheet). The information presented here is indicative of likely occurrence and priority for further study.

At the EIA scoping stage for any proposed wind farm development, it will be necessary to consider all bird species that contribute to the qualifying interest of the SPAs, within the likely range of birds using the potential wind farm development areas, and to apply a filtering process to determine priority species (King *et al.* 2009). This is best undertaken in consultation with the statutory agencies, the RSPB and other organisations that have particular expertise or relevant information. Early consultation will help to develop a consensus as to the focal species and study requirements, although it cannot be ruled out that surveys may identify additional species and issues of note.

Migrating birds (e.g. wildfowl and waders) may enter the collision risk zone if forced to fly at lower elevation because they encounter strong headwinds or bad weather during a sea crossing, or when approaching land, and so need to be included in the EIA risk assessment. Migration may be low over the water when making short sea crossings or at high elevations, well above turbine height, when unimpeded; birds fly at the altitude that maximizes flight efficiency. Many migrants will fly along or within a few kilometres of the coast to avoid making a long distance sea crossing. For example, many waterbirds migrating from the Arctic or other northern breeding grounds migrate through the Baltic or down the Norwegian coast to the Wadden Sea before crossing to the UK. However, some birds cross the North Sea from Scandinavia. Radar could be a useful tool in elucidating current migration patterns across the North Sea, as well as tracking more local offshore movements (Walls *et al*. 2009).

Data collection for environmental assessment

Baseline surveys

In view of the paucity of recent data for most offshore areas, year-round baseline data collection, over a minimum of two years, will be needed for all species (not just those thought to be the most likely priority species) in potential development zones and other areas proposed for wind farm development, to cover breeding and non-breeding distributions. Migration of seabirds, waterbirds and passerines occurs around the UK, notably across the North Sea and the Channel, so spring and autumn surveys will be needed too. Radar will be a valuable adjunct in some cases, for example assessing migration traffic or tracking movements of individual species groups such as geese. As with Round 2, previously unknown bird concentrations may be identified during additional data collection.

Baseline survey requirements will need to extend offshore, owing to a high proportion of the potential development zones occurring outside territorial waters. This will present new challenges to determine how best to deploy the standard techniques. Light aircraft used for aerial survey have limited flying range which will constrain the number of transects that can be flown over outermost zones in one day, but boat-based surveys of the larger zones would require many days, increasing the risk of incomplete coverage owing to unsuitable weather conditions and risking double-counting as birds move around within the zone and surrounding waters. Review of transect separation may be necessary, but needs to enable the production of estimates of bird density with adequate precision. Plugging gaps in the inshore waters aerial survey programme remains a high priority for those potential development zones within territorial waters, including STW, extensions to R1 & R2 sites, and test sites, and for identification of inshore SPAs. There are few inshore blocks that have received no coverage to date, but quite a few that have been surveyed only once, notably during summer. Whilst data collection for individual wind farms is the responsibility of the developer, coordinated survey effort maximises the provision of contextual information and makes best use of limited resources, as demonstrated for R2 (Figures 5a & 5b), so is to be encouraged for future offshore wind development.

Owing to recent confirmation that the low level flights used for conventional visual aerial surveys will not be permitted in many constructed wind farms, high definition techniques are being explored (Thaxter & Burton 2009). These entail recording video or still digital images from higher elevation, of the order of 450m or higher. These methods have several advantages, namely overcoming the health and safety concerns of low-level flights between wind turbines, minimising the risk of disturbance to birds, and providing a permanent image record that can be reanalysed as techniques evolve. This is an evolving technology as digital cameras are repeatedly upgraded and methods refined. The technology is in its infancy and minimum standards are required to ensure that at least compatible information to that from conventional visual aerial surveys is provided, in terms of identification of species/species groups. Further pilot surveys are likely to be needed to achieve the balance between flight time and the number and spacing of transects to obtain population estimates of acceptable precision. Protocols may differ, depending on the focal bird species of interest and the degree of spatial clumping that it adopts. Interpretation of the digital images requires skilled ornithologists and is a time-consuming exercise. Automation of the data extraction from images is a potentially valuable research direction (A. D. Fox pers. comm.). The main concerns in adopting high definition methods are the need to ensure an appropriate sampling framework and to enable comparison between pre- and post- construction data, notably for cases in which pre-construction data were collected by conventional visual aerial surveys and post-construction data are likely to be gathered by high definition methods. Changing methods runs the risk that detection of change after construction of the wind farm will be compromised by methodological differences.

Comprehensive survey of UK Continental Shelf (UKCS) waters is unrealistic, being impractical and hugely costly, but sample surveys are essential, as mentioned elsewhere in this paper, to validate the applicability of ESAS data to current patterns of distribution and abundance of seabirds. The requirements for information prompted by further development of offshore wind around the UK and designation of marine SPAs are joint drivers for coordinated survey effort and funding.

Targeted pre-construction studies

Once the range of species present in each wind farm proposal area has been established, from a combination of existing information and baseline surveys, further studies should focus on addressing specific questions for priority species relevant to each zone or application area, as required to improve our understanding of the potential environmental effects of wind farms. The scoping stage of environmental impact assessments will be crucial to ensure that resources are targeted at the most relevant studies. Such studies include tracking individual birds to establish foraging areas in relation to specific coastal breeding colonies and particular development areas. Studies of little, common and Sandwich terns have been carried out, or are underway, in several proposed locations for wind farms (Perrow *et al.* 2006, 2008), applying visual tracking of foraging birds from breeding colonies, radiotracking, boat-based colony transects to obtain flight bearings and passage rates into and out of breeding colonies, and individual based foraging models. Modelling is likely to be a valuable tool for identifying environmental determinants of bird distributions at sea as part of risk assessment.

Research to elucidate migrations and foraging destinations for a range of seabirds have been carried out using satellite tracking and data loggers (e.g. black-legged kittiwake, Daunt *et al.* 2002; European shag, Daunt *et al.* 2006; northern gannet, Hamer *et al.* 2007; Manx shearwater, Guilford *et al.* 2008), for which further studies, at different breeding colonies, would greatly enhance our understanding of connectivity between specific breeding colonies and foraging areas, and therefore providing essential information for environmental impact assessments of offshore wind farms. Other species that particularly merit application of these approaches include great skua, gull species such as lesser black-backed gull, European shag and common guillemot[2]. Divers and common scoters also would be priority species for tracking if suitable methods could be reliably applied; there has been some preliminary work on divers (A. D. Fox pers comm). Further tracking studies of migratory waterfowl also would enhance our understanding of risks applicable to these species, e.g. Bewick's swan, barnacle and brent geese.

[2] RSPB and partners are about to embark on research focusing on fulmar, gannet, shag, kittiwake, guillemot at sample colonies.

Recommendations

1. Collation of existing information on distribution and abundance of birds in UK continental shelf waters in a GIS compatible form; ideally bringing together data from aerial and boat-based surveys and providing a unified assessment by species of priority areas in breeding, wintering and passage periods, as well as identifying gaps in survey coverage. This would facilitate assessment of risk, but needs rapid delivery to do so.
2. Comprehensive baseline data collection, using a combination of aerial and ship-based surveys, as appropriate, using recommended methods (Camphuysen *et al.* 2004; Maclean *et al.* 2009, Thaxter & Burton 2009). Minimum of 2 years pre-construction data collection.
3. Co-ordinated survey programme to plug gaps in coverage and provide updated contextual information for UKCS waters. To include sample re-surveys of areas covered by ESAS, to determine whether broad patterns of distribution and abundance remain relatively unchanged or whether there have been changes that cast doubt on the value of using just historical ESAS data for identifying marine SPAs or areas of potential greater sensitivity for wind farm development.
4. Further research into foraging ranges and areas used by priority species relevant to each development area, making use of developing technology such as data loggers and habitat suitability modelling (also relevant to identification of marine SPAs).
5. Review sensitivity indices for birds in the UK continental shelf waters – either a workshop or email exchange, with a convener, involving several experienced ornithologists.
6. Collate and, where necessary seek to improve, information on population size, survival and productivity, age structure and frequency of non-breeding to facilitate population modelling for priority species.
7. Encourage and facilitate further research into migration and other flight movements at sea, notably to elucidate routes and variation in these by bird species of conservation priority. Further deployment of satellite tracking with enhanced frequency of positional information shows most promise, but currently is technically restricted to larger seabirds and waterbirds. This is an extension of 3.
8. Deployment of radar offshore, on fixed platforms post-construction, to improve our understanding of avoidance responses by e.g. migratory waterbirds or seabirds commuting to foraging areas (Desholm *et al.* 2005, 2006). Resolve how best to obtain complementary visual observations or use of thermal imaging cameras. OceanPod (Natural Power), and other similar prototype offshore research platforms, may be a useful development to facilitate offshore research.

9. Deployment of land-based radar[3] and complementary visual observations at several key locations, pre-construction, to observe departure and arrival bearings and flight elevation of migratory birds. Offshore deployment of radar to augment baseline data collection also potentially valuable for specific cases (Walls *et al*. 2009).
10. Encourage and facilitate the development of study techniques and, where applicable, mitigation measures for application in the marine environment and at offshore wind farms.

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[3] It is unlikely that this function can be fulfilled using the mobile avian radars, but will require more powerful radar.

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Table 1: Foraging range and habitat (BirdLife International Seabird Foraging Range Database)

	Foraging Range (km)				Key Habitats
Species common name	Max	Mean Max	Mean	Sample Size	
Arctic Tern	20.60	12.24	11.75	19	shallow bays, tidal flats, shoals, tide rips, ocean fronts, upwellings, ice edges and faces of tidewater glaciers
Arctic Skua	100.00	40	28.00	10	seabird breeding colonies, fishing boats
Atlantic Puffin	200.00	62.2	30.35	48	Shallow waters, tidal fronts, sand banks
Balearic Shearwater	200.00	34	29.29	7	continental shelf, fronts, offshore from estuaries
Black Guillemot	55.00	12	4.96	38	shallow inshore waters, hard rocky bottoms, edge of pack ice, kelp, littoral-sublittoral boundary
Black-legged Kittiwake	200.00	65.81	25.45	43	fronts, tidal upwellings and eddies, offshore sandbanks, areas with rocky seabed
Common Eider	100.00	38.33	9.25	10	shellfish beds, submerged reefs, rocky substrates, kelp beds, intertidal zones
Common Guillemot	200.00	60.61	24.49	122	fronts and other ocean features that concentrate prey, offshore sand banks, areas of sandy sediment
Common Scoter	200.00	8.2	4.50	11	shellfish beds, sandy areas, sand-mud, cobbles, gravel substrates,
Common Tern	37.00	33.81	8.67	42	shallow coastal waters, bays, inlets, shoals, tide-rips, drift lines, beaches, saltmarsh creeks, lakes, ponds, or rivers
Diver spp.	56.00	13.33	4.00	3	
European Shag	20.00	16.42	6.53	29	Shallow waters, sandbanks, gravel banks, tidal flow
Great Cormorant	50.00	31.67	8.46	25	Sandy areas, rocky and vegetated substrates, estuaries
Great Skua	100.00	42.33	35.80	5	seabird breeding colonies, fishing boats
Little Gull	50.00		23.58	3	shallow coastal waters, river mouths, tidal fronts, turbulent areas, offshore probably hydrographic features
Little Tern	11.00	6.94	4.14	33	very shallow water, tidal areas, lagoons, creeks, channels, coastal sand-banks
Manx Shearwater	400.00	196.46	171.67	13	continental shelf, frontal systems, stratified water
Northern Fulmar	664.00	311.43	69.35	51	Shelf breaks, offshore banks, frontal zones, tide and rip currents
Northern Gannet	640.00	308.36	140.09	62	Deep-water depressions, tidal mixing fronts, sandbanks, inshore and coastal waters
Razorbill	51.00	31	10.27	48	shallow waters, sandy seabed, upwellings, tidal fronts
Red-throated Diver	50.00	12.21	11.06	9	tidal estuaries, mudflats, surface fronts
Roseate Tern	30.00	18.28	12.30	26	shallow areas, tide rips and shoals, upwelling areas, sandy bottoms, inlets
Sandwich Tern	70.00	42.3	14.70	17	bays, inlets and outflows, gullies, shoals, inshore waters, reefs, sandbanks
Velvet Scoter	20.00	18	7.40	4	shellfish beds, coastal estuaries, bays, hard sand or gravel bottom

Table 2: Sensitivities of species in relation to wind farms, or other known aspects of behaviour, and conservation status, to aid identification of focal study species at proposed offshore wind farms.

Species	Collision[1]	Displacement[1]	Barrier[1]	Habitat/ Prey[1]	SSI[2]	GB/UK Min %[3]	Overall Risk[4]
Bewick's/tundra Swan	***	*	*	-	*21.7*	**	***
Whooper Swan	***	*	*	-	16.7	*	***
Bean Goose (Taiga)	**	**	*	-	13.3	*	**
Pink-footed Goose	**	**	*	-	*15.0*	***	***
Greenland Greater white-fronted Goose	**	**	*	-	ns	***	***
European Greater white-fronted Goose	**	**		-	8.3	*	**
Greylag Goose (Iceland)	**	**	*	-	15.0	***	***
Greylag Goose (NW Scotland)	**	**	*	-	*15.0*	***	***
Barnacle Goose (nearctic)	**	**	*	-	ns	***	***
Barnacle Goose (Svalbard)	**	**	*	-	ns	***	***
Dark-bellied Brent Goose	**	**	*	-	*21.7*	**	**
Light-bellied Brent Goose (Svalbard)	**	**	*	-	ns	**	**
Light-bellied Brent Goose (Canada)	**	**	*	-	ns	***	***
Greater Scaup	*	**	**	**	*15.0*		
Common Eider	*	*	**	**	20.4	*	**
Long-tailed Duck	*	**	**	**	13.1	*	**
Common scoter	*	**	**	**	16.9	*	**
Velvet Scoter	*	**	**	**	27.0	*	**
Goldeneye	*	*	**	**	*15.8*	*	**
Red-breasted Merganser	*	*	**	**	*21.0*	*	**
Red-throated Diver	*	***	**	**	43.3	**	***
Black-throated Diver	*	***	**	**	44.0	*	***
Great Northern Diver	*	***	**	**	ns	**	***
Slavonian Grebe	*	**	**	**	23.3	*	**
Northern Fulmar	*	*	*	**	5.8	*	*
Cory's Shearwater	*	*			ns	?	?
Great Shearwater	*	*			11.9	?	?
Sooty Shearwater	*	*			8.3	?	?
Manx Shearwater	*	*		**	10.1	***	***
Balearic Shearwater	*	*		**	*12.5*	?	**?
European Storm-petrel	*	*		**	*6.0*	*	**
Leach's Storm petrel	*	*		**	*9.0*	*	**
Northern Gannet	**	*	*	*	16.5	***	***
Great Cormorant	**	*	**	**	23.3	**	**
Species	**Collision[1]**	**Displacement[1]**	**Barrier[1]**	**Habitat/ Prey[1]**	**SSI[2]**	**GB/UK Min %[3]**	**Overall Risk[4]**

European Shag	*	**	**	**	26.3	**	**
Corncrake	***		***		ns	***	***
Pomarine Skua	**	*	*	*	10.0	?	**?
Long-tailed Skua	**	*	*	*	ns	?	**?
Arctic Skua	**	*	*	*	10.0	*	**
Great Skua	**	*	*	*	12.4	***	***
Mediterranean Gull	**	*	*	*	ns	*	*
Little Gull	*	*	*	*	12.8	?	?
Black-headed Gull	*	*	*	*	7.5	*	*
Common Gull	*	*	*	*	12.0	*	**
Lesser black-backed Gull	**	*	*	*	13.8	***	***
Herring Gull	**	*	*	*	11.0	*	**
Iceland Gull	**	*	*	*	15.0		*
Glaucous Gull	**	*	*	*	16.7		*
Great black-backed Gull	**	*	*	*	18.3	**	**
Black-legged Kittiwake	**	*	*	*	7.5	*	*
Little Tern	*	*	*	**	ns	*	**
Sandwich Tern	**	*	*	**	25.0	**	**
Common Tern	**	*	*	**	15.0	*	**
Roseate Tern	**	*	*	**	ns	*	**
Arctic Tern	**	*	*	**	13.3	*	**
Common Guillemot	*	**	**	**	12.0	**	**
Razorbill	*	**	**	**	15.8	*	**
Black Guillemot	*	**	**	**	*22.0*	*	**
Little Auk	*	**	**	**	*7.0*	?	**?
Atlantic Puffin	*	**	**	**	15.0	*	**

[1]assessment based on combination of experience from operational wind farms, Garthe & Hüppop 2004, King et al. 2009: *low risk, **moderate risk, ***high risk, – not dependent on marine foraging habitat.
[2]ns = no Species-specific Sensitivity Index (SSI) score presented in Garthe & Hüppop 2004; NB this score takes account of SPEC status.
[3]King *et al*. 2009, sensitivity scores in *itatlics* (see text)
[4] The minimum % of the relevant biogeographical population breeding in Britain, is taken from Mitchell *et al.* 2004; UK non-breeding population estimates are from Baker *et al*. 2006 as a % of European populations from BirdLife International 2004, converted accordingly: * < 25%; ** 25 – 50 %; *** > 50%.
[5]Overall risk taken as the highest score across the table for each species. Species for which the UK has a high % of the population score high risk of impact because of the potential consequences for the population.

Figure 1: Round 3 zones, Scottish Territorial Waters proposed sites, and existing Round 1 & Round 2 sites to which extensions may apply (©The Crown Estate)

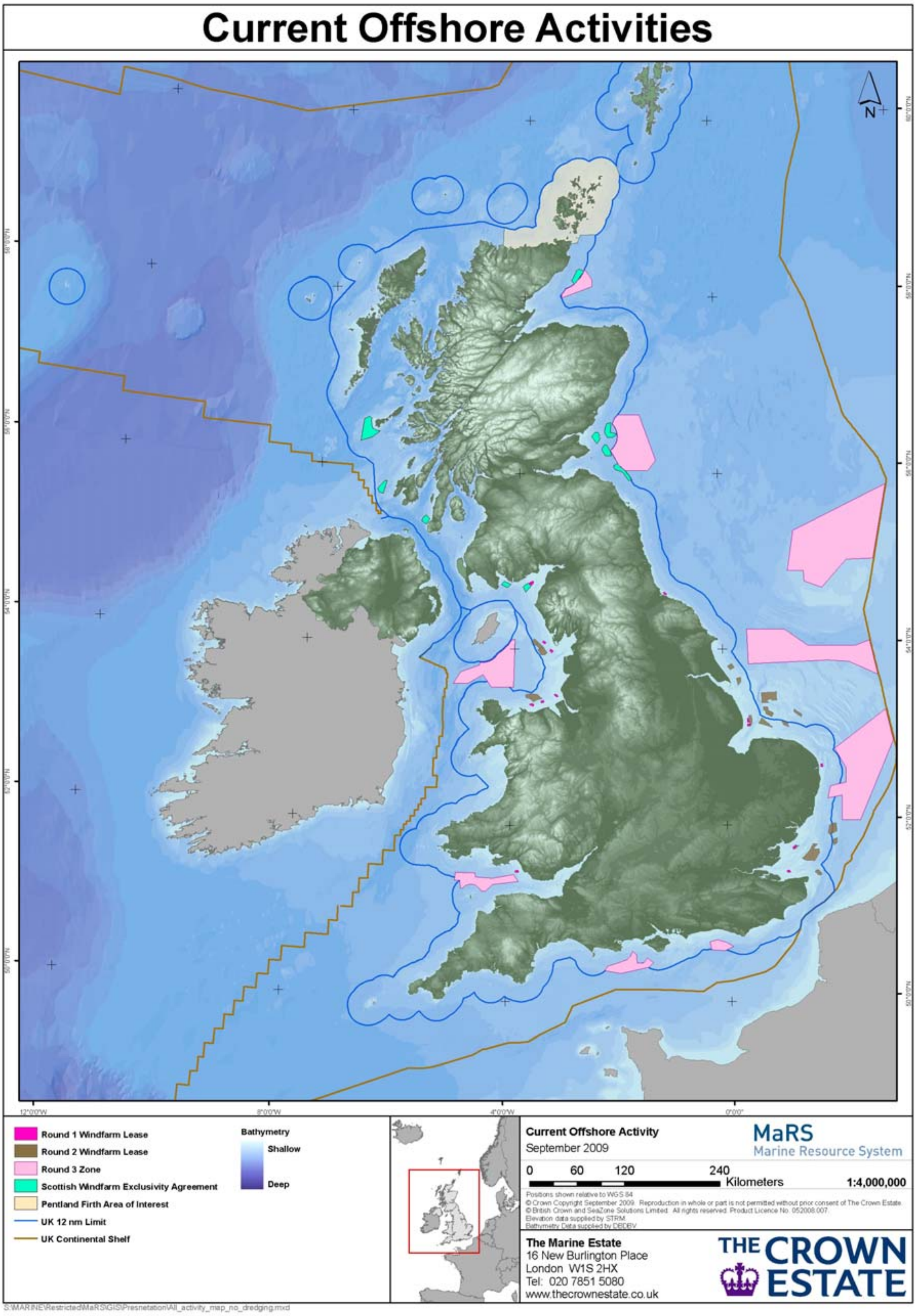


Figure 2 Bathymetry (waters < 40m) and SPAs with breeding seabirds as qualifying features in relation to R3 potential development zones

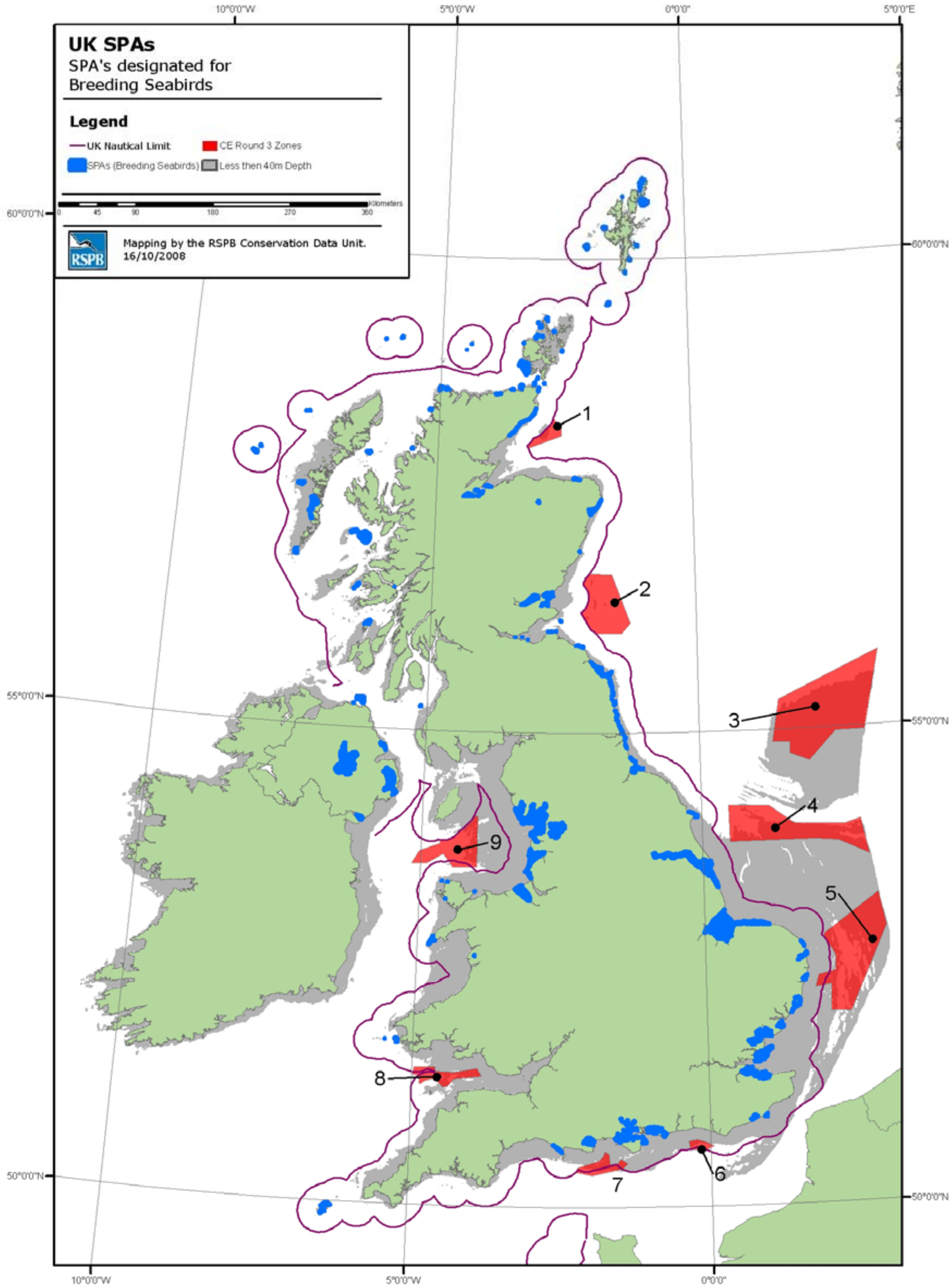


Figure 3: Seabird colonies in the UK (derived from the JNCC Seabird 2000 dataset)

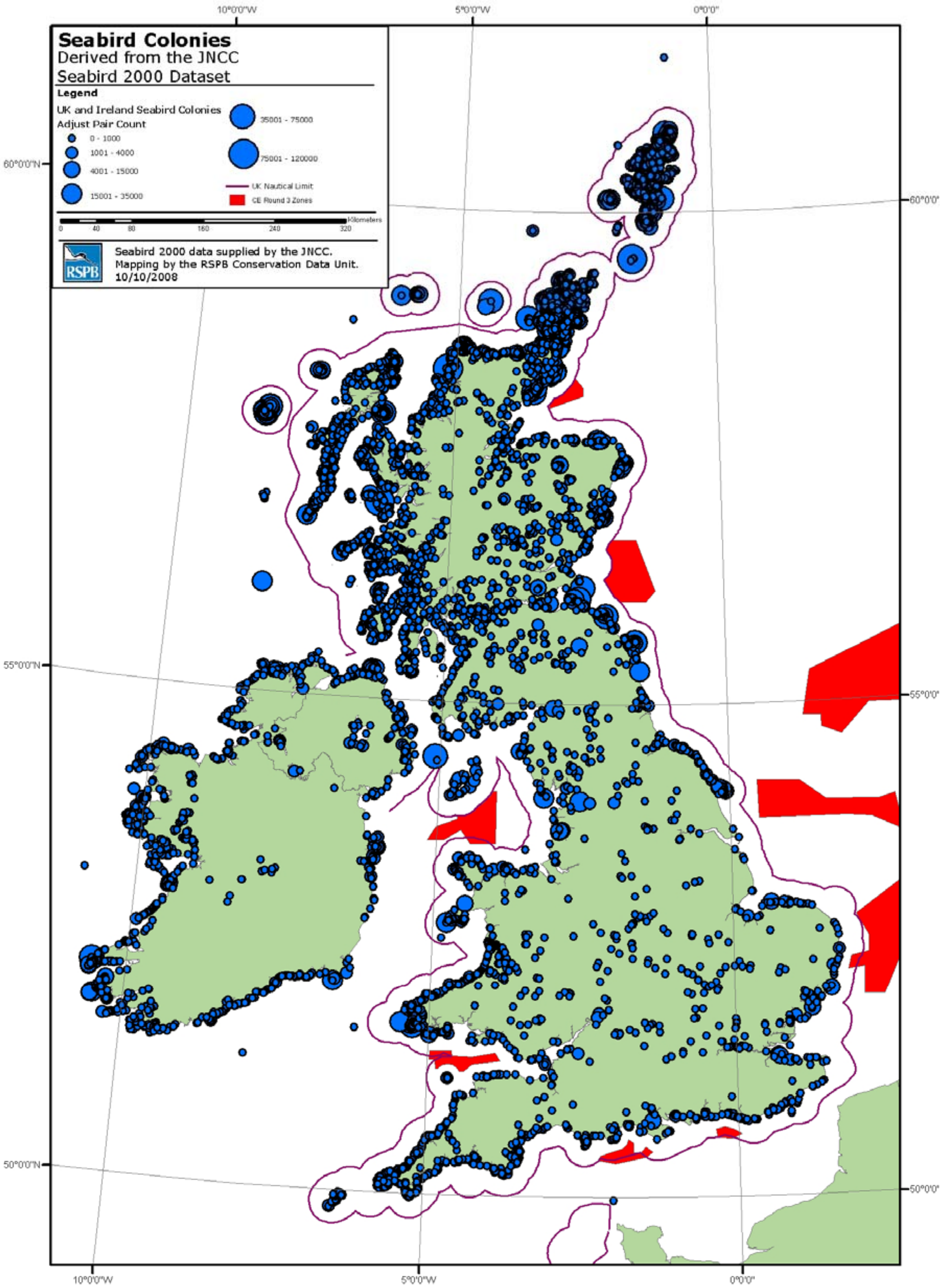


Figure 4: Aerial survey coverage of UK inshore waters 1988/89 to 2007/08 by the JNCC (NB, there is some overlap with Figure 5, notably for winter coverage)

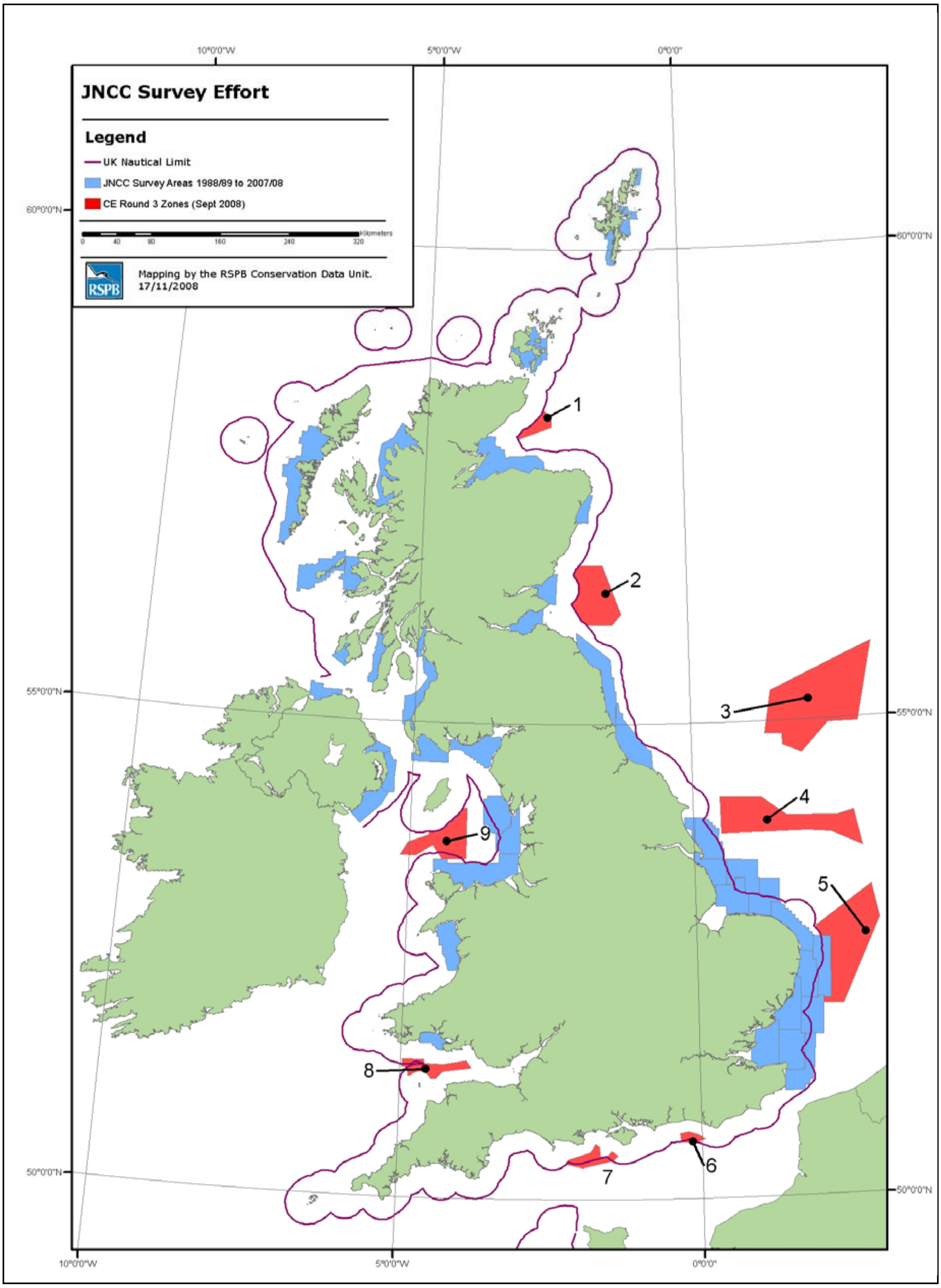


Figure 5a Winter survey coverage of UK waters by aerial surveys (unpublished information, September 2008, compiled from DECC, JNCC & WWT, figure courtesy of WWT)

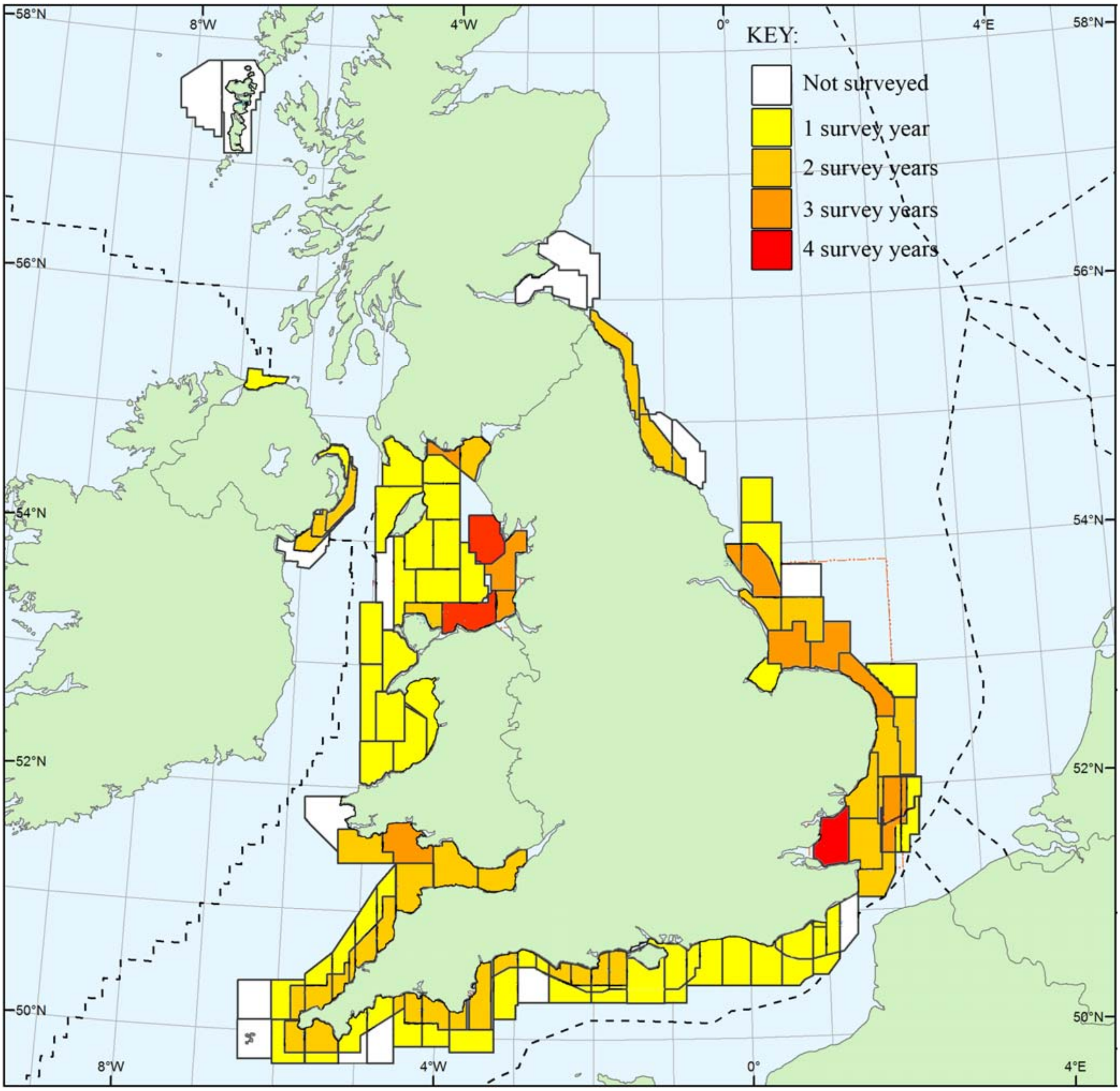
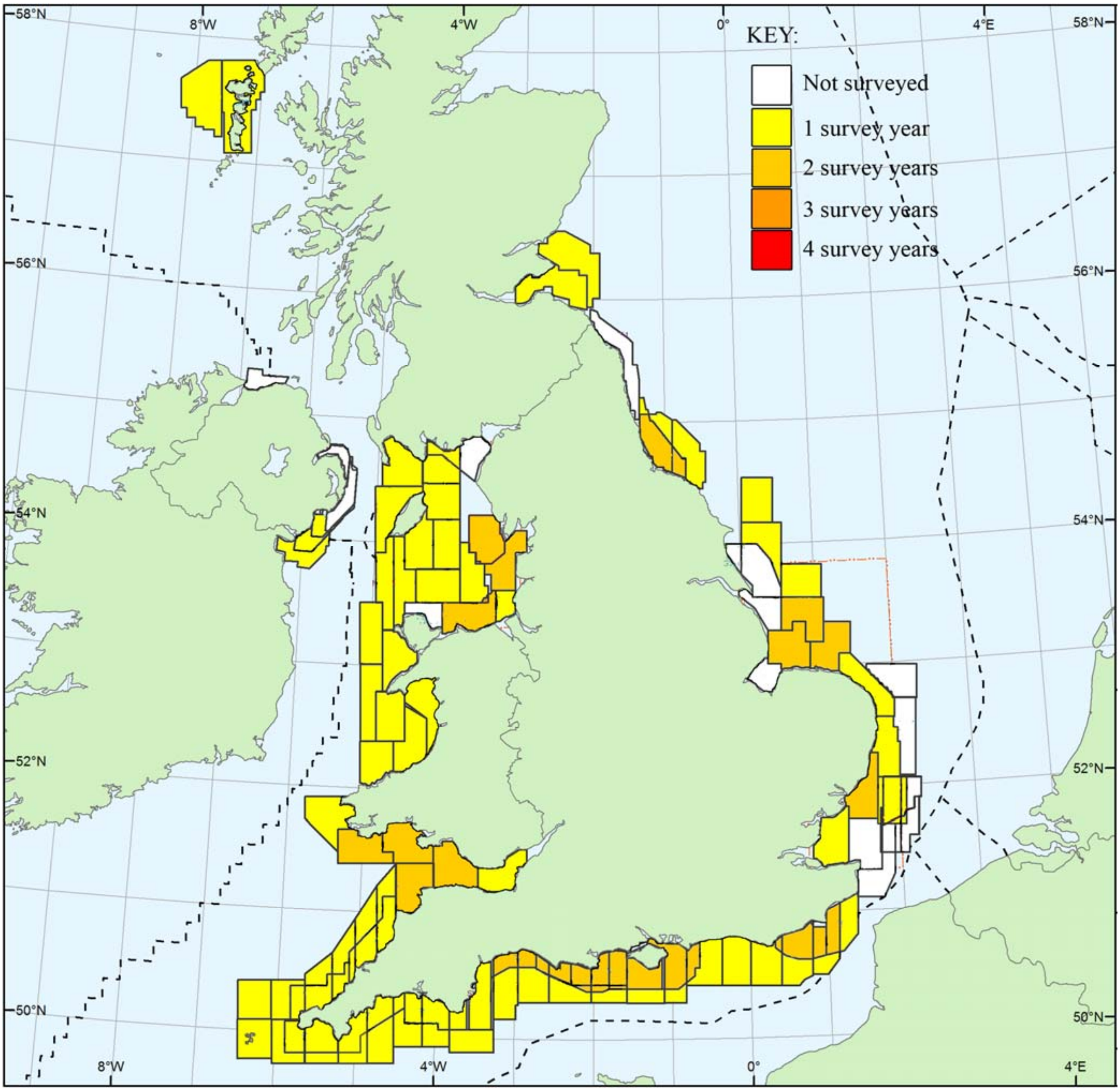


Figure 5b Summer survey coverage of UK waters by aerial surveys (unpublished information, September 2008, compiled from DECC, JNCC & WWT, figure courtesy of WWT)



Appendix I: Bird species mentioned in report (nomenclature follows Dudley *et al*. 2006)

Species		Species	
Northern Fulmar	*Fulmarus glacialis*	Bewick's/tundra Swan	*Cygnus columbianus*
Cory's Shearwater	*Calonectris diomedia*	Whooper Swan	*Cygnus cygnus*
Great Shearwater	*Puffinus gravis*	Bean Goose (Taiga)	*Anser fabalis fabalis*
Sooty Shearwater	*Puffinus griseus*	Pink-footed Goose	*Anser brachyrhynchus*
Manx Shearwater	*Puffinus puffinus*	Greenland White-fronted Goose	*Anser albifrons flavirostris*
Balearic Shearwater	*Puffinus mauretanicus*	European White-fronted Goose	*Anser albifrons albifrons*
European Storm-petrel	*Hydrobates pelagicus*	Greylag Goose (Iceland)	*Anser anser*
Leach's Storm-petrel	*Oceanodroma leucorhoa*	Greylag Goose (NW Scotland)	*Anser anser*
Northern Gannet	*Morus bassanus*	Barnacle Goose (nearctic)	*Branta leucopsis*
Great Cormorant	*Phalacrocorax carbo*	Barnacle Goose (Svalbard)	*Branta leucopsis*
European Shag	*Phalacrocorax aristotelis*	Dark-bellied Brent Goose	*Branta bernicla bernicla*
Corncrake	*Crex crex*	Light-bellied Brent Goose (Svalbard)	*Branta bernicla hrota*
Pomarine Skua	*Stercorarius pomarinus*	Light-bellied Brent Goose (Canada)	*Branta bernicla hrota*
Arctic Skua	*Stercorarius parasiticus*	Greater Scaup	*Aythya marila*
Long-tailed Skua	*Stercorarius longicaudus*	Common Eider	*Somateria mollissima*
Great Skua	*Catharacta skua*	Long-tailed Duck	*Clangula hyemelis*
Mediterranean Gull	*Larus melanocephalus*	Common Scoter	*Melanitta nigra*
Little Gull	*Larus minutus*	Velvet Scoter	*Melanitta fusca*
Black-headed Gull	*Larus ridibundus*	Goldeneye	*Bucephala clangula*
Common/Mew Gull	*Larus canus*	Red-breasted Merganser	*Mergus serrator*
Lesser Black-backed Gull	*Larus fuscus*	Red-throated Diver	*Gavia stellata*
Herring Gull	*Larus argentatus*	Black-throated Diver	*Gavia arctica*
Iceland Gull	*Larus glaucoides*	Great Northern Diver	*Gavia immer*
Glaucous Gull	*Larus hyperboreus*	Slavonian Grebe	*Podiceps auritus*
Great Black-backed Gull	*Larus marinus*		
Black-legged Kittiwake	*Rissa tridactyla*		
Little Tern	*Sterna albifrons*		
Sandwich Tern	*Sterna sandvicensis*		
Common Tern	*Sterna hirundo*		
Roseate Tern	*Sterna dougallii*		
Arctic Tern	*Sterna paradisea*		
Common Guillemot	*Uria aalge*		
Razorbill	*Alca torda*		
Black Guillemot	*Cepphus grylle*		
Little Auk	*Alle alle*		
Atlantic Puffin	*Fratercula arctica*		

Appendix II: Designated seabird SPA breeding colony extensions in Scotland (http://www.snh.org.uk/about/directives/ab-dir15j.asp)

Name of site	Approx. extension	Species for which extension proposed					
		Common Guillemot	Manx Shearwater	Razorbill	Atlantic Puffin	Northern Gannet	Northern Fulmar
Canna & Sanday	1km	*			*		
Marwick Head	1km	*					
North Colonsay & Western Cliffs	1km	*					
Rum	4km	*	*				
St Abbs to Fast Castle	1km	*		*			
Ailsa Craig	2km	*				*	
Buchan Ness to Collieston Coast	2km	*					*
Calf of Eday	2km	*					*
Cape Wrath	2km	*		*	*		*
Copinsay	2km	*					*
East Caithness Cliffs	2km	*		*	*		*
Fair Isle	2km	*		*	*	*	*
Fetlar	2km	*					*
Forth Islands	2km	*		*	*	*	*
Flannan Isles	2km	*		*	*		*
Foula	2km	*		*	*		*
Fowlsheugh	2km	*		*			*
Handa	2km	*		*			*
Hermaness, Saxa Vord & Valla Field	2km	*			*	*	*
Hoy	2km	*			*		*
Mingulay & Berneray	2km	*		*	*		*
North Caithness Cliffs	2km	*		*	*		*
North Rona & Sula Sgeir	2km	*		*	*	*	*
Noss	2km	*			*	*	*
Rousay	2km	*					*
Shiant Isles	2km	*		*	*		*
St Kilda	4km	*	*	*	*	*	*
Sule Skerry & Sule Stack	2km	*			*	*	
Sumburgh Head	2km	*					*
Troup, Pennan & Lion's Head	2km	*		*			*
West Westray	2km	*		*			*

These extensions are considered to represent concentrations of seabirds engaged in maintenance behaviours and do not necessarily reflect foraging ranges or main foraging locations, which will be the subject of separate SPA designations.

Appendix III: Likely focal species for risk assessment in potential R3 development zones

CE zone	Location	Bird species
1	Moray Firth	**Northern Fulmar**
	20 km nearest distance to mainland	*European Storm Petrel*
		Northern Gannet
		European Shag
		Arctic Skua
		Great Skua
		Great black-backed Gull
		Black-legged Kittiwake
		auks
		Whooper Swan
		Pink-footed Goose
		Barnacle Goose (Svalbard)
2	Firth of Forth	*Manx Shearwater* (passage)
	20 km	**Northern Gannet**
		Black-legged Kittiwake
		Arctic Skua
		Herring Gull
		Little Gull
		terns
		Sandwich Tern
		Arctic Tern
		auks
		Migrating waterbirds
3	Dogger Bank	**Northern Fulmar**
	120 km	**Northern Gannet**
		gulls
		Black-legged Kittiwake
		auks
		Migrating waterbirds
4	Hornsea	**Northern Gannet**
		Little Gull
		Black-legged Kittiwake
		auks
		Migrating waterbirds
5	East of Norfolk & Suffolk	**Lesser Black-backed Gull**
		Little Gull
		auks
		divers
		Migrating waterbirds

CE zone	Location	Bird species
6	Hastings	**Mediterranean Gull**
	6 km	**Little Gull**
		terns
		Migrating waterbirds
7	West Isle of Wight	*Balearic Shearwater*
	7 km	**Mediterranean Gull**
		Sandwich Tern
		Common Tern
		Migrating waterbirds
8	Bristol Channel	*Manx Shearwater*
	9 km	*Balearic Shearwater*
		European Storm Petrel
		Northern Gannet
		Lesser Black-backed Gull
		Herring Gull
		auks
9	Irish Sea	*Manx Shearwater*
	17 km	*Great Cormorant*
		Little Gull
		terns
		auks

Key to main concern: **potential collision;** *possible displacement*

These lists are not comprehensive, but aim to identify those species likely to be of greatest potential concern in each R3 potential development zone proposed by the Crown Estate (September 2008). Species are listed, based on proximity to nearest major breeding colonies (including SPAs) and likely foraging range[1,2,3,4,5,8] for seabirds and, for non-breeding seabirds and waterbirds, based on the onshore SPA network[8], offshore distribution (non-breeding) including marine IBAs[6,7], and migration[9].

In combination with any existing data, year-round baseline data collection, for a minimum 2 years, will be needed for all species (not just those listed) and locations to cover breeding and non-breeding distributions to confirm which are the key species for assessment. Migration of seabirds, waterbirds and passerines occurs around the UK, notably across the North Sea and the Channel, so spring and autumn surveys also will be needed. It cannot be ruled out that previously unknown bird concentrations may be identified during additional data collection. Principal concerns are collision risk, displacement from habitat/feeding areas or major flight routes, and especially the cumulative effects of these.

All species that contribute to the qualifying interest of the SPAs within the range encompassed by foraging distances, not just those listed here, will require screening for the EIA. Migratory birds (e.g.

waders) may enter the risk zone if they encounter strong headwinds or bad weather during sea crossing, or when flying at lower elevation close to land, and so need to be included in the risk assessment. This is likely to extend the geographical reference area for impact assessment as passage migrants may be heading for distant sites from the development zone.

This appendix will be require revision in the light of further surveys, documentary evidence and targeted research, as an iterative process involving consultation.

[1]Camphuysen, C. J. 2005. Seabirds at sea in summer in the northwest North Sea. *British Birds* 98: 2-19.
[2]Guilford et al. 2008. GPS tracking of the foraging movements of Manx Shearwaters *Puffinus puffinus* breeding on Skomer Island, Wales. *Ibis* 150: 462-473
[3]McSorley et al. 2003. Seabird use of waters adjacent to colonies. JNCC report 329, Aberdeen
[4]Mitchell et al. Seabird Populations of Britain and Ireland. 2004. A & C Black, London
[5]RSPB 2000. The development of boundary selection criteria for the extension of breeding seabird special protection areas into the marine environment. BirdLife International/RSPB.
[6]Skov et al 1995. Important bird areas for seabirds in the North Sea including the Channel and the Kattegat. BLI, Cambridge
[7]Stone et al. 1995. An atlas of seabird distribution in north-west European waters. JNCC, Peterborough
[8]Stroud et al. 2001. The UK SPA network: its scope and content. JNCC, Peterborough
[9]Wernham et al. 2002. The Migration Atlas: movements of the birds of Britain and Ireland. T & A D Poyser, London

Appendix IV: Likely focal species for risk assessment in Scottish Territorial Waters

Location	Species
Tiree & Coll	*Manx Shearwater*
	European Storm Petrel
	European Shag
	Arctic Skua
	Black-legged Kittiwake
	Arctic Tern
	Common Tern
	Common Guillemot
	Razorbill
	Great Northern Diver
	Whooper Swan
	Greenland White-fronted Goose
	Barnacle Goose (Nearctic)
	Brent Goose (light-bellied, E Canada)
	Corncrake
	Migrating waterbirds
West of Islay	*Manx Shearwater*
	European Storm Petrel
	European Shag
	Herring Gull
	Common Tern
	Common Guillemot
	Razorbill
	Whooper Swan
	Greenland White-fronted Goose
	Barnacle Goose (Nearctic)
	Corncrake
	Migrating waterbirds
West of Kintyre	*Manx Shearwater*
	Northern Gannet
	Herring Gull
	Black-legged Kittiwake
	Whooper Swan
	Greenland White-fronted Goose
	Barnacle Goose (Nearctic)
	Great Northern Diver
	Migrating waterbirds
Wigtown Bay	**Northern Gannet**
	Whooper Swan
	Pink-footed Goose
	Migrating waterbirds
Solway	**Herring Gull**

	Whooper Swan
	Pink-footed Goose
	Barnacle Goose (Svalbard)
	Migrating waterbirds

Key to main concern: **potential collision**; *possible displacement*

These lists are not comprehensive but aim to identify those species likely to be of greatest potential concern in Scottish Territorial Waters (STW), for proposed offshore wind farm developments as of September 2009. Species are listed, based on proximity to nearest major breeding colonies (including SPAs) and likely foraging range[1,2,3,4,5,8] for seabirds and, for non-breeding seabirds and waterbirds, based on the onshore SPA network[8], offshore distribution (non-breeding) including marine IBAs[6,7], and migration[9].

In combination with any existing data, year-round baseline data collection, for a minimum 2 years, will be needed for all species (not just those listed) and locations to cover breeding and non-breeding distributions to confirm which are the key species for assessment. Migration of seabirds, waterbirds and passerines occurs around the UK, notably across the North Sea and the Channel, so spring and autumn surveys also will be needed. It cannot be ruled out that previously unknown bird concentrations may be identified during additional data collection. Principal concerns are collision risk, displacement from habitat/feeding areas or major flight routes, and especially the cumulative effects of these.

All species that contribute to the qualifying interest of the SPAs within the range encompassed by foraging distances, not just those listed here, will require screening for the EIA. Migratory birds (e.g. waders) may enter the risk zone if they encounter strong headwinds or bad weather during sea crossing, or when flying at lower elevation close to land, and so need to be included in the risk assessment. This is likely to extend the geographical reference area for impact assessment as passage migrants may be heading for distant sites from the development zone.

This appendix will be require revision in the light of further surveys, documentary evidence and targeted research, as an iterative process involving consultation.

[1]Camphuysen, C. J. 2005. Seabirds at sea in summer in the northwest North Sea. *British Birds* 98: 2-19.
[2]Guilford et al. 2008. GPS tracking of the foraging movements of Manx Shearwaters *Puffinus puffinus* breeding on Skomer Island, Wales. *Ibis* 150: 462-473
[3]McSorley et al. 2003. Seabird use of waters adjacent to colonies. JNCC report 329, Aberdeen
[4]Mitchell et al. Seabird Populations of Britain and Ireland. 2004. A & C Black, London
[5]RSPB 2000. The development of boundary selection criteria for the extension of breeding seabird special protection areas into the marine environment. BirdLife International/RSPB.
[6]Skov et al 1995. Important bird areas for seabirds in the North Sea including the Channel and the Kattegat. BLI, Cambridge
[7]Stone et al. 1995. An atlas of seabird distribution in north-west European waters. JNCC, Peterborough
[8]Stroud et al. 2001. The UK SPA network: its scope and content. JNCC, Peterborough
9Wernham et al. 2002. The Migration Atlas: movements of the birds of Britain and Ireland. T & A D Poyser, London

Appendix V: Likely focal species for risk assessment in extension areas to R1 & R2 sites (R2.5)

R2 Strategic Area	**Species**
Liverpool Bay	*Great Cormorant*
	Lesser Black-backed Gull
	Herring Gull
	Little Gull
	Arctic Tern
	auks
	Whooper Swan
	Pink-footed Goose
	Red-throated Diver
	Common Scoter
	Migrating waterbirds
Greater Wash	**Sandwich Tern**
	Common Tern
	auks
	Pink-footed Goose
	Migrating waterbirds
Greater Thames	**Northern Gannet**
	Lesser Black-backed Gull
	Common Tern
	auks
	Red-throated Diver
	Migrating waterbirds

Key to main concern: **potential collision;** *possible displacement*

These lists are not comprehensive but aim to identify those species likely to be of greatest potential concern in areas proposed for extensions to R1 and R2 offshore wind farm developments as of September 2009. Species are listed, based on proximity to nearest major breeding colonies (including SPAs) and likely foraging range[1,2,3,4,5,8] for seabirds and, for non-breeding seabirds and waterbirds, based on the onshore SPA network[8], offshore distribution (non-breeding) including marine IBAs[6,7], and migration[9].

In combination with any existing data, year-round baseline data collection, for a minimum 2 years, will be needed for all species (not just those listed) and locations to cover breeding and non-breeding distributions to confirm which are the key species for assessment. Migration of seabirds, waterbirds and passerines occurs around the UK, notably across the North Sea and the Channel, so spring and autumn surveys also will be needed. It cannot be ruled out that previously unknown bird concentrations may be identified during additional data collection. Principal concerns are collision risk, displacement from habitat/feeding areas or major flight routes, and especially the cumulative effects of these.

All species that contribute to the qualifying interest of the SPAs within the range encompassed by foraging distances, not just those listed here, will require screening for the EIA. Migratory birds (e.g. waders) may enter the risk zone if they encounter strong headwinds or bad weather during sea crossing, or when flying at lower elevation close to land, and so need to be included in the risk assessment. This is likely to extend the geographical reference area for impact assessment as passage migrants may be heading for distant sites from the development zone.

This appendix will be require revision in the light of further surveys, documentary evidence and targeted research, as an iterative process involving consultation.

[1]Camphuysen, C. J. 2005. Seabirds at sea in summer in the northwest North Sea. *British Birds* 98: 2-19.
[2]Guilford et al. 2008. GPS tracking of the foraging movements of Manx Shearwaters *Puffinus puffinus* breeding on Skomer Island, Wales. *Ibis* 150: 462-473
[3]McSorley et al. 2003. Seabird use of waters adjacent to colonies. JNCC report 329, Aberdeen
[4]Mitchell et al. Seabird Populations of Britain and Ireland. 2004. A & C Black, London
[5]RSPB 2000. The development of boundary selection criteria for the extension of breeding seabird special protection areas into the marine environment. BirdLife International/RSPB.
[6]Skov et al 1995. Important bird areas for seabirds in the North Sea including the Channel and the Kattegat. BLI, Cambridge
[7]Stone et al. 1995. An atlas of seabird distribution in north-west European waters. JNCC, Peterborough
[8]Stroud et al. 2001. The UK SPA network: its scope and content. JNCC, Peterborough
[9]Wernham et al. 2002. The Migration Atlas: movements of the birds of Britain and Ireland. T & A D Poyser, London