13 WIND FARM ORNITHOLOGY

13.1 INTRODUCTION

1. This Section of the ES evaluates the likely significant effects of the Wind Farm, on birds. The assessment has been undertaken by RPS Group PLC and includes an assessment of cumulative effects.

2. This Section of the ES is supported by the following document:

- Annex 13A: Ornithological Technical Report; and
- Annex 13B: Ornithology HRA Technical Report.

3. In addition to the above, information to inform an appropriate assessment on relevant species under The Conservation (Natural Habitats, &c.) Regulations 1994, as amended, and the Conservation of Habitats and Species Regulations 2010 will be provided for the Competent Authority in a separate document titled Report to Inform an Appropriate Assessment.

4. This Section includes the following elements:

- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Assessment of Effects;
- Mitigation Measures;
- Residual Effect;
- Monitoring and Enhancements
- Summary of Effects;
- Assessment of Cumulative Effects;
- Statement of Significance; and
- References.

13.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

13.2.1 STUDY AREA

5. The Wind Farm forms the core of the study area, since birds seen within the Wind Farm are those at potential risk of effects due to its construction, operation and decommissioning. However, no bird species are considered to be resident within the Wind Farm, hence the study area for this assessment covers a wider area, including seabird breeding colonies and wildfowl wintering locations. In addition the seabird activity across the wider Moray Firth has been assessed, in order that activity observed on the Wind Farm Site can be set in context.

6. In this assessment the term Wind Farm Site refers to the area inside the Wind Farm Site boundary (Figure 13.1). The term 'boat-based survey area' comprises the Wind Farm Site itself plus a 4 km wide buffer around the outside (shown as boat-based transect route on Figure 13.2).

13.2.2 LEGISLATION AND GUIDANCE

7. In addition to the EIA Regulations, key legislation for ornithological interest includes:

- The Council Directive on the Conservation of Wild Birds 2009/147/EC (EU Birds Directive);
- The Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora 1992/43/EEC (EU Habitats Directive);
- Nature conservation (Scotland) Act 2004;
- Wildlife and Countryside Act 1981 (as amended);
- Conservation (Natural Habitats, etc.) Regulations 1994 (as amended); and
- Conservation of Habitats and Species Regulations 2010.

8. The following Sections provide further details on the specific aspects of the above conservation and management legislation relevant to bird ecology.

13.2.2.1 EU Birds Directive

9. The EU Birds Directive 2009/147/EC (certified version of a previous 1979 Directive) aims to provide a comprehensive scheme of protection for all wild bird species naturally occurring in the European Union. To meet the requirements outlined in Article 4 of the Birds Directive, particular emphasis is given to the protection of habitat for endangered as well as migratory species (i.e. as listed under Annex I) via the establishment of a coherent network of SPAs comprising all of the most suitable territories for these species.

13.2.2.2 Nature Conservation (Scotland) Act 2004; Wildlife and Countryside Act (1981)

10. Under the Nature Conservation (Scotland) Act 2004, and the Wildlife and Countryside Act (1981), SSSIs in Scotland are designated by SNH, where the land is considered to be of special interest by reason of any of its natural features, such that they form a network of the best examples of natural features throughout Scotland, and support a wider network across Great Britain and the EU. Under the Nature Conservation (Scotland) Act 2004, SSSIs in Scotland are subject to notifications regarding operations requiring consent and have agreed management statements between SNH and the land owners or occupiers.

11. Guidance on ecological and ornithological assessments for offshore wind farms was derived from:

- IEEM (2010) Ecological Impact Assessment Guidelines for Marine and Coastal Projects;
- Maclean et al., (2009) A review of assessment methodologies for offshore wind farms, and
- King et al., (2009) Developing guidance on ornithological cumulative impact assessment for offshore wind farm developers.

12. Several further sources of guidance for specific effects were also used, and are referred to in the relevant Sections.

13.2.3 CONSULTATIONS

13. Regular consultations were conducted with SNH, the JNCC and the RSPB prior to and during survey and assessment work. These included presentation of interim survey results and discussions of assessment methodologies. A summary of consultation carried out is presented in Table 13.1 below.

Table 13.1 Summary of Consultation Undertaken

Consultee	Summary of Consultation Response	Project Response
SNH/JNCC	Boat surveys unlikely to provide information on wader and wildfowl movements.	Desk based assessments and additional wildfowl migration surveys conducted.
	Wide ranging seabird species need to be considered	Seabird foraging ranges used in assessment of effects.
	Cumulative impacts need to be addressed.	Cumulative Impacts assessed, based on discussions with SNH and JNCC.
	Requested details of contingency for missed boat surveys.	Arrangement made with the Wildfowl and Wetlands Trust Consulting (WWTC) to conduct aerial surveys when boat surveys missed.
	Requested clarifications on boat survey methods.	Details supplied and presented in the assessment.
	Suggested additional survey methods be considered (e.g. tracking studies)	A tracking study was conducted on behalf of both Moray Firth Wind Developers by Plymouth University. Results are discussed in Section 13.3.
	Suggested collection of data to allow habitat modelling to be undertaken.	No additional data were collected since these data were not considered to provide critical information for the assessment of effects.
	Suggested additional means to collecting flight height data (e.g. radar and digital aerial surveys).	No additional methods undertaken, since those proposed are of limited value in this respect. Review of flight height data from other studies used instead.
	Suggested effects of noise on birds be considered.	Underwater noise was subsequently scoped out of the assessment following discussions with noise modelling experts and SNH.
	Potential effects of turbine support structures should be assessed.	These have been included in the assessment.
	Onshore elements need to be considered with respect to bird effects.	These have been considered in a separate ES.
JNCC	Provided historic data collected by the RPSB (stored in JNCC database).	Data contributed to site characterisation.
RPSB	Satisfied that boat survey methods were suitable for collecting baseline data.	None required.

Consultee	Summary of Consultation Response	Project Response
	Suggested tagging study to explore linkages between SPA colonies and the wind farm site.	A tracking study was conducted on behalf of both Moray Firth Wind Developers by Plymouth University. Results are discussed in the baseline section.

13.2.4 DESK STUDY

14. In order to provide historical context for the Wind Farm, records from previous bird surveys were requested from the sources detailed below.

13.2.4.1 Beatrice Demonstrator Project

15. Monthly vantage point surveys were conducted for the Beatrice demonstrator project from the adjacent Beatrice Alpha Oil platform between January 2005 and June 2008. This site lies approximately 11 km to the south west of the Wind Farm Site boundary. The data were used for the current assessment to provide a detailed picture of seasonal abundance of seabirds in the Moray Firth.

13.2.4.2 RSPB Boat Surveys

16. The RPSB conducted monthly boat surveys of the entire Moray Firth, within a line connecting Duncansby Head and Peterhead, each month between January 1982 and December 1983. Although the age of these data limits their applicability in terms of the current assessment, they do provide valuable spatial and temporal context regarding the distribution of seabirds in the region.

13.2.5 SURVEY METHODOLOGY

17. In consultation with SNH, monthly boat surveys to determine seabird presence on the Wind Farm Site were undertaken between October 2009 and September 2011. These have been used to characterise seasonal and spatial patterns in seabird abundance and flying height distributions (see Section 13.3.2).

18. Additional studies conducted for this assessment include wildfowl migration surveys and a breeding seabird tracking study (see Section 13.2.5.4). Aerial surveys of the Wind Farm Site and the adjacent Moray Firth Round 3 Zone (seven surveys conducted between May 2009 and February 2010) were also used for the baseline characterisation.

13.2.5.1 Boat Surveys

19. The survey protocol for the Wind Farm was designed in accordance with the standard methods adopted for offshore boat surveying. These follow the European Seabirds at Sea (ESAS) methods, as detailed in the relevant COWRIE guidance (Camphuysen et al., 2004, Maclean et al., 2009). The total area surveyed, comprising the Wind Farm Site plus a 4 km wide buffer was approximately 383 km^2 (see Figure 13.1). Further details on the survey and analysis methods are provided in Annex 13A.

20. Twenty two boat surveys were conducted monthly between October 2009 and September 2011 (see Table 13.2). Surveys were typically conducted over two consecutive days. Exceptions to this were the December 2009 and September 2010 surveys (first and second days separated by seven and 11 days respectively due to unsuitable weather) and May 2011 when the survey was completed in a single day. Prolonged unsuitable weather prevented surveys in November 2009, January 2010, November 2010 and March 2011. Additional surveys were undertaken in April 2010 and January 2011 to ensure adequate coverage of the early breeding season and winter periods was still achieved.

Table 13.2 Dates of boat surveys of the Wind Farm and 4 km buffer conducted by the IECS between October 2009 - September 2011

Survey number	Year	Month	Day 1	Day 2
1	2009	October	14	15
2	2009	December	3	10
3	2010	February	12	13
4	2010	March	3	4
5	2010	April	8	9
6	2010	April	27	28
7	2010	May	15	16
8	2010	June	22	23
9	2010	July	19	20
10	2010	August	15	16
11	2010	September	19	30
12	2010	October	12	13
13	2010	December	13	14
14	2011	January	19	20
15	2011	January	27	28
16	2011	February	27	28
17	2011	April	10	11
18	2011	May	31	n/a
19	2011	June	16	17
20	2011	July	1	2
21	2011	August	1	2
22	2011	September	(August 31st)	1

21. The results of the boat surveys form the core of the baseline characterisation. Density and abundance were estimated using Distance sampling methods (Thomas

et al., 2010) which account for declines in detection with distance from the observer. Further details are provided in Annex 13A.

13.2.5.2 Aerial Surveys

22. Aerial surveys were conducted by HiDef Aerial Surveying and the WWTC using high definition digital video and human observers respectively. The HiDef surveys were conducted during summer 2009, while the WWTC surveys were conducted between November 2009 and February 2010 (see Table 13.3). These surveys, commissioned by the Crown Estate, provide a useful additional source of seabird distribution data and covered a wider area, thus offering valuable contextual information. An additional aerial survey of the Wind Farm Site was conducted by WWTC in March 2011 as a replacement for a missed boat survey.

Table 13.3 Dates of aerial surveys of the Wind Farm Site and Moray Firth Round 3 Zone conducted by HiDef Consulting and WWTC between May 2009 and March 2011

Survey number	Surveyor	Year	Month	Day	Coverage of Wind Farm Site
1	HiDef	2009	5	29	Partial
2	HiDef	2009	6	9, 10, 29	Partial
3	HiDef	2009	8	5, 6	Partial
4	WWTC	2009	11	7	Complete
5	WWTC	2009	12	10	Partial†
6	WWTC	2010	2	8	Complete
7	WWTC	2010	2	19	Complete
8 *	WWTC	2011	3	28	Complete

† This survey used the previous coordinates
* This survey (8) was a replacement for a missed boat survey as a result of a prolonged period of unsuitable weather during the month.

23. Four of the aerial surveys provided complete coverage of the Wind Farm Site, while the other four covered approximately 67% (the primary focus of the partial surveys was the Moray Firth Round 3 Zone adjacent to the Wind Farm Site).

24. Further details of the surveying and data analysis methods are provided in Annex 13A.

13.2.5.3 Wildfowl Migration Surveys

25. In both Autumn 2010 and Spring 2011, for periods of eight weeks, regular vantage point surveys for migrating wildfowl (primarily geese and swans) were conducted from four locations on the Moray Firth coast. Two sites were located in Caithness and two in Aberdeenshire. Between them, these locations permitted flocks of migrating wildfowl likely to traverse the Wind Farm Site to be recorded. The direction of flight was recorded as birds either headed offshore towards the Wind Farm Site or came onshore having potentially traversed the Wind Farm Site. These

observations were used to extrapolate the expected flight lines and from these flights were categorised as either:

- Probably having crossed the Wind Farm Site (extrapolated flightline crossed the Wind Farm Site boundary);
- Possibly having crossed it (extrapolated flightline passed within 2 km of the Wind Farm Site boundary), or
- Not having crossed it (extrapolated flightline passed more than 2 km from the Wind Farm Site boundary.

26. During the survey periods, an additional surveyor was also employed on the boat surveys whose role was to scan for migrating wildfowl. Where possible, the boat and land based observations were conducted simultaneously. Further details of the survey methods are provided in Annex 13A.

13.2.5.4 Seabird Tracking Study

27. During the 2011 breeding season, breeding individuals from four species (fulmar, kittiwake, guillemot and razorbill) within colonies which comprise the East Caithness Cliffs SPA were caught and fitted with satellite tags for periods of up to five days. This duration permitted recording of several foraging trips per individual and also maximised the likelihood of successful tag retrieval. This SPA was selected due to its proximity to the Wind Farm Site and the Moray Firth Round 3 Zone. On recapture the tags were retrieved and positional data downloaded. These data provided detailed information about the foraging activity and choice of foraging locations for breeding individuals of these species. This study was undertaken by researchers from the University of Plymouth. A total of 74 tags with foraging data were retrieved (17 fulmars, 20 guillemots, 19 kittiwakes and 18 razorbills), out of a total deployment of 248 (approximately 30% of fitted tags were recovered).

13.2.6 ASSESSMENT METHODOLOGY

28. This Section sets out the methods followed for the assessment for birds. The following are described in more detail below:

- Definitions of species sensitivity;
- Determination of the magnitude of predicted effect;
- Determination of the significance of effects based on the interaction of sensitivity and magnitude (using a matrix approach);
- Identification of the potential effects for each stage of the project based on the worst case scenario identified for that effect;
- Determination of the magnitude for each potential effect and hence the significance for each receptor, using the matrix;
- Identification of any mitigation measures which would avoid, reduce or remedy significant effects; and
- Assessment of residual effects i.e. post mitigation effects.

13.2.6.1 Defining species sensitivity

29. The sensitivity of each bird species observed within the Wind Farm Site plus 4 km buffer during the surveys (boat and aerial) was defined according to a range of criteria. These included measures of the importance of both the numbers of birds on the site and/or the conservation status of the species as a whole, and whether the species is protected under certain legislation, or is cited as an interest feature of a designated site of national or international importance. The sensitivities range from high to low (Table 13.4).

Table 13.4 Definition of Species Sensitivity

Sensitivity	Definition
High	• Species present in internationally important numbers i.e. greater than 1% of European flyway population • Cited interest of SPAs. Cited means mentioned in the citation text for the site as a species for which the site is designated. • Other species which contribute to the integrity of an SPA (i.e. within assemblage criteria).
Medium	• Regionally important population of a species, either because of population size or distributional context. • EU Birds Directive Annex 1, EU Habitats Directive priority habitat/species and/or Wildlife and Countryside Act Schedule 1 species (if not covered above). • UK BAP priority species (if not covered above). • Red and Amber-listed of the Birds of Conservation Concern in the UK. • Species present in nationally important numbers i.e. greater than 1% of the Great Britain population
Low	• Any other species of conservation interest under Article 1 of the Birds Directive (e.g. Green-listed species of the Birds of Conservation Concern).

30. The importance of the number of birds of any species estimated to be present in the boat-based survey area was defined in relation to estimated international, national and regional populations through the use of the 1% criterion (Eaton et al., 2009) as shown in Table 13.4.

31. Threshold values for international and national populations were derived from figures provided by BirdLife International (2004), which represents the most up to date synthesis of international and national population data. The 1% criterion, whilst not necessarily of biological relevance, has been previously used as a standard for designating areas of conservation interest (Skov et al., 2007). Appropriate numbers for both breeding and wintering populations were determined for each species, taking into account seasonal patterns of movement.

32. Species which typically occur on passage (e.g. shearwaters) may be drawn from breeding populations located considerable distances from the Wind Farm Site,

including ones from other countries. This makes determination of appropriate population sizes very difficult. In these cases, passage populations were estimated from knowledge of the species' ecology and movements and consideration of the breeding sites which could contribute to those birds observed on the Wind Farm Site.

13.2.6.2 Defining Magnitude

33. The magnitudes of any potential effects resulting from the Wind Farm were considered in relation to the construction and decommissioning phases, and the operational phase.

34. The magnitudes of effect used in this assessment range from large to negligible (see Table 13.5).

Table 13.5 Definition of Magnitude of Effect

Magnitude	Definition
Large	Major effects on the feature / population, which would have a sufficient effect to irreversibly alter the nature of the feature in the short-to-long term and affect its long-term viability (i.e. > 20% population loss).
Medium	Effects that are detectable in short and long-term, but which should not alter the long-term viability of the feature / population (i.e. 5-20% population loss).
Small	Minor effects, either of sufficiently small-scale or of short duration to cause no long-term harm to the feature / population, (i.e. 1-5% population loss).
Negligible	A potential effect that is not expected to affect the feature / population in any way; therefore no effects are predicted (i.e. <1% population loss).

35. It is important to note that the definitions of magnitude are not taken literally and serve as generic guidelines that can be adapted to suit the different types of effect. For example, in relation to disturbance and displacement the proportion of the 'population' lost is interpreted as that which could be disturbed and subsequently displaced from the site. Similarly for collision, it is not the proportion of the entire population that is killed as a result of the Wind Farm, but a comparison of mortality resulting from collision with the background level of mortality through natural causes (e.g. predation or disease and anthropogenic effects such as pollution in the case of seabirds) as an effect 'over and above' background mortality levels.

13.2.6.3 Defining Significance

36. The significance of effect upon each receptor was determined by combining the sensitivity of the species (Table 13.4) with the magnitude of the effect (Table 13.5). Within this assessment Significance is defined as negligible, minor, moderate or major as show in Table 13.6.

Table 13.6 Significance of an effect resulting from each combination of receptor sensitivity and the magnitude of the effect upon it

Sensitivity	**Magnitude of Effect**			
	Negligible	**Small**	**Medium**	**Large**
Low	Negligible	Negligible	Minor	Minor
Medium	Negligible	Minor	Minor	Moderate
High	Negligible	Minor	Moderate	Major

37. The four point measures of negligible, minor, moderate and major significance resulting from the different combinations of sensitivity and magnitude are interpreted as defined in Table 13.7.

Table 13.7 Definition of Significance Terms

Effect	**Definition**
Major	The effect on birds gives rise to serious concern and should be considered unacceptable.
Moderate	The effect on birds gives rise to some concern but it is likely to be tolerable (depending upon its scale and duration)
Minor	The effect on birds is undesirable, but of limited concern. Not significant.
Negligible	Not significant

38. An effect of major significance, whilst considered unacceptable, need not necessarily lead to the development being abandoned or even radically overhauled, if the effect can be demonstrated not to be irreversible or of sufficient duration to be damaging in the longer term, especially where effective mitigation is supplied. Where mitigation is undertaken, it is the nature of the resulting residual effect that needs to be carefully considered. Similarly, effects of moderate significance may be judged as tolerable even without mitigation if the effects are of limited scope and duration.

39. Effects of major or moderate significance are considered to be significant for the purposes of the EIA regulations. Effects of minor or negligible significance are considered to be not significant.

13.2.7 DEFINING THE WORST CASE - THE ROCHDALE ENVELOPE

40. In order to present a worst case assessment within the realistic parameters of the Project, the project parameters that represent those most likely to result in the greatest magnitude of change have been selected from the extensive options set out in Section 7: Project Description.

41. In respect of the bird assessment, the key elements considered are:

- Foundation construction - assumes either piling operations or gravity bases, dependent on the effect under consideration;
- Distance between turbines - assumes the smallest turbine separation distance; and
- Total Rotor Frontal Area- assumes the largest possible combined rotor swept area (i.e. the combination of turbine model (rotor diameter) and number of turbines which results in the greatest rotor swept area).

13.2.7.1 Nature of Effects - Construction and Decommissioning

Disturbance Due to Construction Activity

42. Construction and decommissioning works are likely to involve noisy and potentially disturbing works such as pile driving. Turbine foundation options currently under consideration include pin piles, gravity bases and suction bases. Of these, piling operations will be expected to generate the greatest source of direct disturbance to birds, through vessel activity and above sea noise. Underwater noise effects on diving seabirds have been scoped out of this assessment following discussions with SNH. Thus, in line with the Rochdale Envelope approach, consideration for construction effects will focus on the direct disturbance and potential indirect effects on birds, predicted to occur from piling operations, as this is predicted to be the worst case scenario for this particular activity.

43. As a worst case scenario such activity could result in the complete avoidance of the surrounding area out to a given range by all the individuals of one or more species for the duration of activity (currently estimated to be up to five years; 2014-2018, although foundation installation such as piling is predicted to last for up to two years). However, a lack of specific information on the responses of many species to noise, in particular the type, duration and severity of the effect and the speed at which birds may habituate, makes it difficult to predict the level to which different species may be affected. Susceptibility to disturbance and its consequences may depend on:

- The foraging strategy of the birds involved, i.e. aerial, swimming or surface diving foragers;
- Whether the birds present in the site are actively feeding, or simply loafing or rafting, with the relative proportions of these activities likely to vary depending on the season;
- The period and duration of occupancy of the site and the reasons behind it (e.g. whether birds are engaged in another activity other than feeding such as resting or undergoing moult); and
- The origin of the birds involved (i.e. whether they are breeding birds or temporary migrants).

44. Each of these factors has, therefore been taken into account when assessing the potential effect of construction activities on any given species.

Disturbance due to Boat Traffic

45. For each sensitive bird species, the effect of disturbance from increased boat traffic was evaluated on the basis of:

- Knowledge of the sensitivity of each bird species from prior studies;
- The magnitude of disturbance that is expected to take place; and
- Information on the likely vulnerability of a species to disturbance from boat traffic (Garthe and Hüppop 2004).

46. The potential for boat traffic effects was considered to be similar during both construction and decommissioning, thus these effects are considered together.

13.2.7.2 Nature of Effects - Operational Effects

Disturbance due to Boat Traffic

47. The potential for boat traffic effects during maintenance operations were considered to be similar to those likely during construction and decommissioning. However, they are predicted to be of a lower magnitude, and thus the effects will be of no greater magnitude and significance than those assessed for boat traffic effects of construction.

Barrier Effects

48. Offshore wind farms can present a barrier to bird movement. Previous studies of existing offshore wind farms have revealed that some bird species actively avoid wind farms by not flying in close proximity to them (Pettersson 2005; Petersen et al., 2006). Large wind farms may thus represent barriers to movement for some bird species including migrating wildfowl, which tend to move in large flocks along linear flight lines.

49. Flight deviation as a result of any potential barrier effect caused by the presence of a wind farm may increase journey distance, and therefore represent an energetic cost to each individual (Masden et al., 2010). For each individual, the cost of this deviation increases in proportion to the frequency of passages across the site. Thus, breeding birds making multiple trips will suffer some energetic costs if they avoid travelling through wind farms even if these are relatively low compared to other stochastic variables, such as weather conditions. A study of the potential additional energy costs incurred due to single deviations around a wind farm (e.g. as could occur during seasonal migration between breeding and wintering locations) estimated this would result in trivial effects (Speakman et al., 2009). Daily diversions, as could occur between breeding and foraging sites, could increase daily demands by up to 6% for each 15 km increase in flight distance. The potential for such daily deviations in flight during the breeding season as a consequence of the Wind Farm was assessed on the basis of the apparent relative importance of the Wind Farm Site, or areas located beyond it, for foraging seabirds.

Displacement Effects

50. Assessment of the potential extent to which species will be displaced from the Wind Farm Site due to avoidance of turbines, and the consequent effects on their

populations, is difficult to predict. While comparative studies of offshore wind farms pre- and post-construction have been undertaken (e.g. Horns Rev and Nysted Offshore Wind Farms, hereafter Horns Rev and Nysted, Denmark, Petersen et al., 2006; Utgrunden and Yttre Stengrund Offshore Wind Farms, Sweden, Pettersen 2005; Egmond ann Zee Offshore Wind Farm, hereafter Egmond ann Zee, Netherlands, Lindeboom et al., 2011), the wind farms studied have all been located in shallower depths and nearer to shore than the proposed Wind Farm. Consequently, a different suite of species, notably comprising wintering populations of seaducks and auks, have been the primary targets for research on displacement effects. In some of these studies evidence for avoidance of the wind farm by some species has been found, whilst for other species no apparent effects have been found. Thus, while previous research can guide displacement predictions, these studies are not directly comparable to the assessment of potential effects on foraging seabirds during the breeding season.

51. In order to generate predictions of how the presence of the wind farm may affect foraging seabirds, a simple mechanistic model was developed. This model used estimates of radial turbine avoidance distances to predict the total area within the Wind Farm Site from which seabirds would be displaced. Whilst there are no empirical estimates of avoidance distance from wind turbines for most seabird species, this approach provides a framework within which the topic can be explored. In addition, because this method is based on a simple mechanism, the approach can be used in reverse to estimate avoidance distances from published displacement percentages. The method assumes that displacement of birds from a wind farm occurs due to the presence of the turbines directly, rather than due to indirect effects on their prey. The worst case displacement scenario would result from the most densely packed turbines which in this case was the 3.6 MW model. The predicted percentage displacement resulting from a range of radial avoidance distances around turbines spaced at 642 m is provided in Table 13.8. Note that the greatest avoidance distance of 400 m in combination with turbine spacing of 642 m represents overlapping avoidance distances within the wind farm array itself.

Table 13.8 Seabird avoidance distances and associated predicted displacement percentages for the worst case turbine scenario based on turbines with 3.6 MW capacity and their associated minimum spacing, predicted to be 642 m

Radial avoidance distance of individual turbines (m)	Displacement percentage resulting from 3.6 MW (min. spacing: 642 m)
50	2
100	7.6
200	30.5
300	68.6
400	100

52. The effects on displaced breeding birds were explored using deterministic population models developed using published demographic data. This was based on the assumption that each displaced breeding individual was one half of a pair

which subsequently failed to reproduce. Therefore this assessment considered the likely effects resulting from the worst case scenario, based on the conservative assumption that foraging birds displaced from the areas around the turbines cannot be accommodated within equivalent quality neighbouring areas. Instead they are forced to use sub-optimal foraging locations which prevent successful reproduction. The species selected for modelling were those for which the Wind Farm Site was determined to provide an important foraging area during the breeding season. These were fulmar, kittiwake, guillemot and razorbill.

53. For the purposes of the impact assessment, complete displacement from the wind farm was considered. This is represented in Table 13.8 as 100% displacement. The total area of exclusion at this level included an additional buffer around the Wind Farm Site of 400 m, effectively adding the radial turbine avoidance distance to the Wind Farm Site boundary.

Direct Mortality Due to Collision with Turbines

54. To quantify the potential risk of additional mortality above the current baseline for each species as a result of collisions with operational turbines, collision risk modelling (CRM) was undertaken. Two methods were employed; the first used the method described in the guidance by MacLean et al., (2009). In this, the authors recommend that the Band et al., (2007) model (directional approach) is used, which has been the standard method for most onshore and offshore wind farms to date. The second used the recently developed revision to this method (Band 2011), developed through the Crown Estate's SOSS. The main revision is the incorporation of seabird density estimates in the calculations. Further details on the two methods are provided in Annex 13A.

55. A precautionary approach to the CRM process was adopted, with the worst case scenario used to generate collision risk estimates. To identify which of the turbine options represented the greatest collision risk some preliminary calculations were made (see Table 13.9). In terms of potential for collisions, the most important variable is the rotor frontal area (the area of the rotor disc) divided by the rotor diameter (this provides a proxy for the number of potential rotor transits). The scenario which represented the greatest potential risk of collisions was the smallest turbine under consideration (3.6 MW), with a proposed total number installed of 277. Since this turbine option represents the greatest risk, only collision mortality estimates for this turbine option were provided here. If one of the other turbine options (e.g. 7 MW) is subsequently used for the Wind Farm, lower estimated collision mortality rates would be predicted, largely due to the smaller number of turbines which would be installed (mortality estimates based on the 7 MW turbine option would be approximately 20% lower). In all cases birds are assumed to be moving through the site continuously and each species' densities are maintained, irrespective of any collisions that might deplete the population.

Table 13.9 Alternative turbine options and corresponding rotor swept areas

Scenario	Power output (MW)	Planned number	Rotor radius (m)	Rotor frontal area (m²)		Total rotor frontal area / rotor diameter
				Per turbine	Total	
1	3.6	277	53.6	9,025.7	2,500,110	23,322
2	7	142	82.5	21,382.5	3,036,310	18,402

56. Data used to estimate mean densities of birds within the Wind Farm Site were taken from the boat-based surveys conducted between October 2009 and September 2011 inclusive. Typically, CRM outputs are presented as annual estimates, with individual months discussed where appropriate (e.g. periods of peak collisions). To generate monthly estimates the collision mortality was calculated for each survey and the average across replicate months used as the final estimate for that month. In both 2009 and 2010 poor weather in November prevented the boat survey from being undertaken. Collision estimates for November were therefore calculated as the average of the October and December overall estimates. Collision estimates are presented as annual and breeding season totals using species specific data to determine breeding months (Snow and Perrins 1998).

57. A critical component of CRM is the choice of species specific avoidance rates. These provide an estimate of the percentage of individuals which will take avoiding action to prevent collision with a wind turbine. SNH recommend that an avoidance rate of 98% should be applied for seabirds as there is insufficient empirical evidence to support the use of higher rates (SNH 2010). However, a recent review undertaken by the British Trust for Ornithology (BTO) for the Crown Estate (Cook et al., 2011) presents the results from a range of studies for offshore wind farms. They recommend that a minimum of 99% is appropriate for seabirds and that for many species the actual rate will be higher. Combining estimates of avoidance made at close range to turbine ('micro' avoidance) and avoidance made at greater distances ('macro' avoidance), it can be seen that minimum avoidance rates in excess of 99.5% have been found at other wind farms (see Annex 13A.). Therefore, the results of CRM were presented for a range of avoidance values: 98%, 99%, 99.5% and 99.9%. The lower value is included for comparative purposes with older wind farm assessments. In this account the 99% rate was used for assessing the potential impacts, as recommended in the most recent review (Cook et al., 2011).

58. Collision risk modelling for wildfowl on migration was estimated using data collected during the wildfowl migration surveys. For all the goose and swan species observed the number of flights which were assessed as either having probably, or possibly, crossed the Wind Farm Site during survey sessions, were used to estimate the total number of each species within each category during the complete migration period, thereby accounting for unsurveyed periods. Further details on the methods used are presented in Annex 13A.

Indirect Effects

59. Any potential indirect effects on birds are expected to result from changes in the abundance and/or distribution of their fish prey. Effects of construction activity (e.g. piling), habitat loss and changes in commercial fishing are assessed in Section 10: Wind Farm Benthic Ecology and Section 16: Wind Farm Commercial Fisheries, respectively. The key prey species present in the Moray Firth include sandeel and clupeids (e.g. herring). The results of the impact assessment for these species are considered here in terms of any knock-on effects on seabirds which prey on them. Consideration is also given to expected changes in commercial fishing activity within the Wind Farm Site (including re-distribution of effort) since seabird species which are recognised to target fishing vessels in order to take advantage of discards (e.g. gannet and gulls) may be affected.

13.3 BASELINE CONDITIONS

13.3.1 SITES DESIGNATED FOR NATURE CONSERVATION INTERESTS

60. The coast between Peterhead in Aberdeenshire and Duncansby Head in Caithness contains eight SPAs, five of which are also designated as Ramsar sites (Table 13.10). Another 11 SPAs in Orkney have been considered in this assessment, in acknowledgement of the wide range over which some breeding seabird species forage (Table 13.11). A further seven UK SPAs designated for breeding gannet and fulmar are listed, in recognition of the particularly long foraging distances these species undertake (Table 13.12). Whilst these protected areas do not overlap with the Wind Farm Site, the proposed Wind Farm Site does fall within the foraging range of qualifying species from all of these SPAs. It is therefore possible that for some species, likely significant effects will be identified, leading to a requirement for a Habitats Regulations Appraisal (See Section 13.10 and Annex 13B)). Tables 13.10, 13.11 and 13.12 provide population estimates for each of the SPA qualifying species, and the shortest distances from the protected sites to the Wind Farm Site boundary. Many of these SPAs comprise component SSSI and/or Ramsar sites, however no additional details for these sub-components is necessary since the SPA citations cover these interests. A map of the Moray Firth and Orkney SPAs is provided in Figure 13.2.

61. The nature conservation objectives for these sites primarily operate to protect the SPAs themselves (i.e. the habitats which support the bird populations). However, effects on the bird qualifying interests resulting from sources outside the boundaries of the SPAs must not act in such a way as to prevent the long-term maintenance of the populations as viable components of the SPA. Thus it is at the level of the SPA populations that potential effects due to the proposed Wind Farm will be considered.

Table 13.10 SPAs in the vicinity of the Wind Farm Site, and their qualifying interests (listed under Annex I and Annex II). Data from http://jncc.defra.gov.uk/page-1409, accessed 12.12.2011

Site name (distance to the wind farm)	**Species listed on SPA citation**	
	Species (season)	**Population (year)**
East Caithness Cliffs Spa (11 Km)	Fulmar (breeding)	15,000 prs. (1985-1988)
	Great cormorant (breeding)	230 prs. (1985-1988)
	European shag (breeding)	2,300 prs. (1985-1988)
	Peregrine falcon (breeding)	6 prs. (mid-1990s)
	Herring gull (breeding)	9,400 prs. (1985-1988)
	Great black-backed gull (breeding)	800 prs. (1985-1988)
	Kittiwake (breeding)	32,500 prs. (1985-1988)
	Common guillemot (breeding)	106,700 ind. (1985-1988)
	Razorbill (breeding)	15,800 ind. (1985-1988)
	Atlantic puffin (breeding)	1,750 prs. (1985-1988)
North Caithness Cliffs SPA (29 Km)	Fulmar (breeding)	14,700 prs. (1985-1988)
	Peregrine falcon (breeding)	6 prs. (mid-1990s)
	Kittiwake (breeding)	13,100 prs. (1985-1988)
	Common guillemot (breeding)	38,300 ind. (1985-1988)
	Razorbill (breeding)	4,000 ind. (1985-1988)
	Atlantic puffin (breeding)	1,750 prs. (1985-1988)
Moray And Nairn Coast SPA, Ramsar (55 Km)	Pink-footed goose (wintering)	139 ind. (1992-1996)
	Greylag goose (wintering)	2,679 ind. (1992-1996)
	Osprey (breeding)	7 prs (early 1990s)
	Redshank (wintering)	862 ind. (1992-1996)
Dornoch Firth And Loch Fleet SPA, Ramsar (58 Km)	Greylag goose (wintering)	2,079 ind. (1992-1996)
	Wigeon (wintering)	15,022 ind. (1992-1996)
	Osprey (breeding)	20 ind. (early 1990s)
	Bar-tailed godwit (wintering)	1,300 ind. (1992-1996)
Troup, Pennan And Lion's Heads SPA (62 Km)	Fulmar (breeding)	4,400 prs. (1995)
	Herring gull (breeding)	4,200 prs. (1995)
	Kittiwake (breeding)	31,600 prs. (1995)
	Common guillemot (breeding)	44,600 ind (1995)
	Razorbill (breeding)	4,800 ind. (1995)
Inner Moray Firth SPA, Ramsar (68 Km)	Greylag goose (wintering)	2,651 ind. (1993-1997)
	Red-breasted merganser (wintering)	1,184 ind. (1993-1997)
	Osprey (breeding)	2 ind. (early 1990s)
	Bar-tailed godwit (wintering)	1,090 ind. (1993-1997)

Site name (distance to the wind farm)	**Species listed on SPA citation**	
	Species (season)	**Population (year)**
	Redshank (wintering)	1,621 ind. (1993-1997)
	Common tern (breeding)	310 prs. (1985-1988)
Loch Of Strathbeg SPA, Ramsar (86 Km)	Whooper swan (wintering)	183 ind. (1992-1996)
	Pink-footed goose (wintering)	39,924 ind. (1992-1996)
	Greylag goose (wintering)	3,325 ind. (1992-1996)
	Teal (wintering)	1,898 ind. (1992-1996)
	Goldeneye (wintering)	109 ind. (1992-1996)
	Sandwich tern (breeding)	530 prs. (1993-1997)
Cromarty Firth SPA, Ramsar (87 Km)	Whooper swan (wintering)	64 ind. (1993-1997)
	Greylag goose (wintering)	1,782 ind. (1993-1997)
	Osprey (breeding)	2 prs. (early 1990s)
	Bar-tailed godwit (wintering)	1,355 ind. (1993-1997)
	Common tern (breeding)	294 prs. (1989-1993)

Table 13.11 SPAs in Orkney and their qualifying interests (listed under Annex I and Annex II). Data from http://jncc.defra.gov.uk/page-1409, accessed 12.12.2011

Site name (distance to the Wind Farm)	Species listed on SPA citation	
	Species (season)	**Population (year)**
Hoy (57 km)	Red-throated diver (breeding)	58 breeding territories (1994).
	Fulmar (breeding)	35,000 prs. (1985-1988).
	Peregrine (breeding)	6 prs. (mid 1990s).
	Arctic skua (breeding)	59 prs. (1996).
	Great skua (breeding)	1,900 prs. (1996)
	Great black-backed gull (breeding)	570 prs. (1985-1988).
	Kittiwake (breeding)	3,000 prs. (1985-1988).
	Guillemot (breeding)	13,400 prs. (1985-1988).
	Puffin (breeding)	3,500 prs. (1985-1988).
Copinsay (63 km)	Fulmar (breeding)	1,615 prs. (1985-1988).
	Great black-backed gull (breeding)	490 prs. (1985-1988).
	Kittiwake (breeding)	9,550 prs. (1985-1988).
	Guillemot (breeding)	29,450 ind. (1985-1988).
Rousay (94 km)	Fulmar (breeding)	1,240 prs. (1986 + 1997).
	Arctic skua (breeding)	130 prs. (1992).
	Kittiwake (breeding)	4,900 prs. (1986 + 1997).
	Arctic tern (breeding)	790 prs. (1991-1995).
	Guillemot (breeding)	10,600 ind. (1986 + 1997).
Calf of Eday (97 km)	Fulmar (breeding)	1,955 prs. (1985-1988).
	Cormorant: (breeding)	223 prs. (1985-1988).
	Great black-backed gull (breeding)	938 prs. (1985-1988)
	Kittiwake (breeding)	1,717 prs. (1985-1988).
	Guillemot: (breeding)	12,645 ind. (1985-1988).
West Westray (XX km)	Fulmar (breeding)	1,400 prs. (1985-1988).
	Arctic skua (breeding)	78 prs. (1985-1988).
	Kittiwake (breeding)	23,900 prs. (1985-1988).
	Arctic tern (breeding)	1,140 prs. (1985-1988).
	Guillemot (breeding)	42,150 ind. (1985-1988).
	Razorbill (breeding)	1,946 ind. (1985-1988).

Table 13.12 UK SPAs designated for breeding fulmar and gannet within the mean maximum foraging range of these species (311 km and 308 km respectively). Data from http://jncc.defra.gov.uk/page-1409, accessed 12.12.2011 and Wanless et al., (2005)

Site Name	Number of prs. gannet (year)	Number of prs. fulmar (year)
Fair Isle (150 km)	1,875 (2004)	35,210 (1985-1988).
Forth Islands (255 km)	48,065 (2004)	798 (1994)
Hermaness, Saxa Vord and Valla Field (296 km)	15,633 (2003)	19,539 (1999)
North Rona & Sula Sgeir (206 km)	9,225 (2004)	11,500 (1985-1986)
Noss (220 km)	8,652 (2003)	6,350 (1987-1992)
Sule Skerry & Sule Stack (130 km)	4,675 (2004)	NA

13.3.2 DESCRIPTION OF BIRD SURVEY RESULTS

13.3.2.1 Summary of Survey Results

62. A total of 21,419 bird observations were made across the entire study area during the 22 boat surveys between October 2009 and September 2011. These can be divided into birds seen within the transect area on the sea surface (18,360 observations of 18 species and four species groups), or in snapshots of birds in flight (3,059 observations of 20 species or three species groups) (see Table 13.13).

63. For species observed in sufficient numbers (> 50 observations), the density of birds observed on the water was estimated using Distance based methods (Thomas et al., 2010). From these densities, the abundance of birds across the Wind Farm Site and the 4 km buffer were derived. The peak density and abundance recorded for each species across all 22 surveys is provided in Table 13.13.

Table 13.13 Total number of birds recorded during boat surveys of the Wind Farm study area between October 2009 and September 2011. Density and abundance were only estimated for species with sufficient observations (> 50)

Species	Numbers observed during boat surveys					Peak estimates (study area)			
	In transect		In snapshot		Total	Peak density (birds/km² (CV))		Peak abundance	
	Wind Farm Site	4 km buffer	Wind Farm Site	4 km buffer		Breeding season	Non-breeding season	Breeding season	Non-breeding season
Fulmar	398	1284	242	535	2459	7.82 (0.14)	1.27 (0.35)	2955	481
Manx shearwater	-	2	-	7	9	-	-	-	-
Sooty shearwater	-	112	1	5	118	0.12 (1.3)	0.53 (1.0)	46	200
Storm petrel	1	3	1	4	9	-	-	-	-
Gannet	84	307	32	105	528	1.21 (0.31)	1.63 (0.32)	458	614
Cormorant	-	-	1	1	2	-	-	-	-
Shag	19	20	1	1	41	0.04 (1.0)	0.23 (0.51)	14	87
Arctic skua	5	7	4	3	19	0.23 (1.2)	0	89	0
Great skua	23	50	9	9	91	0.43 (0.35)	0.1 (0.6)	164	40
Kittiwake	1077	1185	55	202	2519	3.78 (0.45)	5.88 (0.43)	1430	2223
Lesser black-backed gull	-	5	2	1	8	-	-	-	-
Herring gull	61	163	77	114	415	0.14 (0.74)	1.55 (0.31)	55	586
Great black-backed gull	175	211	36	80	502	0.27 (0.47)	1.45 (0.29)	104	547
Unidentified large gull	1	5	6	8	20	-	-	-	-
Common tern	-	-	-	1	1	-	-	-	-

Species	Numbers observed during boat surveys					Peak estimates (study area)			
	In transect		In snapshot		Total	Peak density (birds/km² (CV))		Peak abundance	
	Wind Farm Site	4 km buffer	Wind Farm Site	4 km buffer		Breeding season	Non-breeding season	Breeding season	Non-breeding season
Arctic tern	-	18	5	6	29	0.46 (0.86)	0	174	0
Guillemot	3939	4569	267	364	9139	52.83 (0.1)	21.4 (0.15)	19961	8080
Razorbill	470	1096	38	117	1721	4.09 (0.21)	8.62 (0.2)	1547	3258
Black guillemot	-	-	-	2	2	-	-	-	-
Unidentified auk	379	955	99	422	1855	2.78 (0.32)	4.10 (0.29)	1050	1550
Puffin	459	914	5	11	1389	11.1 (0.13)	9.45 (0.21)	4192	3571
Little auk	2	7	-	-	9	-	-	-	-
Unidentified passerine	-	-	-	1	1	-	-	-	-
Grey phalarope	-	-	-	1	1	-	-	-	-
Whooper swan	-	2	-	-	2	-	-	-	-

64. The bird observations obtained from the aerial surveys covered a larger area than that surveyed by boat. Visual comparison of the distribution of observations obtained from the aerial and boat surveys did not indicate that the Wind Farm Site represents an area of particular importance for seabirds, with similar densities recorded across the entire aerial survey area (see Annex 13A).

65. Analysis of the RSPB survey data provided further evidence to indicate that the Wind Farm Site does not provide an area of primary importance within the wider region. With the exception of species which favour coastal waters (e.g. shag), the RSPB data did not identify any particular offshore locations which appeared to be favoured significantly more than others (see Annex 13A).

66. The Beatrice demonstrator project data revealed very similar seasonal trends in abundance to those derived from the boat surveys of the Wind Farm Site. Thus, the patterns observed during the boat surveys appear to provide a reliable picture of how the numbers of each species vary through the year (see Annex 13A).

67. The individual tagging study provided very detailed information about the movements of tagged birds. Fulmars are known to undertake the longest foraging trips of the four species tagged, and this was found for this study with foraging trips extending into the middle of the North Sea. None of the fulmars tagged spent any time on the Wind Farm Site. Among the tagged kittiwake, two individuals foraged as far as Peterhead, although most trips were made to areas of the inner Moray Firth. Similar patterns of trips were found for both guillemot and razorbill, with guillemot making longer trips than razorbill, but both favouring the inner Moray Firth. Plots of the trips made by each tagged individual are presented in Annex 13A. None of the tagged individuals of any species entered the Wind Farm Site during the period of the study.

13.3.2.2 Determination of Sensitive Bird Species

68. The seabird species chosen for detailed consideration and impact assessment were selected from the list of potential species present within regional SPAs by evaluating boat survey data and determining species occurrence in the study area. During the breeding season, individuals were assumed to originate from seabird colonies within the mean maximum foraging range of the Wind Farm Site. Outside the breeding season most seabird species undertake wide ranging migrations. Thus estimation of the population size from which each species was assumed to be drawn during the non-breeding season was based on accounts of passage and winter movements (e.g. Snow and Perrins 1998) and the wider populations these accounts indicated should be included (Mitchell et al., 2004).

69. Species sensitivity was evaluated by examining the conservation status of the European and national population levels, combined with regional and local population size, and density and peak population estimates on the survey site. At this stage, ecology and behaviour which might affect avifauna response to wind farm construction were not considered, therefore species sensitivity is defined solely by their conservation status and presence within the study area, rather than by behaviour.

70. The timing of peak abundance on the Wind Farm Site has a bearing on the classification of the species with regards to the numbers seen and thresholds of regional significance. Thus, species which peaked in abundance during the breeding season were typically assessed against smaller regional populations (defined above) than those which peaked in the non-breeding season.

71. Peak populations recorded in the boat-based survey area (comprising the Wind Farm Site and the 4 km buffer) which exceeded 1% of the national threshold were classified as nationally important populations; peak populations which exceeded 1% of the regional population thresholds were classified as regionally important (see Table 13.14).

72. Thirteen seabird species were identified as sensitive species (see Table 13.14), and the potential for them to be affected by the proposed Wind Farm assessed.

Table 13.14 Peak abundance of birds recorded in the Wind Farm survey area compared to regional and national abundance thresholds

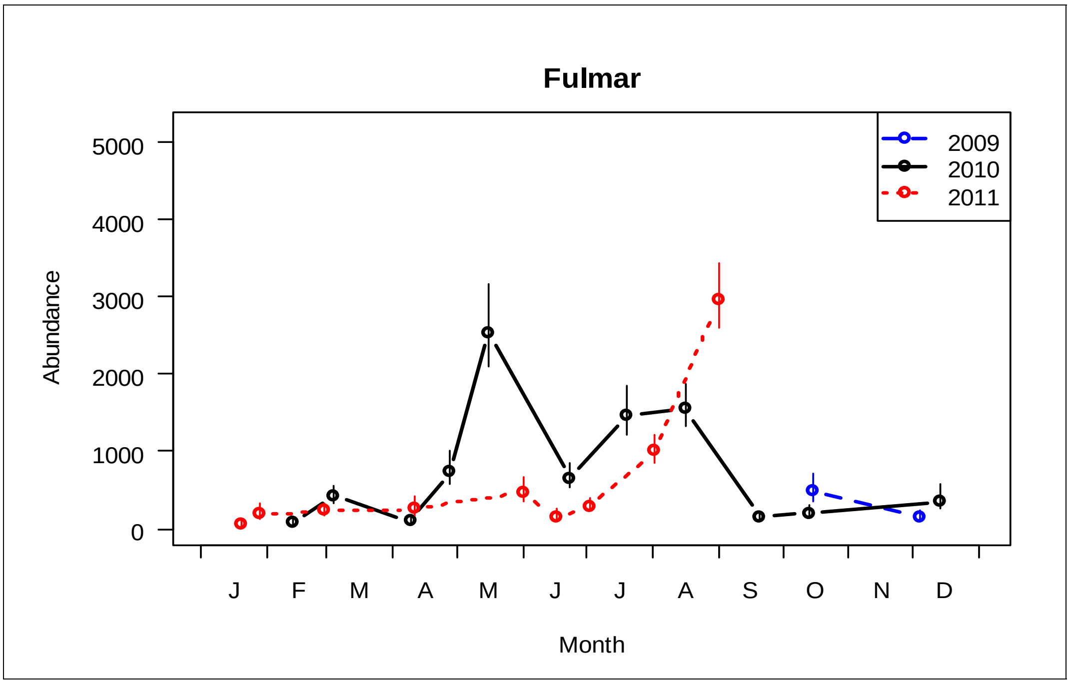
Species	Estimated Peak Population (Boat survey)	Month of peak	GB 1% Threshold	Nationally Important Population?	Regional Population (Seabird 2000)	Regionally Important Population?
Fulmar	2955.2	Sep 2011	5,390	No	256,590	Yes
Sooty shearwater	200.1	Sep 2011	Passage sp.	n/a	n/a	Unknown
Shag	86.6	Dec 2010	375	No	7,934	Yes
Gannet	614.4	Oct 2009	4,371	No	12,444	Yes
Arctic skua	88.6	May 2011	32	Yes	1,582	Yes
Great skua	163.7	May 2010	85	Yes	4,428	Yes
Kittiwake	2222.6	Apr 2010	4,900	No	278,074	No
Great black-backed gull	546.9	Feb 2011	190	Yes	11,978	Yes
Herring gull	586.1	Feb 2011	1,600	No	29,484	Yes
Arctic tern	174.2	Jun 2011	440	No	29,776	No
Guillemot	19960.6	Apr 2010	7,035	Yes	483,194	Yes
Razorbill	3258.3	Apr 2010	991	Yes	38,347	Yes
Puffin	4192.5	Aug 2011	4,490	No	126,202	Yes

73. Brief summaries are presented for each species based on the data collected during the boat surveys. In addition, summary figures providing a breakdown of observations by season are presented: pre-breeding (February to April), breeding (May to July), post-breeding (August to October) and wintering (November to January). Comprehensive descriptions of the seasonal and spatial distribution for each of these species, utilising all the available data sources, are provided in Annex 13A.

Fulmar

74. Fulmars were recorded on the Wind Farm Site all year round (Figure 13.3). The peak density of birds observed at the Wind Farm Site was 7.82 per km², in September 2011. In 2010 numbers were generally high between May and August, coinciding with the period when adults are attending nests, and the lowest numbers occurred in all years between November and January (Plate 13.1). A slightly different pattern was seen during the 2011 breeding period, with numbers remaining low until August before a peak in September.

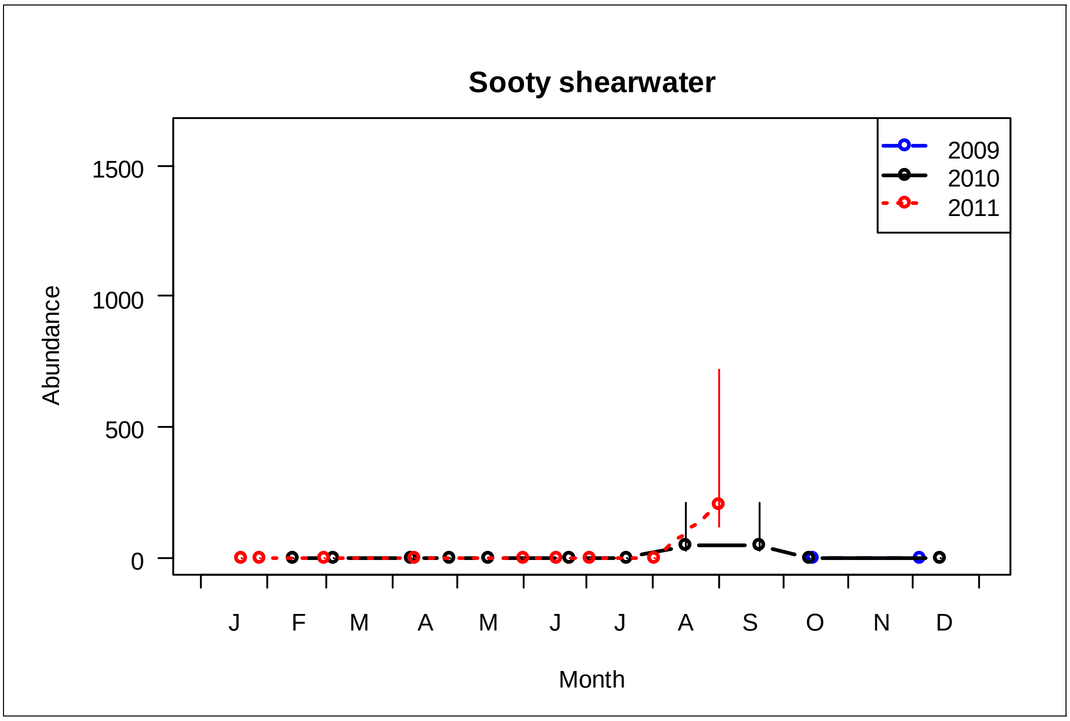
Plate 13.1 Fulmar seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



Sooty Shearwater

75. Sooty shearwaters were only observed in August and September (Figure 13.4). The maximum density was 0.53/km² (Plate 13.2). The pattern of observations was consistent across both years of survey.

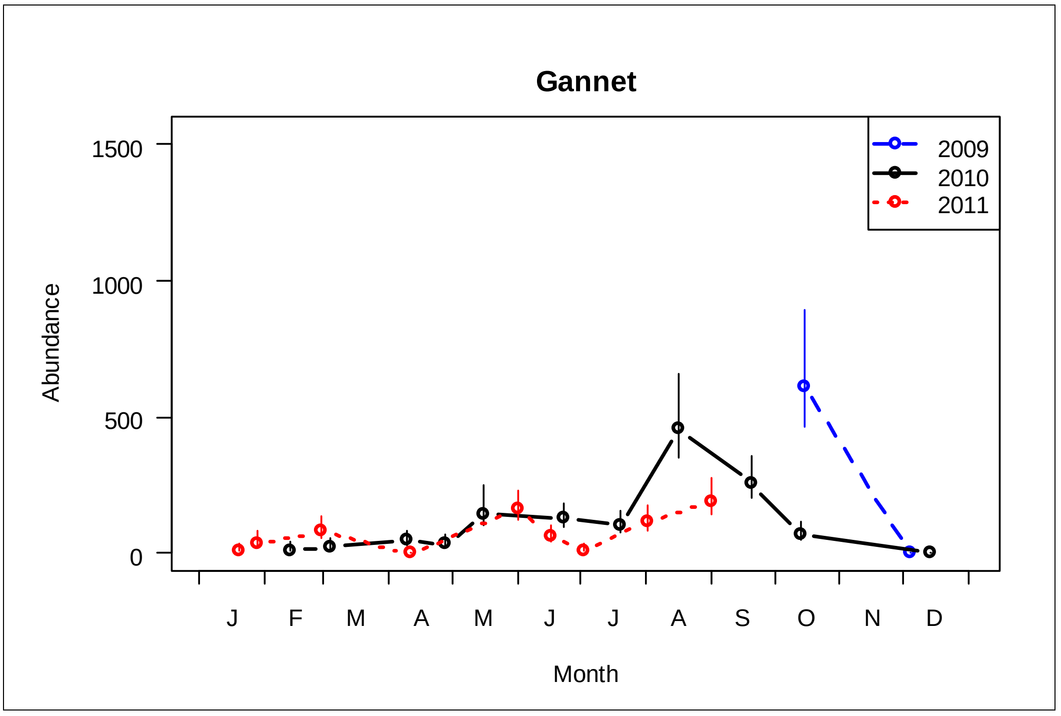
Plate 13.2 Sooty shearwater seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



Gannet

76. Gannets were observed at low densities in most months (Figure 13.5), with numbers peaking in August, September and October (see Plate 13.3, max. density 1.6 / km²).

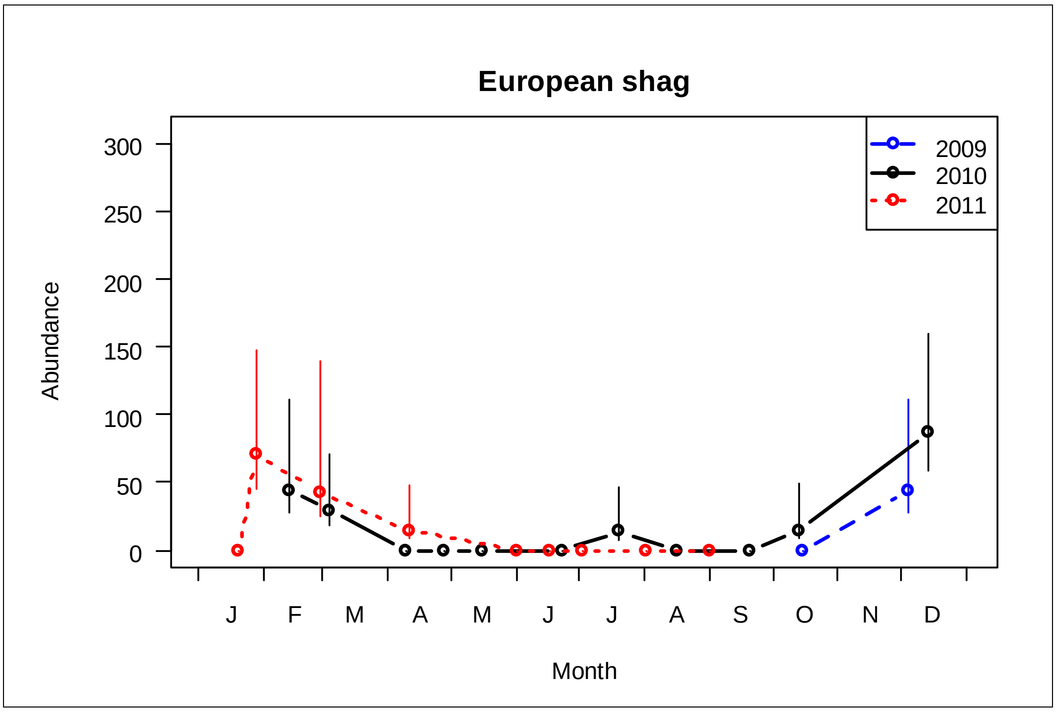
Plate 13.3 Gannet seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



Shag

77. Shags were virtually absent from the Wind Farm Site between April and September (see Figure 13.6), with numbers peaking in December and January (see Plate 13.4, max density 0.23/km²).

Plate 13.4 European shag seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



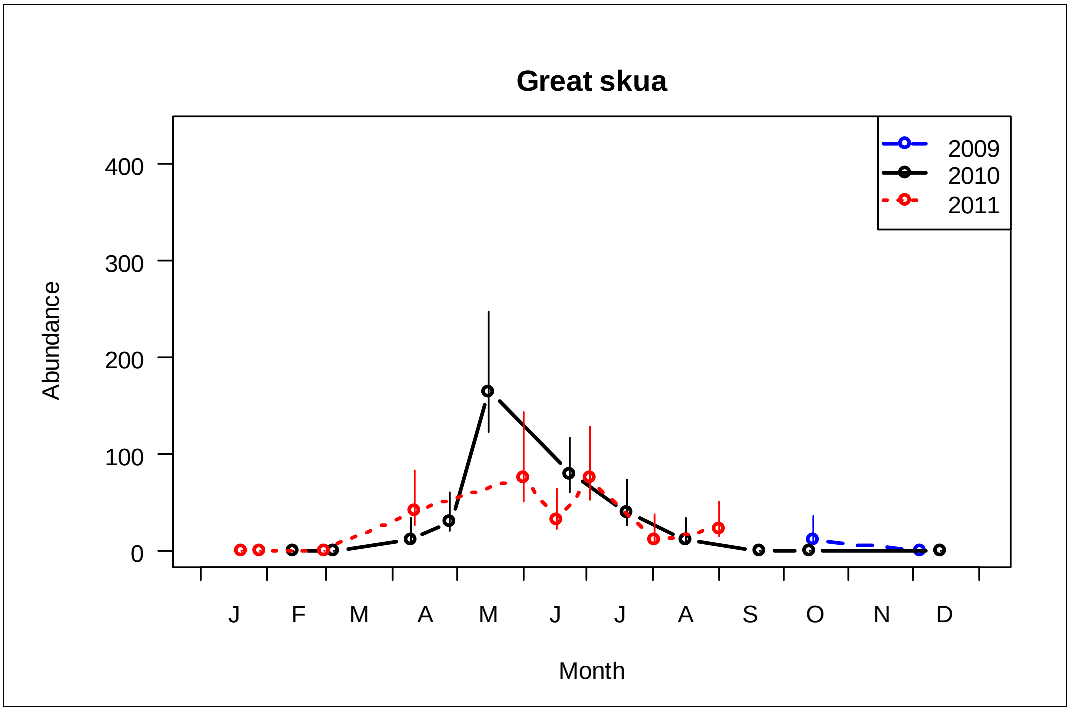
Arctic Skua

78. Arctic skuas were only seen between May and August (see Figure 13.7). Only 17 were observed which was insufficient to permit reliable density estimation.

Great Skua

79. Great skuas were seen between April and September (see Figure 13.8), with numbers peaking in May 2010 (see Plate 13.5, max density 0.43/km²).

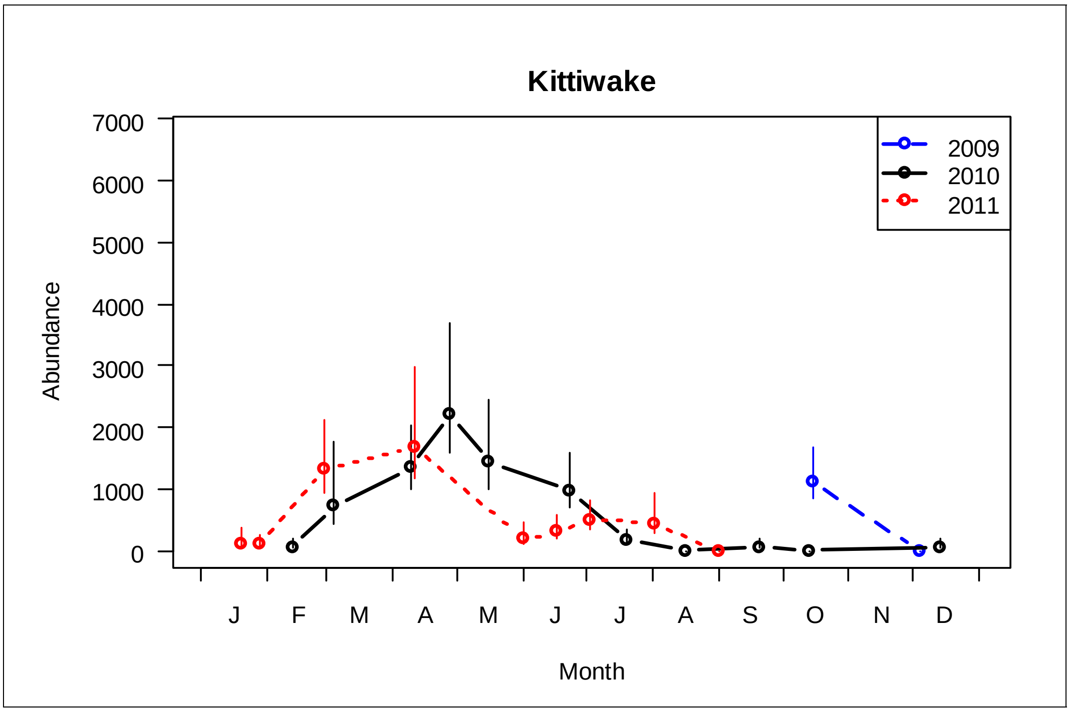
Plate 13.5 Great skua seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



Kittiwake

80. Kittiwakes were observed throughout the year (see Figure 13.9), with a peak in numbers in April 2010 (see Plate 13.6, max density 5.9/km^2).

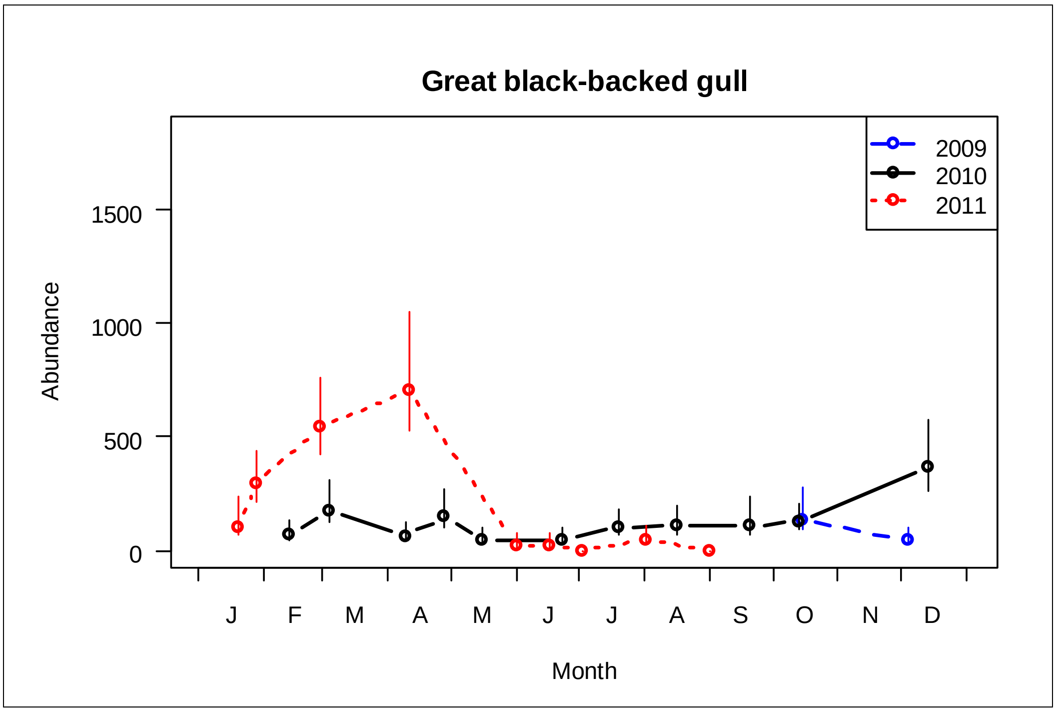
Plate 13.6 Kittiwake seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



Great Black-backed Gull

81. Great black-backed gull were seen all year round (see Figure 13.10), with numbers peaking in early spring 2011 (see Plate 13.7, max density 1.45 / km²).

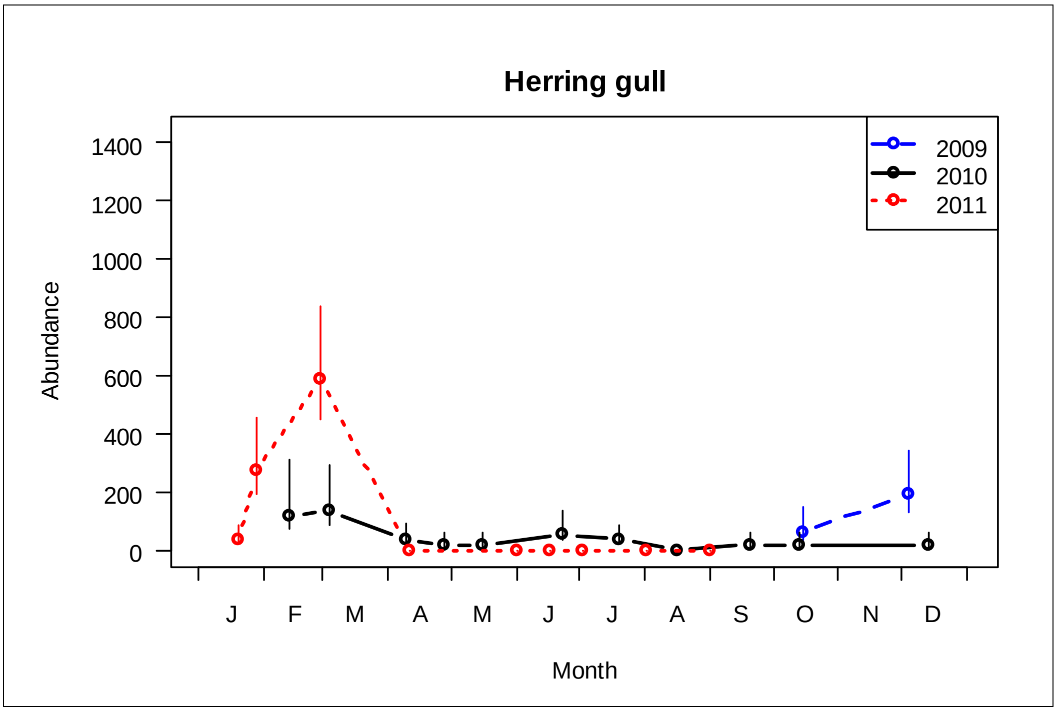
Plate 13.7 Great black-backed gull seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



Herring Gull

82. Across both years, herring gulls were recorded in all months except August, albeit in very low numbers during the spring and summer months (see Figure 13.11). The highest density was recorded in February 2011 (see Plate 13.8, max density 1.5 / km²).

Plate 13.8 Herring gull seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



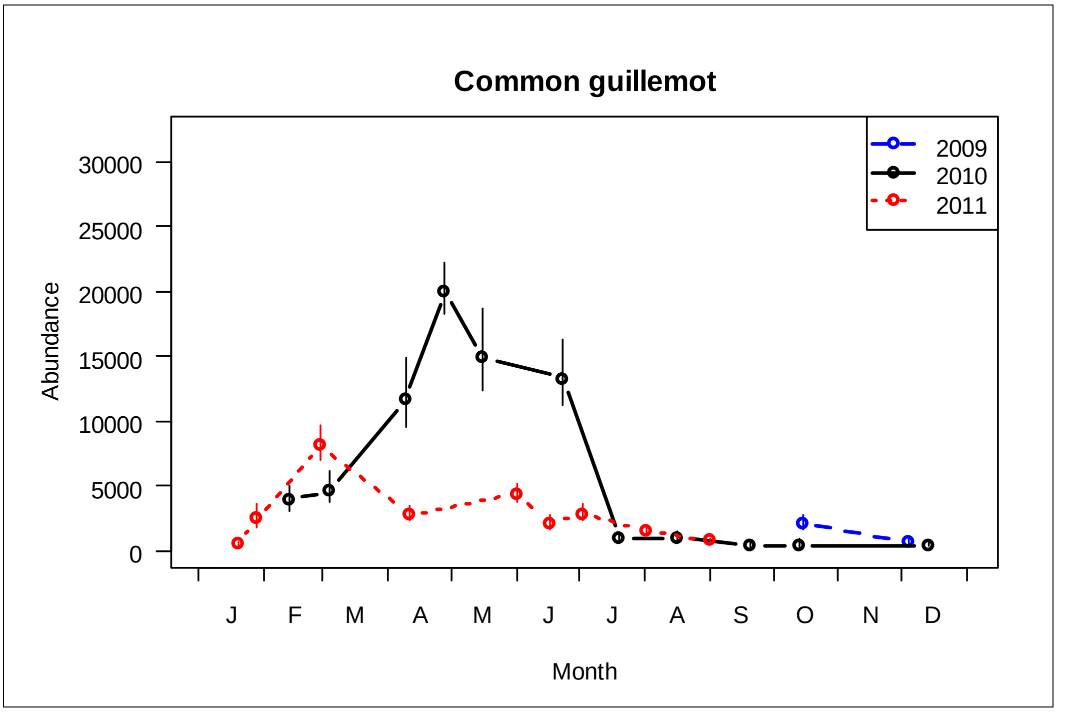
Arctic Tern

83. Arctic terns were seen in May to July only (see Figure 13.12). Only 29 were observed which was insufficient to permit reliable density estimation.

Common Guillemot

84. Common guillemot were seen all year round (see Figure 13.13), with numbers peaking in April 2010 (see Plate 13.9, max density 52.8 / km²).

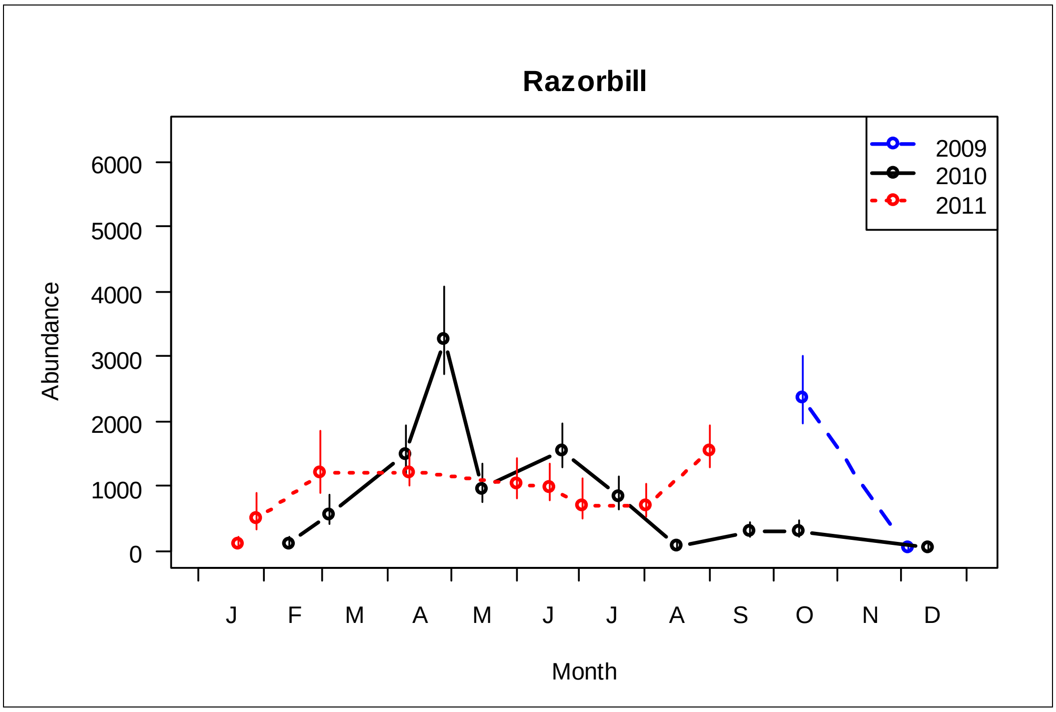
Plate 13.9 Common guillemot seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



Razorbill

85. Razorbills were recorded all year round (see Figure 13.14), with numbers peaking in April 2010 (see Plate 13.10, max density 8.6 / km²).

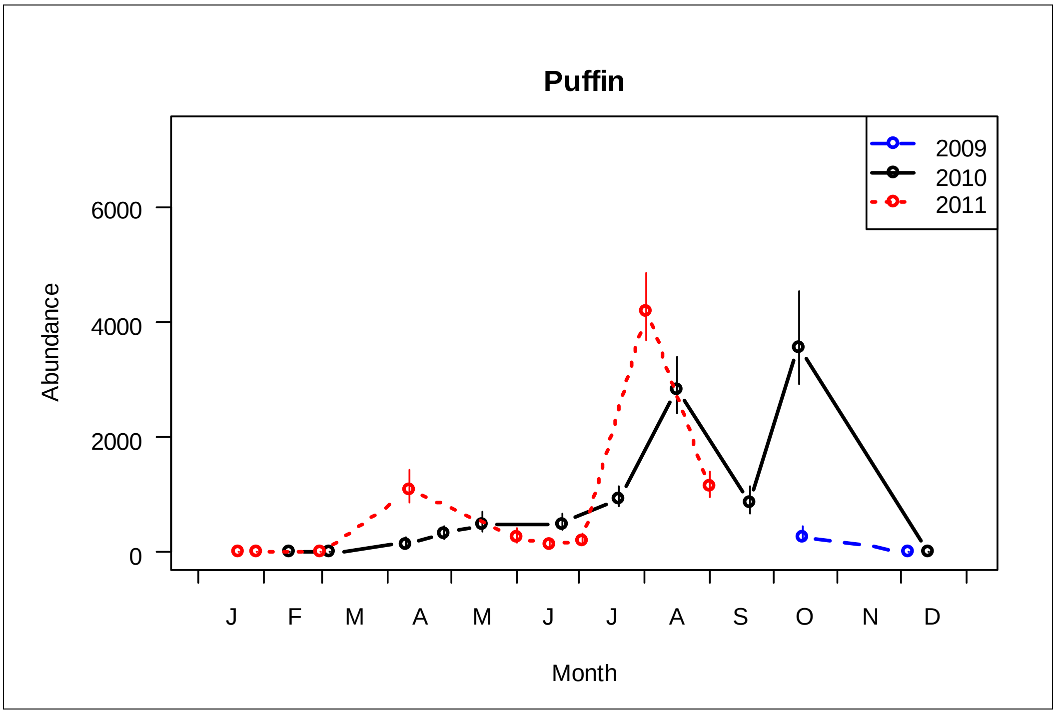
Plate 13.10 Razorbill seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer)



Puffin

86. Puffins were recorded between April and October (see Figure 13.15) with numbers peaking in August (2010 and 2011) and October 2010 (see Plate 13.11, max density 11.1 / km^2).

Plate 13.11 Puffin seasonal abundance (±1 standard error) estimated using boat survey data for the whole boat based survey area (Wind Farm Site plus 4 km buffer).



13.3.2.3 Wildfowl Migration Surveys

87. It was estimated that over 36,000 pink footed geese, over 5,700 greylag geese, over 3,300 unidentified geese but no more than 100 whooper swans probably flew across the Wind Farm Site during the autumn 2010 and spring 2011 migration (combined across both periods). See Annex 13A for further details.

88. All these species (and unidentified geese) were treated as potentially at risk and the likely effects on their populations from the Wind Farm have been assessed. The distribution of flight heights was derived from observations made during the boat surveys. This permitted estimation of the proportion of flights expected to cross the Wind Farm Site at rotor height.

13.3.2.4 Additional Birds Observed During Boat Surveys

89. Birds recorded within the boat based survey area, but not within transect or in snapshots (i.e. incidental observations) are summarised in Table 13.15 (19 species and three species groups).

Table 13.15 Birds observed during boat surveys outside of transect region and not in snapshots. Total number summed across all surveys between October 2009 and September 2011.

Species	Wind Farm Site	4 km buffer
Little tern		1
Black-headed gull		4
Black guillemot	1	3
Lesser black-backed gull	1	14
Common gull	1	8
Great northern diver		1
Red-throated diver	1	4
Unidentified diver	2	
Pink-footed goose	292	880
Eider		1
Wigeon		2
Curlew	1	1
Dunlin	2	5
Golden plover	8	
Unidentified wader	2	
Grey heron		1
Carrion crow	1	2
Goldcrest		1
Meadow pipit	2	1
Starling		1
Swallow	2	4
Unidentified passerine	2	7

90. The only species or group recorded in numbers exceeding 10 individuals were pink-footed goose and common gull. Since the boat surveys were conducted during daylight hours they may have missed nocturnal movements of waders, wildfowl and passerines during migratory periods. However, the very small numbers of potential migrants (pink-footed goose excepted) recorded during the boat surveys are likely to reflect that these species usually migrate over the sea at high altitudes, particularly at night, and although for this reason may not be recorded during surveys in peak numbers, they will be at little risk of collision or barrier effects from the Wind Farm. A two year project to investigate the collision risk of migrating birds in the Danish offshore wind farms, Horns Rev and Nysted, using data obtained from a combination of radar, visual and acoustic observations showed that during periods of mass migration, birds tended to be recorded at higher altitudes with strong preferences for altitudes in excess of 800 m (Blew et al., 2008). Krijgsveld et al., (2005) found that during baseline studies of Dutch offshore wind farms, night-time migration flight altitudes were typically higher than those

recorded during the day, and took place predominantly at altitudes of between 200 m and 600 m. Thus the majority of migratory movements would pass above the maximum rotor swept height of 198 m. Flight activities at night were mostly of migrating waders and larger passerines.

91. Wildfowl migration was the subject of a specific study, however no other potential migratory species (e.g. waders or passerines) were considered for impact assessment since the combination of low observed numbers and typical flight height observations made in other studies (e.g. Blew et al., 2008, Krijgsveld et al., 2005) clearly indicate these species are at little or no risk of effect (for a more detailed review of studies of risks to migrating birds see Annex 13A).

13.4 ASSESSMENT OF EFFECTS

13.4.1 CONSTRUCTION AND DECOMMISSIONING EFFECTS

92. Potential effects associated with the construction and decommissioning of the wind farm include:

- Disturbance/displacement due to increased boat traffic;
- Disturbance/displacement due to construction activities; and
- Indirect effects of pile-driving or installation of gravity bases upon local habitat conditions and prey stocks.

93. During these phases effects will be temporary and extend over comparatively small areas (i.e. they would be localised within the Wind Farm Site at any one time). Effects would include those due to the presence and movement of vessels on site and as a result of particular construction activities. Therefore it is possible that birds may re-distribute around the Wind Farm Site, making use of non-impacted areas during periods of construction activity. These effects are considered in more detail below.

94. It is anticipated that decommissioning effects will be less than those of construction and as a consequence the assessment focusses on the effects of construction. As a precautionary approach, decommissioning effects are assumed to be the same in this assessment.

13.4.1.1 Disturbance due to Construction Activity

95. One study which has reported on construction effects (Leopold and Camphuysen, 2007), noted that the only birds seen to be present around the Egmond aan Zee Wind Farm in the Netherlands at the times of (observed) pile driving were gulls (mainly lesser black-backed and herring gulls) and terns (mainly sandwich and common terns). These birds were mainly seen flying by (i.e. in the air, where they were not subjected to underwater noise). They concluded that there was little, if any effect of pile driving on the presence of gulls in the area.

96. Very little is known about how diving birds may respond directly to underwater noise. As species which have hearing adapted primarily for use in air, it is expected that hearing sensitivity underwater will generally be low, in comparison to that for marine mammals, for example.

97. Consequently, it seems likely that for some species, the effect of construction activity (especially pile driving) would occur indirectly through effects upon the distribution of prey species. High intensity sounds within the water column are known to have a highly significant and potentially lethal effect on certain fish species if they are in close vicinity to pile driving (e.g. Caltrans 2001). However, the range over which such effects could occur is not well understood (Thomsen et al., 2006). It is possible therefore that pile driving could influence the abundance and distribution of some prey species during construction, and potentially beyond the period of construction if fish populations are significantly affected. The fish species considered to be of most importance as prey for seabirds are sandeels and clupeids (e.g. herring).

98. The Section 11: Wind Farm Fish and Shellfish Ecology provided an assessment of noise effects on sandeels, which constitute a major resource for many of the seabirds foraging within the Wind Farm Site. This concluded that sandeels and herring (with the exception of spawning herring) are at risk of effects of minor significance (spawning herring were assessed as at risk of effects of moderate significance). It seems plausible that a minor effect on their fish prey species would have a lesser effect on seabirds which feed on them, since they are more able to relocate to forage in unaffected areas. Thus, indirect effects on seabirds of construction activity are considered to constitute effects of negligible significance.

99. Large numbers of guillemots, and lower numbers of razorbills were recorded in the boat survey area during the breeding season, with considerable foraging activity throughout this period. Pile driving operations may cause fish to re-distribute over comparatively short distances away from the sources of disturbance for the duration of noise generation. Any birds feeding on these fish would be expected to respond by simply moving with the shoals. It is predicted that a maximum of two concurrent piling events would take place on site. The temporary displacement of fish from the immediate area of each operating vessel is therefore expected to be of little consequence to birds in the context of the wider Moray Firth area.

100. The various seabird surveys conducted across the Moray Firth have revealed that much of the region provides foraging opportunities for guillemots and razorbills. Furthermore, the tracking study conducted during the 2011 breeding season (see Annex 13A) highlighted the importance of south western areas of the Moray Firth for foraging. Individuals which nest at more northerly locations than those selected for the tagging study might be expected to forage within the Wind Farm Site, due to their closer proximity to it. However, it is notable that the birds tagged undertook foraging trips to destinations much farther away from their nest sites than the Wind Farm Site. Thus, it appears that the south western area of the Moray Firth was more favoured for foraging than the Wind Farm Site for those individuals studied. The peak abundance of each species recorded during the breeding season represented approximately 4% of the guillemot breeding population and approximately 6% of the razorbill breeding population (as percentages of the nearest colony; East Caithness Cliffs). Construction activity will not occur across the entire site at the same time, therefore not all of these birds would be at risk of

effects simultaneously. Since these species distribute widely outside the breeding season, they are not considered at risks of effect during this period. Overall, therefore, it is considered that displacement of guillemots and razorbills from the Wind Farm Site due to construction activity could have at most a population level effect of small magnitude, giving rise to a negative effect of minor significance.

101. The peak abundance estimate for puffins on the Wind Farm Site during the breeding season was 1,455. This represents approximately 41% of the breeding population at the nearest colony (East Caithness Cliffs). However, it seems plausible that the late summer peak in numbers in fact reflects a post-breeding influx of individuals from colonies farther afield (e.g. Orkney), therefore the population against which this should be considered is considerably larger. Since construction activity will not occur across the entire site at the same time, not all of the birds present across the site would be at risk of effects simultaneously. It is therefore considered highly unlikely that displacement of birds from the Wind Farm Site due to construction activity could have a population level effect. Consequently, construction activity is expected to give rise to a small magnitude of change for this high sensitivity species resulting in a negative effect of minor significance.

102. Opportunistic scavenging species such as gulls and fulmar may benefit from foraging opportunities created by construction works. Great black-backed gulls, for example, frequently associate with vessels and human activity such as fishing (Mitchell et al., 2004). Individuals of this species may exploit novel foraging opportunities created by the presence of vessels or noise disturbance, bringing potential prey (dead or alive) to the surface. It is considered highly unlikely that birds would be displaced from the Wind Farm Site due to construction activity, and thus no negative population level effects are predicted. Therefore, negligible magnitudes of change are assessed for these high sensitivity species resulting in negative effects of negligible significance.

103. Whilst gannets have been recorded feeding within the Wind Farm Site, this has been in low numbers. This species has an extremely flexible foraging strategy, which includes associating with human activity at sea, for example aggregating around fishing vessels in order to take advantage of discards. There is potential therefore that individuals may take advantage of any fish disorientated by construction activity. Based on their low sensitivity to ship and helicopter traffic (Garthe and Hüppop 2004) gannets are considered unlikely to respond adversely to noise and other construction activity. Consequently construction activity is expected to give rise to a negligible magnitude of change for this high sensitivity species resulting in negligible effects that are not significant.

104. As kleptoparasites (food thieves) of other species, Arctic skua and great skua are not expected to be directly affected by effects on fish and loss of foraging areas as a result of the construction process, but may be indirectly affected by the way in which species they parasitise (e.g. auks and kittiwake) respond. Since their foraging strategies tend to cause them to focus their efforts on seabird breeding colonies this lends further support to the prediction of minimal direct effects due to

construction. Both skua species would be expected to exhibit flexible responses to shifts in the distribution of other species by moving into areas that are more profitable. Thus construction activity is expected to give rise to a small magnitude of change for these medium sensitivity species resulting in an effect of minor significance.

105. Sooty shearwater are considered to be less reliant on fish than other species under consideration here, also eating crustaceans, shrimp, squid and jellyfish (Snow and Perrins 1998). Since indirect effects are expected to be mostly mediated via the effects on fish of piling, this reduces the likelihood of any indirect effects on this species. Moreover, sooty shearwaters only occur in the Moray Firth for a limited time during the autumn migration period. Thus, individuals are only likely to be within the site for very short periods limiting the time over which any theoretical effect could occur. Consequently construction activity is expected to give rise to a negligible magnitude of change for these medium sensitivity species resulting in effects of negligible significance.

106. No other seabird species were considered to make use of the Wind Farm Site in ways which would lead them to be affected during construction or decommissioning. Thus the significance of effects due to construction for all the remaining sensitive bird species was classed as not significant.

107. Overall, the significance of construction activity is predicted to range from negligible to minor and is therefore not significant in terms of the EIA Regulations. No further action beyond the adoption of best practice will be required to minimise any potential adverse effects.

13.4.1.2 Disturbance Due to Vessel Traffic

108. Fulmar, sooty shearwater, gannet, Arctic skua, great skua, kittiwake, great black-backed gull, herring gull and Arctic tern are all highly mobile foragers, which spend significant proportions of time in flight, rapidly covering large sea areas in search of prey. Therefore a small magnitude of change is assessed for these high and medium sensitivity species resulting in negative effects that are of minor significance.

109. Guillemot, razorbill and puffin were classed as being of medium sensitivity to disturbance from vessel activity by Garthe and Hüppop (2004). Auks often show a degree of disturbance by vessel activity either by flushing from the water surface or diving when a vessel approaches. However, the distance of displacement tends to be very small, particularly within the context of available suitable habitat within the Moray Firth. Given the relatively small spatial range over which vessel disturbance will extend it is considered highly unlikely that important numbers of birds would be displaced from the Wind Farm Site due to vessel activity, and thus no negative population level effects are predicted. Therefore a small magnitude of change is assessed for these high sensitivity species resulting in negative effects of minor significance.

110. Shags are considered to be moderately vulnerable to disturbance due to boat traffic (Garthe and Hüppop 2004). However, low numbers were recorded on site during

the breeding season (peak estimated abundance: 14), and given the relatively small spatial range over which vessel disturbance will extend it is considered highly unlikely that important numbers of birds would be displaced from the Wind Farm Site due to vessel activity, and thus no negative population level effects are predicted. Therefore a negligible magnitude of change was assessed for this high sensitivity species resulting in negative effects that are of negligible significance.

111. Overall, the effect of site specific vessel activity is predicted to range from negligible to minor significance and is not significant in terms of the EIA Regulations. No further action beyond the adoption of best practice will be required to minimise any potential adverse effects.

13.4.2 OPERATIONAL EFFECTS

13.4.2.1 Barrier Effects

112. Species that move through the Wind Farm Site on a single occasion during migration are unlikely to bear a measurable cost in most cases, particularly as deviation may begin from a large distance away. Pettersson (2005) showed that the increased distance travelled by migratory waterfowl in relation to offshore wind farms in Sweden represented only 0.2 - 0.4% of the total migration distance from the breeding grounds to wintering areas and vice versa. Whilst this represented a likely increase in energy expenditure, it is of a negligible magnitude (Speakman et al., 2009). For species recorded predominately on passage through the region, such as sooty shearwater, European storm petrel and (at certain times of year) gannet, barrier effects could potentially consist of one movement through or around the area, increasing to two if the species also takes the same route during its return migration in the spring (this description equally applies to migrating wildfowl). The magnitude of a barrier effect would therefore be negligible. However, individuals of some species such as fulmar, kittiwake, guillemot, puffin, razorbill and herring gull which breed within foraging range of the Wind Farm Site have the potential to make repeat movements through the site or occupy the site for a longer period. If individuals of such species make repeated trips which include additional travel to avoid the Wind Farm Site, then there is the potential for a greater magnitude of effect.

113. A review of a number of studies conducted at existing wind farm sites indicated that wildfowl begin to take avoiding action from wind farms at distances of between 100 - 3000 m from the wind farm, with the avoidance distances increasing on the darkest nights (Drewitt and Langston 2006). Avoidance in this way does however reduce collision risk. For example, at Nysted, data suggest that <1% of the migrant wildfowl migrate close enough to the turbines to be at any risk of collision (Desholm and Kahlert 2005). Overall, 71 - 86% at Horns Rev, and 78% at Nysted, of all bird flocks heading for the wind farm at 1.5 - 2.0 km distance avoided entering into the wind farm between the turbine rows (Petersen et al., 2006). There was considerable movement of birds along the periphery of both wind farms, as birds preferentially flew around rather than between the turbines. Such avoidance was calculated to add an additional period of flight equivalent to an extra 0.5 - 0.7% on normal migration costs of eiders migrating through Nysted Changes in flight

direction tended to occur closer to the wind farm by night than day at both sites, but avoidance rates remained high in darkness, when it was also shown birds tend to fly higher.

114. Therefore, for species on migration, including wildfowl, seaduck and seabirds, it is considered extremely unlikely that survival or reproduction will be affected by any flight deviations made around the Wind Farm Site. Therefore a negligible magnitude of change is assessed for these species resulting in negative effects of negligible significance.

Fulmar

115. Fulmar, originating from nearby SPAs and sites along the North Caithness coast and Northern Isles, have the potential to pass through the Wind Farm Site on passage, with the additional potential for repeat movements into the site by a smaller number of breeding adults. Fulmars, however are wide-ranging, with the consequence that diversions around the proposed wind farm would be expected to add comparatively little to the distance travelled. It is considered highly unlikely that any barrier effect could have a population level effect, even if a few individuals were slightly affected. Therefore a negligible magnitude of change is assessed for this high sensitivity species resulting in a negative effect of negligible significance.

Kittiwake

116. Kittiwakes are present on the Wind Farm Site throughout the breeding season but there is no evidence at present to suggest that this species is prone to displacement from offshore wind farms, and consequently the likelihood of the Wind Farm Site operating as a barrier is considered to be very small. Thus, it is considered highly unlikely that a negative population level effect would result and therefore a negligible magnitude of change is assessed for this high sensitivity species resulting in a negative effect of negligible significance.

Gannet

117. As well as being an autumn migrant through the site, gannet from breeding colonies have the potential to make repeat movements into the Wind Farm Site whilst foraging during the breeding period. However, preliminary studies have indicated that the majority of gannets avoided flying into the Egmond aan Zee Wind Farm (Fijn et al., 2011). In addition, this species exhibits a highly flexible approach to habitat use (Hamer et al., 2000), which coupled with the large distances travelled by this species when foraging, mean that a negative population level effect is very unlikely to result from any barrier effects. Overall, a negligible magnitude of change is assessed for this high sensitivity species resulting in a negative effect of negligible significance.

Guillemot

118. The energetic costs of barrier effects were explored by Masden et al., (2010). This study suggested that breeding guillemot would suffer a comparatively small increase in Daily Energy Expenditure (DEE) as a result of diversions due to the presence of wind farms. Razorbill were not assessed, however the close similarity

between these two species suggests that they would suffer similarly modest effects. It therefore seems reasonable to assume that these two species would not experience negative population effects due to barrier effects. Therefore at most a small magnitude of change is assessed for these high sensitivity species resulting in negative effects of at most minor significance.

Puffin

119. Puffin were also considered by Masden et al., (2010). The increase in costs due to barrier effects was estimated to be very similar to that for guillemot, however because the puffin foraging range used in their assessment was over four times that for guillemot, the percentage of their DEE required for flight was considered to be much higher. Consequently, the effect of additional flight distances was also estimated to be higher. Based on the survey results obtained for this assessment, along with the RPSB surveys of the entire Moray Firth (see Annex 13A) it seems unlikely that this pattern is reflected for birds originating from the East Caithness Cliffs SPA colonies. Indeed, the distribution of puffin observations from the latter surveys indicated that this species was more prevalent within coastal waters during the breeding season than either guillemot or razorbill. Consequently, it seems reasonable to assume that while barrier effects have the potential to considerably elevate puffin DEE, for birds foraging in the vicinity of the Wind Farm Site this is unlikely. Therefore no population level effect is predicted and a small magnitude of change is assessed for these high sensitivity species resulting in a negative effect of minor significance.

Great Black-backed Gulls and Herring Gulls

120. Great black-backed gulls and herring gulls which breed and over winter in the North Sea in the area of the Wind Farm Site could conceivably make repeated movements through the site. Reasonable numbers of these species were seen within the Wind Farm Site and buffer. However, gulls are not considered to be particularly sensitive to the presence of turbines. Therefore a small magnitude of change is assessed for these high sensitivity species resulting in negative effects of minor significance.

121. No other species were considered to be at risk of barrier effects.

13.4.2.2 Displacement Effects

122. Displacement is defined here as the prevention of individuals from a species of seabird from undertaking their normal behaviour within areas previously utilised, due to the presence of a novel stimulus. For the purposes of this assessment, the novel stimulus is considered to be the presence and operation of wind turbines (and associated structures) but does not include the wind farm related vessel traffic (e.g. maintenance vessels). The maximum average number of service vessels predicted to be on site in relation to operations and maintenance, is expected to be five per day (see Section 7: Project Description). These vessels will typically be 20 m long, the presence of which is not considered to constitute a source of significant disturbance to seabirds. Therefore no further assessment of this has been undertaken.

123. The species of primary concern with regards to the potential effects of displacement on their populations were those for which the Wind Farm Site appeared to be of importance for foraging during the breeding season. The species present in greatest abundance during the breeding season, estimated from the boat survey data, were fulmar, kittiwake, guillemot and razorbill. Therefore these species were considered to be most at risk of population level effects due to displacement. Species with peak abundances recorded in months outside the breeding season were not considered at significant risk of displacement effects, since observations made at these times were expected to reflect passage movements and ad hoc site use rather than active selection of Wind Farm Site for foraging. While great skua have a breeding season peak abundance on the Wind Farm Site, this species' habitat flexibility and feeding habits lead to it being regarded as at low probability of effect due to displacement.

124. For each species the assessment has been conducted on the basis that the birds on site are from the nearest breeding population, the East Caithness Cliffs SPA. This approach is precautionary, since it concentrates the potential effects on smaller populations than if the effects were assessed against all possible breeding populations within foraging range. Since the probability of birds originating from any given colony will decrease as distance to the Wind Farm Site increases, if effects on the East Caithness Cliffs SPA populations are identified as not significant, the effects on more distant sites will also be non-significant. Further assessment of the potential effects on all SPAs potentially connected with the proposed Wind Farm are summarised in Section 13.10 with further analysis presented in Annex 13B. A Report to Inform an Appropriate Assessment will be follow this ES.

Fulmar

125. For fulmar, the assessment of potential displacement effects was restricted to the East Caithness Cliffs SPA population (28,400 breeding individuals, SNH 2008) on the basis that as the closest breeding colony any effects were most likely to be concentrated here.

126. The peak abundance of fulmar recorded on the Wind Farm Site and turbine buffer (400 m) during the breeding season was 1,096 individuals. The effect on the East Caithness Cliffs population size of complete displacement of this number of fulmar was investigated using a population model (see Annex 13A for details).

127. The baseline annual population growth rate predicted by the population model was 3.29%. The magnitude of reduction in the population growth rate of the East Caithness Cliffs SPA population, resulting from exclusion of all 1,096 individuals, which consequently fail to breed in each year of the lifetime of the wind farm was small, with a reduction in the annual population growth of only 0.14%.

128. Therefore a small magnitude of change is assessed for this high sensitivity species resulting in a negative effect at most minor significance.

Kittiwake

129. For kittiwake, the effects of displacement were considered in relation to the East Caithness Cliffs SPA population. This is currently estimated to consist of 80,820

breeding individuals (SNH 2008). Immature birds also associate with breeding colonies, and can typically comprise 40% of the total population (estimated using a population model, see Annex 13A for details). To account for the presence of these immature birds, which may also have been recorded on the Wind Farm Site, a more conservative estimate of 30% was applied to scale up the estimated population size. This raised the estimated total East Caithness Cliffs SPA population to 115,457 (see Annex 13A for details).

130. The peak abundance of kittiwake recorded on the Wind Farm Site and turbine buffer (400 m) during the breeding season was 530 individuals. While a proportion of the birds seen in the Wind Farm Site are expected to be immature birds, thereby reducing the impact of displacement on the breeding population, a precautionary approach was adopted here, with all displaced individuals assumed to be breeding birds. The effect on the total population size of complete displacement of this number of breeding kittiwake was investigated using a population model (see Annex 13A for details).

131. The baseline annual population growth rate predicted by the population model was 4.35%. This is close to the observed annual trend for Berridale Cliffs of 4.5% between 1988 and 2002 (Mitchell et al., 2004). The magnitude of reduction in the population growth rate of the East Caithness Cliffs SPA population, resulting from 100% of the estimated Wind Farm Site foraging population being excluded and consequently failing to breed, is small, with a reduction in the annual population growth of only 0.03%.

132. Therefore a negligible magnitude of change is assessed for this high sensitivity species resulting in negative effects of negligible significance.

Guillemot

133. For guillemot, the effects of displacement were considered in relation to the East Caithness Cliffs SPA population. This is currently estimated to consist of 158,985 individuals (SNH 2008). This will include both breeding birds and immature individuals associating with the breeding colonies. Harris (1989) recommends a correction factor of 0.67 to convert total counts to the number of breeding pairs (or 1.34 to estimate the number of breeding individuals). Applying this correction yields an expected number of breeding individuals of 214 (see Annex 13A).

134. The peak abundance of guillemot recorded on the Wind Farm Site and turbine buffer during the breeding season was 7,406 individuals. The effect on the total population size of complete displacement of this number of breeding guillemot was investigated using a population model (see Annex 13A for details).

135. The baseline annual population growth rate predicted by the population model was 5.68%. The magnitude of reduction in the population growth rate of the East Caithness Cliffs SPA population, resulting from 100% of the estimated Wind Farm Site foraging population failing to breed was small, with a reduction in the annual population growth of only 0.07%.

136. Therefore a negligible magnitude of change is assessed for this high sensitivity species resulting in negative effects of negligible significance.

Razorbill

137. For razorbill, the effects of displacement were considered in relation to the East Caithness Cliffs population. This is currently estimated to consist of 17,830 individuals (SNH 2008). This will include both breeding birds and immature individuals associating with the breeding colonies. Harris (1989) recommends a correction factor of 0.67 to convert total counts to the number of breeding pairs (or 1.34 to estimate the number of breeding individuals). Applying this correction yields an expected number of breeding individuals of 23,892 (see Annex 13A for details).

138. The peak abundance of razorbill recorded on the Wind Farm Site and turbine buffer during the breeding season was 574 individuals. The effect on the total population size of complete displacement of this number of breeding razorbill was investigated using a population model (see Annex 13A for details).

139. The baseline annual population growth rate predicted by the population model was 2.21%. The magnitude of reduction in the population growth rate of the East Caithness Cliffs SPA population, resulting from 100% of the estimated Wind Farm Site foraging population failing to breed was small, with a reduction in the annual population growth of only 0.17%.

140. Therefore a small magnitude of change is assessed for this high sensitivity species resulting in a negative effect of minor significance.

Summary of Displacement Effects

141. Overall, the assessment of potential displacement effects on the breeding populations present in the nearest colonies (East Caithness Cliffs SPA) of the species present in the greatest numbers during the breeding season is assessed to result in changes of minor or negligible significance.

142. Since the effects of displacement were of negligible significance on each species as assessed against the nearest breeding colonies, the potential effects on more distant ones would also be negligible, since many fewer individuals from these colonies will be expected to be at risk of displacement.

13.4.2.3 Lighting Effects

143. Birds are often attracted to structures such as oil rigs during the hours of darkness, as they may provide opportunities for extended feeding periods, shelter and resting places or navigation aids for migrating birds. Any benefits of lighting however may be outweighed by increased risks of collision with oil flares, or in the case of turbines, with rotating blades. Lighting on turbines are not expected to be as powerful as oil rig lighting, and so any benefits on foraging are likely to be negligible.

144. Disturbance effects of lighting may derive from changes in orientation, disorientation and attraction or repulsion from the altered light environment, which

in turn may affect foraging, reproduction, migration, and communication (Longcore and Rich 2004). Birds may collide with each other or structures, or become exhausted due to disorientation. Conversely, unlit turbines could lead to elevated collision risk at night since moving rotors may be less detectable. Fog and other meteorological conditions which make towers difficult to see have been associated with fatalities at terrestrial communication tower sites (Trapp 1998), although movements of many species are more limited at such times.

145. Migrating birds are likely to be particularly susceptible to any adverse effects of lighting. Around two thirds of all bird species migrate during darkness, when collision risk is expected to be higher than during daylight (Hüppop et al., 2006). Visibility has been demonstrated to be an important risk factor for predicting collisions at lit communication towers (Kerlinger and Curry 2002). On nights with poor visibility, migrating birds are attracted to communication tower lights and may collide with the guy wires. However, birds are also more likely to migrate at high altitude under such conditions (e.g. Blew et al., 2008; Krijgsveld et al., 2005) and so will be expected to pass over the turbines without risk of collision. Conversely, migrating seabirds will often simply rest on the sea surface during periods of poor visibility, before resuming their journeys when conditions improve (Petersen et al., 2006).

146. The defined worst-case scenario for the Wind Farm Site (as outlined in Section 13.2.7) involves 277 turbines and the maximum amount of ancillary structures, which would be fitted with full lighting requirements for aviation and shipping, with no consideration of directionality.

147. It is only likely however that a significant effect would result for any species if large numbers of migrants pass through the site at one time. Although it is acknowledged that the ornithological surveys conducted are limited in this respect, due to the difficulties of surveying nocturnal passage, there is no evidence from the baseline surveys that the Wind Farm Site would be important for passerine or wader species and the Wind Farm Site does not lie on a notable migration route for these species. Moderate numbers of geese, in particular pink-footed geese, were estimated to pass across the Moray Firth on migration (including nocturnal flights). Evidence from radar studies has found that geese fly higher at night (Desholm and Kahlert 2005), thereby reducing the likelihood of lighting effects. Overall therefore, population level effects as a result of turbine lighting would only occur if large number of birds were drawn to the turbines and were unable to avoid collision with rotors, or became disoriented, exhausted and were consequently unable to complete their migrations. Given the low passage rate of migrants across the Wind Farm Site and the high altitudes which are associated with nocturnal flights, such effects are considered to be very unlikely. Therefore, a negligible magnitude of change is assessed for all species resulting in a negative effect of negligible significance.

13.4.2.4 Direct Mortality Due to Collision with Turbines

148. Birds may collide with wind turbines and associated structures and this is almost certain to result in death of the individual in the event that it happens. Most studies

at operational wind farms have found evidence that levels of avian mortality are low, as birds are able to take avoiding action (Drewitt and Langston, 2006). The actual risk of collision depends on a number of factors including the location of a wind farm, the bird species using the area, weather conditions and the size and design of the wind farm including the number and size of turbines and use of lighting.

149. Different types of bird movement constitute different levels of risk of collision:

- Feeding movements, either as part of daily commuting between foraging and roosting locations, or opportunistic;
- Roosting flights, typically often involving large flocks and in lower light levels; and
- Seasonal migration between widely separated breeding and wintering locations.

150. Collision risk modelling was undertaken separately for seabirds and wildfowl. For seabirds, data collected during the monthly boat surveys was used. For wildfowl, data collected during the migration surveys in Autumn 2010 and Spring 2011 was used.

151. The effect of an individual loss on a population is influenced by several characteristics of the affected population, notably its size, density, recruitment rate (additions to the population through reproduction and immigration) and background mortality rate (the natural rate of losses due to death and emigration). In general, the effect of an individual lost from the population will be greater for species that are relatively long-lived and reproduce at a low rate. Most seabird species fall into this category. Conversely, the effect will often be much less for relatively shorter-lived species with higher reproductive rates, including some smaller gulls. Species that habitually fly at night or during low light conditions at dawn and dusk may also be at increased risk from collisions, although seaducks such as eiders and scoters have been shown to detect and avoid offshore turbines at night in both the Netherlands (Winkelman 1995) and at offshore towers at Tuno Knob in Denmark (Tulp et al., 1999).

152. It should be noted that operational disturbance/displacement and collision risk effects are mutually exclusive in a spatial sense, i.e. a bird that avoids the wind farm area cannot be at risk of collision with the turbine rotors at the same time. However, they are not mutually exclusive in a temporal sense; a bird may initially avoid the wind farm, but habituate to it, and would then be at risk of collision. In addition, birds may generally avoid wind farms, but during periods of poor visibility may fly closer to turbines before taking avoiding action.

153. In general, effects of increased mortality on populations due to collisions with turbines are considered to be long-term (i.e. throughout the operational wind farm's lifespan). One simplifying assumption of collision risk modelling is that collision rates do not decrease in response to losses from the population. In reality, effects may change over time due to the interplay of many factors (e.g. habituation to the presence of turbines, changes in fishing activities, climate change effects on prey

species, etc.). The modelling therefore predicts collisions on the basis of maintenance of current conditions.

13.4.2.5 Seabird Collision Risk Modelling

Species Selection

154. Not all species observed on the Wind Farm Site are likely to be affected to any significant extent by increases in mortality from collisions, either due to low numbers of flights recorded within the Wind Farm Site, or behaviour that indicates that the species is not susceptible to collisions. Therefore survey data and information on species' ecology were used to screen which species were included in CRM.

155. Initial selection was based on the list of species of principal concern to determine which species warranted consideration for CRM. This was based on three aspects: (i) the total number of birds in flight recorded in snapshot within the Wind Farm Site each year; (ii) the proportion of birds recorded flying at potential collision height (PCH, 20 m - 150 m); and (iii) the sensitivity of a species to collision risk, based on risk ratings for flight manoeuvrability, altitude and proportion of time spent flying presented in Garthe and Hüppop (2004), and recommended avoidance rates in Maclean et al., (2009).

156. Based on these criteria, the following eight species were included in collision risk modelling: Arctic skua, Arctic tern, fulmar, great black-backed gull, gannet, herring gull, kittiwake and great skua (see Table 13.16). At the request of SNH, common guillemot and razorbill were added to this list. No other species of note occurred in sufficient numbers to warrant CRM.

157. Although the total numbers of birds recorded in snapshots were very low for Arctic skua, arctic tern, and great skua, these species were encountered in relatively few months, and therefore additional mortality rates may be significant during these brief periods, hence their inclusion in the list.

Table 13.16 Percentage of flights recorded in snapshots on boat surveys between October 2009 and September 2011

Species	Percentage at potential collision height (20 – 150 m) within Wind Farm Site		Total number of individuals recorded during snapshots (all heights)	Species Sensitivity to collisions (Garthe and Hüppop 2004)
	From boat surveys	SOSS-02 (Cook et al., 2011)		
Fulmar	0.5	4.9	242	Low
Sooty shearwater	0	0	1	Low
Gannet	18.7	15.8	32	Medium
Shag	7	13.1	1	Low
Arctic skua	8.6	3.3	4	Medium
Great skua	7.1	6.5	9	Medium
Kittiwake	13.3	16.0	55	Medium

Species	Percentage at potential collision height (20 – 150 m) within Wind Farm Site		Total number of individuals recorded during snapshots (all heights)	Species Sensitivity to collisions (Garthe and Hüppop 2004)
	From boat surveys	SOSS-02 (Cook et al., 2011)		
Great black-backed gull	36.2	35.0	38	Medium
Herring gull	34.7	30.6	81	High
Arctic tern	10.9	4.4	5	Low
Guillemot	0.2	4.1	356	Low
Razorbill	0.1	6.8	51	Low
Puffin	0	0.02	5	Low

158. Snapshot data were used from all 22 surveys. Outputs from the modelling are presented as annual totals and also for just the breeding season (based on species specific periods, Snow and Perrins 1998). The more recent CRM (Band 2011) generated collision estimates approximately 40% higher than those calculated using the previous CRM (Band et al., 2007). It is important that this difference is borne in mind when considering the results presented here, in particular when undertaking comparisons with previous offshore wind farm CRM results.

159. The following species assessments are based on the higher mortality estimates, derived from the Band (2011) model, however for comparison with previous estimates of collision mortality at offshore wind farms the results from the Band (2007) model are also presented.

Fulmar

160. The annual collision mortality for fulmar was estimated at 27 individuals (see Table 13.17). If this was concentrated on the breeding birds within the East Caithness Cliffs SPA breeding population this would represent an addition to the annual mortality rate of 0.09% (from 1.4% to 1.49%). However, mortality was distributed evenly throughout the year, therefore collisions outside the breeding season would be distributed amongst the much larger wintering population.

161. Therefore a negligible magnitude of change was assessed for this high sensitivity species resulting in a negative effect of negligible significance.

Table 13.17 Annual and breeding season collision mortality for fulmar estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance rate (%)				
			0	98	99	99.5	99.9
Fulmar	Band (2007)	Annual	1987	40	20	10	2
Fulmar	Band (2007)	Breeding	799	16	8	4	1
Fulmar	Band (2011)	Annual	2675	53	27	13	3
Fulmar	Band (2011)	Breeding	1114	22	11	6	1

Gannet

162. The annual collision mortality for gannet was estimated at 132 individuals (see Table 13.18). If this mortality was concentrated on the nearest breeding populations (Moray Firth, Orkney and Shetland) this would represent an addition to annual mortality of 0.19% (from 6% to 6.19% 3). If all breeding colonies within mean maximum foraging range are considered the increase falls to 0.05%.

163. Therefore a negligible magnitude of change was assessed for this high sensitivity species resulting in a negative effect of negligible significance.

Table 13.18 Annual and breeding season collision mortality for gannet estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance Rate				
			0	**98**	**99**	**99.5**	**99.9**
Gannet	Band (2007)	Annual	8863	177	89	44	9
Gannet	Band (2007)	Breeding	3267	65	33	16	3
Gannet	Band (2011)	Annual	13249	265	132	66	13
Gannet	Band (2011)	Breeding	5357	107	54	27	5

Arctic Skua

164. The annual collision mortality for Arctic skua was estimated at six individuals (see Table 13.19). If this mortality was concentrated on the nearest breeding populations this would represent an addition to annual mortality of 4% (from 16% to 20%).

165. However, during the breeding season this species obtains food predominantly through kleptoparasitism, and consequently breeding birds tend to remain close (< 2 km) to the breeding colonies of their hosts. Individuals observed at greater distances from shore (i.e. during boat surveys) are therefore considered unlikely to be members of the local breeding population. The timing of the observations (Arctic skua were only recorded in snapshots in May and August) also suggests passage movements of birds to and from breeding sites further north. Therefore the mortality estimates should be considered with respect to the regional population, or potentially the whole Great Britain breeding population, almost all of which breeds at sites north of the Wind Farm Site. The regional population has undergone declines since the last comprehensive seabird census (Mitchell et al., 2004), and the regional population was estimated to have fallen from 1,582 to 1,044 in 2010. Using this population, the increase in background mortality which would result from the predicted level of collisions for the regional population is 0.5% (from 16% to 16.5%).

166. Therefore a negligible magnitude of change was assessed for this medium sensitivity species resulting in a negative effect of negligible significance.

Table 13.19 Annual and breeding season collision mortality for Arctic skua estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance rate (%)				
			0	98	99	99.5	99.9
Arctic skua	Band (2007)	Annual	399	8	4	2	0
Arctic skua	Band (2007)	Breeding	399	8	4	2	0
Arctic skua	Band (2011)	Annual	558	11	6	3	1
Arctic skua	Band (2011)	Breeding	558	11	6	3	1

Great Skua

167. The annual collision mortality for great skua was estimated at 13 individuals (see Table 13.20). There is only one known breeding population (Muckle Skerry), consisting of a single pair, within the mean maximum foraging range of the Wind Farm Site. However, the abundance of this species estimated using the boat survey data peaked at 164 individuals across the whole boat based study area in May 2010.

168. Maps of breeding season distributions of great skua show concentrations around the main breeding colonies on Orkney and Shetland (Stone et al., 1995), with the distribution of birds originating from Orkney extending into the Moray Firth and encompassing the Wind Farm Site. Thus birds recorded on site are considered to be likely to originate from colonies on Orkney and potentially farther afield, and also may include birds of pre-breeding age. The largest breeding colony, on Hoy and South Walls, accounts for 90% of the Orkney population (Mitchell et al., 2004). Inclusion of this population in the category of breeding birds within range of the Wind Farm Site raises the effective regional population size assessed to almost 4,000.

169. Assuming collision mortality is distributed within this breeding population this would represent an addition to annual mortality of 0.3% (from 10% to 10.3%).

170. Therefore a negligible magnitude of change was assessed for this medium sensitivity species resulting in a negative effect of no significance.

Table 13.20 Annual and breeding season collision mortality for great skua estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance rate (%)				
			0	98	99	99.5	99.9
Great skua	Band (2007)	Annual	841	17	8	4	1
Great skua	Band (2007)	Breeding	841	17	8	4	1
Great skua	Band (2011)	Annual	1254	25	13	6	1
Great skua	Band (2011)	Breeding	1254	25	13	6	1

Kittiwake

171. The annual collision mortality for kittiwake was estimated at 132 individuals (see Table 13.21). If this was concentrated on the breeding birds within the East Caithness Cliffs breeding population this would represent an addition to the annual mortality rate of 0.16% (from 19% to 19.16%).

172. Therefore a negligible magnitude of change was assessed for this high sensitivity species resulting in a negative effect of negligible significance.

Table 13.21 Annual and breeding season collision mortality for kittiwake estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance rate (%)				
			0	98	99	99.5	99.9
Kittiwake	Band (2007)	Annual	9989	200	100	50	10
Kittiwake	Band (2007)	Breeding	4477	89	45	22	4
Kittiwake	Band (2011)	Annual	13166	263	132	66	13
Kittiwake	Band (2011)	Breeding	6200	124	62	31	6

Great Black-backed Gull

173. The annual collision mortality for great black-backed gull was estimated at 302 individuals (see Table 13.22). Of this, approximately 20% occurred in breeding season months (May and July). This low number during the breeding season corresponds to reports that breeding birds become closely associated with their breeding colonies between May and July, where they catch their seabird prey (Tasker et al., 1987). Thus, even the comparatively low number recorded during the breeding season is likely to comprise a large proportion of immature non-breeders. Of the birds for which an estimate of age was recorded during the boat surveys, only 37% were recorded as adults.

174. During the winter the population of great black-backed gulls in British waters is swelled by birds from mainland Europe. Mortality outside the breeding season would thus be distributed amongst a large population; in winter the UK population has been estimated at 71,000 to 81,000 individuals (Banks et al., 2007). Within the Moray Firth, this will include birds from more northerly breeding colonies passing through the region (Snow and Perrins 1998, Wernham et al., 2002). Thus the population against which most of the predicted mortality was assessed was that estimated to pass through the Moray Firth on passage and also wintering birds. As a conservative estimate this comprises 17,900 individuals (Mitchell et al., 2004).

175. Assessing annual collision mortality against the potential passage population represents an addition to annual mortality of 1.7% (from 7% to 8.7%).

176. A detailed assessment of the potential effects of mortality on the breeding population of Great Black-backed Gull in the East Caithness Cliffs SPA is presented in Annex 13B. A summary of the key findings is presented below.

177. A stochastic population model was developed to enable prediction of the effect on the population of a range of additional mortality levels. Using this model it was determined that the predicted level of annual mortality attributable to the East Caithness Cliffs SPA population would trigger a population decline in fewer than 5% of model simulations (use of the 5% threshold is considered to provide a precautionary threshold for detrimental impacts).

178. Therefore a small magnitude of change was assessed for this high sensitivity species resulting in a negative effect of minor significance.

Table 13.22 Annual and breeding season collision mortality for great black-backed gull estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance rate (%)				
			0	98	99	99.5	99.9
Great black-backed gull	Band (2007)	Annual	23100	462	231	116	23
Great black-backed gull	Band (2007)	Breeding	4264	85	43	21	4
Great black-backed gull	Band (2011)	Annual	30186	604	302	151	30
Great black-backed gull	Band (2011)	Breeding	6154	123	62	31	6

Herring Gull

179. The annual collision mortality for herring gull was estimated at 494 individuals (see Table 13.23). Only 29 of these were predicted to occur during the breeding season, thus annual mortality would be distributed amongst a wintering and passage population of at least 27,324 (Mitchell et al., 2004). The addition to the annual mortality rate for this population would be 1.7% (from 7% to 8.7%).

180. Therefore a small magnitude of change was assessed for this high sensitivity species resulting in a negative effect of minor significance.

Table 13.23 Annual and breeding season collision mortality for herring gull estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance rate (%)				
			0	98	99	99.5	99.9
Herring gull	Band (2007)	Annual	40,943	819	409	205	41
Herring gull	Band (2007)	Breeding	2,024	40	20	10	2
Herring gull	Band (2011)	Annual	49,353	987	494	247	49
Herring gull	Band (2011)	Breeding	2,927	59	29	15	3

Arctic Tern

181. The annual collision mortality for Arctic tern was estimated at eight individuals (see Table 13.24), all of which occurred during the breeding season. The nearest breeding colonies of Arctic tern to the Wind Farm Site are on the island of Muckle Skerry in the Pentland Firth and Portgower on the east Sutherland coast, located

40 km and 41 km respectively from the nearest point on the Wind Farm Site boundary. Arctic terns typically feed within 3 km of the colony, with maximum estimates of 20 km from the Farne Islands and 15 km from Papa Westray in Orkney. It is therefore considered that the birds seen on the Wind Farm Site do not form part of these breeding colonies (i.e. non-breeders).

182. Consequently, the population against which additional mortality should be assessed is taken from that along the Moray Firth coasts, North Caithness and Orkney colonies, comprising 29,776 individuals. This represents a conservative estimate, since this accounts only for breeding birds does not include immature birds which will be associated with these colonies. The addition to the annual mortality rate for this population would be 0.02% (from 12.5% to 12.52%).

183. Therefore a negligible magnitude of change was assessed for this low sensitivity species resulting in a negative effect of no significance.

Table 13.24 Annual and breeding season collision mortality for Arctic tern estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance rate (%)				
			0	98	99	99.5	99.9
Arctic tern	Band (2007)	Annual	527	11	5	3	1
Arctic tern	Band (2007)	Breeding	527	11	5	3	1
Arctic tern	Band (2011)	Annual	805	16	8	4	1
Arctic tern	Band (2011)	Breeding	805	16	8	4	1

Common guillemot

184. The annual predicted collision mortality estimate for common guillemot was 13 individuals (Table 13.25). Most of the predicted mortality is concentrated during the breeding season. This indicates that birds seen on the Wind Farm Site are probably associated with the breeding colonies in the East Caithness Cliffs SPA. However, even with all the annual mortality concentrated on this population, the background mortality rate would only increase by 0.01% (from 11.5% to 11.51%). Therefore a negligible magnitude of change was assessed for this high sensitivity species resulting in a negligible negative effect which is not significant.

Table 13.25 Annual and breeding season collision mortality for common guillemot estimated using flight height proportions recorded on the Wind Farm Site

Species	Model	Period	Avoidance rate (%)				
			0	98	99	99.5	99.9
Common guillemot	Band (2007)	Annual	1044	21	10	5	1
Common guillemot	Band (2007)	Breeding	723	14	7	4	1
Common guillemot	Band (2011)	Annual	1339	27	13	7	1
Common guillemot	Band (2011)	Breeding	970	19	10	5	1

Razorbill

185. The annual predicted collision mortality estimates for razorbill was one individual. No further assessment was considered necessary for this negligible magnitude impact which was of no significance.

13.4.2.6 Wildfowl Collision Risk Modelling

186. Collision mortality for wildfowl on migration was estimated for the total number of individuals estimated to have crossed the Wind Farm Site (see Table 13.26).

Table 13.26 Estimated number of wildfowl crossing the Wind Farm Site during autumn and spring migration and estimated collision mortality

Species	GB population	Annual mortality		Total annual number of individuals estimated to:		Percentage additional mortality
		Percent	Number	Cross Wind Farm Site	Collide with turbines	
Pink-footed goose	364,212	14 †	50,990	54409	36.1	0.01
Greylag goose	109,496	30 *	32,849	6235	4.4	0.004
Barnacle goose	58,269	8 †	4,662	146	0.1	<0.001
Whooper swan	16,618	15 ‡	2,493	204	0.4	0.004

† Trinder, M., Rowcliffe, M., Pettifor, R., Rees, E., Griffin, L., Ogilvie, M. and Percival, S. (2005). Status and population viability analyses of geese in Scotland. Scottish Natural Heritage Commissioned Report No. 107 (ROAME No. F03AC302).
* Trinder, M., Mitchell, C., Swann, B. and Urquhart, C. (2010) Status and population viability of Icelandic greylag geese *Anser anser* in Scotland, Wildfowl 60, 64-84.
‡ Trinder M. (2011) The potential consequences of elevated mortality on the population viability of whooper swans in relation to wind farm developments in Northern Scotland Scottish Natural Heritage Commissioned Report No. 459

187. For all the wildfowl species a negligible magnitude of change was assessed for these high sensitivity species resulting in negative effects of negligible significance.

13.4.2.7 Indirect Impacts

188. The turbine substructures may be coated with anti-fouling treatments to inhibit the settlement and growth of macro invertebrates. If this is the case the structures will be effectively neutral in terms of habitat creation within the water column. However, if such treatments are not used, micro-habitats supporting populations of invertebrates (e.g. molluscs, crustaceans etc.) and fish will be expected to develop on the structures themselves. In addition, modification of currents at the sea bed may lead to the development of benthic communities capable of supporting fish. This could include fish species which might otherwise be scarce due to lack of suitable habitat. A potential indirect effect of such habitat modification is to increase prey availability for birds by raising the carrying capacity of the area for stocks of invertebrates and fish. Foundation structures might also influence tidal flow patterns and sediment dynamics, at least at the local microhabitat scale. This may give rise to habitat modifications that affect some bird species.

189. The most important fish prey species present on the Wind Farm Site are herring and sandeels. The potential effects on these species of direct loss of available habitat resulting from the worst case turbine foundations is provided in Section 11: Wind Farm Fish and Shellfish Ecology. This was based on the use of gravity bases fitted to 277, 3.6 MW turbines, covering a total of 2.5% of the total seabed area of the Wind Farm Site. The worst case inter-array cable option, in terms of disturbance to the seabed, would result from 350 km of cable laid on the surface with up to 50% covered in protective matting with a width of 3 m (connecting 277, 3.6 MW turbines). This would lead to an additional 0.37% of seabed loss within the Wind Farm Site. Finally the total habitat loss associated with the OSPs is 69, 330 m^2 which bring total habitat loss as a result of the Wind Farm to just under 2.9%.

190. In comparison to the spawning habitat available for herring within the region, the effect of the predicted loss of habitat due to the Wind Farm was assessed as leading to a negligible effect. For sandeel, taking into account the availability of suitable habitat within the region, the effect of the predicted loss due to the Wind Farm was assessed as negligible.

191. Consequently, this magnitude of seabed loss was not considered likely to have a detectable effect on seabird populations as a result of indirect effects on prey species.

192. A study of fish species composition in a wind farm site before and after construction found evidence for a high degree of variability, but no indication that these changes were influenced by the wind farm (Lindeboom et al., 2011). Leonhard and Pedersen (2006) reported that fish biomass increased considerably in the vicinity of the turbine bases due to the shelter afforded by scour protection.

193. It is possible that there may be a net positive effect on birds as a result of increasing prey abundance and availability. However, negative indirect effects are equally possible. For example collision mortality could increase if birds are attracted to the turbines in greater numbers due to the presence of prey fish shoals around foundation structures. However, increased foraging opportunities could also lead to improved breeding success for the local populations. At present, the lack of detailed studies examining such effects precludes any further assessment. Therefore, a small magnitude of change was assessed, resulting in either negative or neutral effects of no more than minor significance.

13.5 MITIGATION MEASURES

194. The only mitigation measures appropriate with regards to effects on birds are those already performed as best practice within industry standards.

13.6 RESIDUAL EFFECTS

195. No specific mitigation has been identified for ornithological effects in relation to the construction, operational or decommissioning phases of the proposed wind farm. Therefore residual effects are those discussed within Section 13.4.

13.7 MONITORING AND ENHANCEMENTS

196. It is expected that best practice monitoring of bird use within the Wind Farm Site and 4 km buffer will be undertaken. Typically this comprises periods of pre-construction, construction and post-construction monitoring in order to identify any changes in bird usage of the Wind Farm Site attributable to the development. The scope and periods (e.g. post-consent/pre-construction) of monitoring required will be determined in discussion with SNH and Marine Scotland.

13.8 SUMMARY OF EFFECTS

197. This assessment is based on data collected during 22 boat surveys of the Wind Farm Site and buffer zone, eight aerial surveys of the Wind Farm Site and the Moray Firth Round 3 Zone to the east, vantage point observations made from four locations on the Moray Firth coast, three and a half years of observations made from the Beatrice Alpha Platform, satellite tracking data of breeding birds from colonies along the East Caithness coast and two years of boat surveys conducted by the RPSB across the entire Moray Firth during the 1980s.

198. Thirteen seabird species and three wildfowl species were identified for detailed assessment, on the basis of their recorded occurrence in the surveys and the species known to be present within the region. Detailed baseline descriptions for these species are provided in Annex 13A.

199. The potential effects of the Wind Farm on the ornithological interests are assessed in relation to construction and decommissioning and operation. Effects considered include those due to increased vessel traffic, construction activities, disturbance and displacement, collision with rotors and indirect effects. A summary of predicted effects is provided below and in Table 13.27. In summary:

- Effects due to boat traffic were determined to be negligible or minor and therefore not significant;
- Effects due to construction activities were determined to be negligible or minor and therefore not significant;
- Effects due to displacement of foraging birds were determined to be minor and therefore not significant for all species;
- Effects due to barrier effects were determined to be negligible or minor and therefore not significant;
- Effects due to collisions with rotors were determined to be negligible or minor and therefore not significant; and
- Effects due to indirect effects were determined to be negligible or minor and therefore not significant.

Table 13.27 Summary of Effects

Impact	Species	Effect	Significant (yes/no)
Disturbance due to construction activity	Fulmar	Negligible	No
	Sooty shearwater	Negligible	No
	Gannet	Negligible	No
	Shag	Negligible	No
	Arctic skua	Minor	No
	Great skua	Minor	No
	Kittiwake	Negligible	No
	Great black-backed gull	Negligible	No
	Herring gull	Negligible	No
	Arctic tern	Negligible	No
	Guillemot	Minor	No
	Razorbill	Minor	No
	Puffin	Minor	No
Disturbance due to boat traffic	Fulmar	Minor	No
	Sooty shearwater	Minor	No
	Gannet	Minor	No
	Shag	Negligible	No
	Arctic skua	Minor	No
	Great skua	Minor	No
	Kittiwake	Minor	No
	Great black-backed gull	Minor	No
	Herring gull	Minor	No
	Arctic tern	Minor	No
	Guillemot	Minor	No
	Razorbill	Minor	No
	Puffin	Minor	No
Barrier effects	Wildfowl	Negligible	No
	Fulmar	Negligible	No
	Sooty shearwater	Negligible	No
	Gannet	Negligible	No
	Shag	Negligible	No
	Arctic skua	Negligible	No
	Great skua	Negligible	No
	Kittiwake	Negligible	No
	Great black-backed gull	Minor	No
	Herring gull	Minor	No

Impact	Species	Effect	Significant (yes/no)
	Arctic tern	Negligible	No
	Guillemot	Minor	No
	Razorbill	Minor	No
	Puffin	Minor	No
Displacement effects	Fulmar	Minor	No
	Sooty shearwater	Negligible	No
	Gannet	Negligible	No
	Shag	Negligible	No
	Arctic skua	Negligible	No
	Great skua	Negligible	No
	Kittiwake	Negligible	No
	Great black-backed gull	Negligible	No
	Herring gull	Negligible	No
	Arctic tern	Negligible	No
	Guillemot	Negligible	No
	Razorbill	Minor	No
	Puffin	Negligible	No
Lighting	All	Negligible	No
Collision mortality	Wildfowl	Negligible	No
	Fulmar	Negligible	No
	Sooty shearwater	Negligible	No
	Gannet	Negligible	No
	Shag	Negligible	No
	Arctic skua	Negligible	No
	Great skua	Negligible	No
	Kittiwake	Negligible	No
	Great black-backed gull	Minor	No
	Herring gull	Minor	No
	Arctic tern	Negligible	No
	Guillemot	Negligible	No
	Razorbill	Negligible	No
	Puffin	Negligible	No
Indirect effects	All species	Minor	No

13.9 ASSESSMENT OF CUMULATIVE EFFECTS

13.9.1 INTRODUCTION

200. In addition to identifying the potential effects of the Wind Farm on bird species in isolation, it is also necessary to consider the cumulative effects of the Project together with other existing and reasonably foreseeable developments

201. A CIADD (MFOWDG 2011) was produced which set out the developments to be considered and the assessment method for each technical assessment and is the basis of this assessment. The CIADD is presented in Annex 5B.

202. The main potential cumulative effects are assessed as:

- Disturbance and potential displacement due to boat traffic;
- Disturbance and potential displacement due to noise and vibration mainly during wind farm construction and decommissioning, but also perhaps including operation (this includes non wind farm developments as appropriate);
- Avoidance of turbines and subsequent displacement, including a barrier effect during operation;
- Collision with turbines during operation; and
- Indirect effects through loss of, or changes to, habitat at all stages of construction, operation (including maintenance) and decommissioning (including non wind farm developments).

13.9.2 SCOPE OF ASSESSMENT

203. The scope and method of this assessment was previously described in the CIADD (MFOWDG 2011). This remains unchanged from the method presented in the CIADD.

The assessment of significance of cumulative effects has used the same criteria to determine significance based on the sensitivity of the receptor and the magnitude of the potential change as presented in Section 13.2.6.

204. The assessment of cumulative effects has been made against the existing baseline conditions as presented in Section 13.3.

205. Data to inform this cumulative assessment are available for the proposed Moray Firth Round 3 Zone Eastern Development Area wind farm development, located adjacent to the Wind Farm Site (data were shared between the two wind farm developers for the purposes of this assessment). Results of the impact assessment for the European Offshore Wind Development Centre (EOWDC), located off the coast of Aberdeen were presented in the ES for that application and have also been used for the current assessment. There were no data available from any other proposed wind farm sites. Wherever possible the same methods and assessment criteria have been applied in the consideration of cumulative effects as used in the main assessment. However, for certain aspects, the level of survey data available necessitated a less quantitative approach be taken. In these cases, assessment is based on the best available information on the potential effects which each development would contribute to the cumulative effect.

13.9.2.1 Consultation

206. The CIADD (MFOWDG 2011) was presented to Marine Scotland for review in April 2011 for comment. The scope of the cumulative assessment was presented in this document which was provided for consultation to SNH and JNCC.

207. This consultation was used to determine agreed data collection and analysis methods, as well as the list of species, Special Protection Areas and other developments which needed to be taken into consideration (MFOWDG 2011).

13.9.2.2 Geographical Scope

208. The study area is species specific, covering seabird breeding colonies from Shetland to the Firth of Forth. This encompasses all seabird colonies which have the potential (based on estimated foraging ranges, Birdlife International 2012) to be linked to the Wind Farm Site during the breeding season.

13.9.2.3 Developments Considered in Assessment

209. The potential for cumulative effects during construction phases will only arise if more than one of the site construction programmes were to coincide, however a detailed discussion on the project for inclusion in this assessment is presented in the CIADD (MFOWDG 2011).

210. Section 4.6.6 of the CIADD (MFOWDG, 2011) presented the developments for which it was considered an assessment of cumulative impacts with the BOWL project should be undertaken for ornithology. These were:

- Beatrice Offshore Wind Farm;
- Moray Firth Round 3 Zone Eastern Development Area;
- Moray Firth Round 3 Zone Western Development Area ;
- BOWL OfTW;
- Moray Firth Round 3 Zone OFTO cable;
- Proposed SHETL cable;
- Proposed SHETL hub;
- Marine energy development in the Pentland Firth and Orkney waters;
- Dredging and sea disposal in the Moray Firth;
- Relevant oil and gas activities;
- Firth of Forth and Tay Offshore Wind Farms; and
- Aberdeen Offshore Wind Farm.

211. It should be noted that the 'medium term' options outlined in Marine Scotland's current Strategic Environmental Assessment (SEA) of the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters have been scoped out of this assessment, they are not considered to be 'reasonably foreseeable' and no data are likely to be available. For particularly wide-ranging species such as gannet, or migratory species such as geese and swans, where the effects of other wind farms, including onshore developments and other offshore developments, may need to be taken into account, additional sites will be considered on a case by case basis. For the purpose of this cumulative impact assessment only data from the Moray Firth Round 3 Zone Eastern Development Area is considered as these are the only data available for

comparison on potential effects. Hence the combined effects of these two adjacent offshore wind farms forms the main focus of this assessment. The other wind farms which may contribute to cumulative effects are considered in a separate Section. The proposed Moray Firth Round 3 Zone Western Development Area has not been surveyed and thus no quantitative assessment is currently possible. The construction of this wind farm will not overlap with that for the Wind Farm, thus no consideration for cumulative construction effects is required. A qualitative assessment has been included for the potential cumulative operational effects to which the Western Development Area could contribute.

212. All non-wind farm projects will be discussed briefly but in the absence of any data from these projects no quantitative conclusions can be made. Collision and barrier effects are fairly specific to wind farms, therefore no non-wind farm projects will be considered in the cumulative assessment of these effects. In relation to disturbance/displacement and indirect effects on habitat and prey species, there could be potential for cumulative effects with non wind farm projects, such as other marine renewable projects (e.g. wave and tidal), although this has yet to be demonstrated.

213. The assessment of ornithology effects arising from the Onshore Transmission Works was scoped out through the scoping process. Due to the nature of the OnTW project no cumulative effects on ornithology are predicted and hence these are not considered in this cumulative assessment.

13.9.3 PREDICTED EFFECTS

13.9.3.1 Construction and De-commissioning Impacts

Disturbance and Displacement

214. Disturbance and displacement are assessed by summing the number of individuals of each species, that may be disturbed or displaced for consideration in relation to the relevant population (e.g. local, regional, national) and discussed in the context of the species' conservation status. The predictions of the levels of disturbance and displacement which may occur are informed by studies conducted elsewhere. The assessment considers the potential for disturbance and displacement which may arise due to construction, operation and decommissioning activities.

215. Potential cumulative effects of construction and decommissioning considered here were:

- Disturbance and potential displacement due to boat traffic;
- Disturbance and potential displacement due to construction noise; and
- Indirect effects of sequential pile driving upon local habitat conditions and prey (invertebrates and fish) stocks.

Cumulative Disturbance and Displacement due to Increased Boat Traffic

216. The cumulative effect of disturbance due to increased boat traffic was assessed as minor for the majority of species and thus no further action other than the adoption of best practice at individual sites was required in those cases. This assessment was based on the fact that shipping levels within the Moray Firth are already high and

thus additional ship traffic related to the offshore wind farms will not add significantly to this background level (see Section 18: Wind Farm Shipping and Navigation). Therefore, a small magnitude of change was assessed, resulting in negative effects of no more than minor significance.

Cumulative Disturbance and Displacement due to Construction Activity

217. The construction periods for of the Wind Farm and the Moray Firth Round 3 Zone are very likely to overlap, with construction of the Wind Farm due to last for up to five years, commencing in 2014 and the Moray Firth Round 3 Zone due to last for up to six years, commencing in 2015. Thus, there is potential for combined construction effects, lasting for between two and seven years. However, the scale over which construction activity will exert effects within the context of the Moray Firth is such that, combined effects across the two sites is not considered likely to lead to an increase in effect magnitude and significance above those predicted for the Wind Farm in isolation.

218. Piling activity at wind farm sites further south (e.g. Aberdeen and in the Firths of Forth and Tay) were not included in this assessment since the greater distances between these developments and those in the Moray Firth is considered likely to reduce the likelihood of any effects on the same populations to very low levels.

219. Overall, therefore the combined effect of construction activity is not expected to present any increase over and above that previously assessed. Therefore, a small magnitude of change was assessed, resulting in negative effects of no more than minor significance.

Cumulative Indirect Impacts upon Prey

220. The potential for a cumulative effect of wind farm construction on prey availability for bird species is likely to depend on the extent to which foraging occurs within the wind farm sites and the extent to which construction activities coincide on the two sites (and the proximity of such activity).

221. Cumulative effects on fish prey species (Section 11: Wind Farm Fish and Shellfish Ecology) were not considered significant, either as a result of habitat loss (due to gravity bases or cable installation) or due to construction activity (e.g. piling).

222. The overall effect of disturbance on prey species due to combined construction activity was assessed as of small magnitude and thus no further action other than the adoption of best practice at the two sites will be required. Therefore, a small magnitude of change was assessed, resulting in negative effects of no more than minor significance.

13.9.3.2 Operational Impacts

Disturbance and Displacement

223. Potentially significant cumulative operational effects of wind farms on birds include:

- Disturbance due to maintenance activity;

- Avoidance and displacement from the site due to the presence of the wind farm itself;
- Barrier effects limiting or preventing free movement;
- Direct collision of birds with turbines; and
- Indirect effects on distribution of prey and foraging habitat.

Cumulative Disturbance due to Maintenance Activity

224. In comparison to the construction phase, maintenance activities are likely to involve fewer, smaller boats and shorter visits, reducing the magnitude of any effect. However, given that any disturbance effects will persist over the operational lifetime of the respective wind farms, temporal overlap in maintenance activity between sites is likely to occur. The cumulative disturbance effect of maintenance on all sites must therefore be considered.

225. The number of maintenance boats predicted to be present on the Wind Farm Site on an average day is anticipated to be between five and eight, although on some days vessels may be absent (see Section 7: Project Description). Details of the maintenance schedule for the Moray Firth Round 3 Zone Eastern Development Area were not available at time of writing, however the proposed development is of a similar scale so it therefore seems reasonable to assume that a similar number of maintenance vessels would be employed.

226. The proposed Moray Firth Round 3 Zone Western Development Area is at an early stage of development and hence predicted maintenance requirements are unknown. However, this site is smaller than either the Wind Farm Site or the Eastern Development Area, and hence is likely to require fewer site visits. In addition, it is likely that improvements in offshore turbine reliability will lead to lower maintenance requirements by the time this site is developed. Therefore the increase in vessel traffic due to the Western Development Area is considered unlikely to contribute to a cumulative effect.

227. As disturbance effects will persist over the operational lifetime of the respective wind farms, temporal overlap in maintenance activity between sites is very likely to occur. Given the localised nature of the disturbance events spatial overlap between wind farms is unlikely. The level of disturbance expected to result from the presence of maintenance vessels is assumed to be similar to that which would occur in relation to fishing vessels and of no greater magnitude than that experienced during construction. Therefore, a negligible magnitude of change was assessed, resulting in negative effects of no greater than negligible significance.

Displacement

228. The cumulative effects of displacement were considered separately for breeding birds against regional populations and non-breeding birds against larger passage or wintering populations. Of the birds recorded during the breeding season, the effect on those recorded in highest numbers across the Wind Farm Site and the Moray Firth Round 3 Zone (fulmar, kittiwake, guillemot, razorbill and puffin) were considered using the same methods used in the standalone assessment (Section 13.4.2.2). The other species recorded across the two wind farm sites during the

breeding season were assessed against regional population sizes without recourse to population models.

229. The only species with sufficiently large foraging ranges for which the other proposed offshore wind farms (Aberdeen Offshore Wind Farm and the Firth of Forth and Firth of Tay developments) could potentially be of importance are fulmar and gannet. However, the EOWDC is not considered likely to contribute to a significant effect due to its small size and this site is thus excluded. The Firth of Forth and Firth of Tay sites are located within the upper end of their foraging ranges, and it therefore seems likely that very few birds would be at risk of combined effects. Therefore these sites are also excluded. The Moray Firth Round 3 Zone Western Development Area was not considered in this cumulative assessment as this site has not been surveyed and there are therefore no seabird density data available.

230. The turbine option with the highest number of turbines and the closest spacing was considered to represent the worst case scenario for displacement. For both the Wind Farm Site and the Moray Firth Round 3 Zone Eastern Development Area, the worst case scenario would result from the use of 3.6 MW turbines placed at approximately 642 m intervals (both orientations).

231. Using the population models described in Annex 13A for fulmar, kittiwake, guillemot, razorbill and puffin, the effects on each population's growth rate resulting from displacement of the peak abundance from the combined wind farm sites were assessed. To minimise the risk of double counting across the two sites, for each species the cumulative abundance was determined for each month when both sites were surveyed and the highest of these used as the peak cumulative abundance. This reduced the risk of double counting which could otherwise result from summing peaks which occurred in different months on each site.

232. For fulmar, kittiwake, guillemot and puffin, displacement of the combined peak abundance recorded on the Wind Farm Site and the Moray Firth Round 3 Zone Eastern Development Area reduced the predicted population growth rates by between 0.2% and 0.6% (see Table 13.28 and Annex 13A). Therefore small magnitudes of change are assessed for these high sensitivity species resulting in negative effects of minor significance.

Table 13.28 Annual population growth rate determined using population models for key species in relation to potential displacement from the combined Moray Firth wind farm sites. Baseline population growth rate is presented as 0% displacement

Species	Peak abundance		Annual population growth rate (%)	
	Wind Farm	Moray Firth Round 3 Zone	0% displaced	100% displaced
Fulmar	879	1840	3.29	2.92
Kittiwake	496	6653	4.35	3.81
Guillemot	5180	15705	5.68	5.48
Razorbill	331	5194	2.21	-0.07
Puffin	1455	6736	5.66	5.07

233. For razorbill a greater reduction in the population growth rate was estimated, with complete displacement triggering a predicted population decline at a rate of 0.07% per year, an overall decrease in the growth rate of 2.28% from the baseline value.

234. This cumulative effect predicted for razorbill as a result of displaced birds failing to breed is in marked contrast to the effects predicted for the Wind Farm Site in isolation, which predicted a maximum reduction in the growth rate of only 0.17%. The cumulative effect is due to the much higher peak number of razorbill estimated to be present on the Moray Firth Round 3 Zone Eastern Development Area (8,422), compared with the maximum of 331 estimated for the Wind Farm Site during the same survey month. Razorbills have a smaller foraging range than either guillemots or puffins, thus all else being equal, it would be predicted that the density of razorbills would decrease with distance from the coast across the two wind farm sites, resulting in higher densities being recorded on the Wind Farm Site. However, the results from the two wind farm sites suggest that higher densities have been recorded farther offshore on the Moray Firth Round 3 Zone Eastern Development Area. One explanation for this could be the presence of a favoured foraging region within the Moray Firth Round 3 Zone Eastern Development Area, although this would still be expected to lead to relatively high numbers being recorded on the Wind Farm Site (e.g. on passage). Alternatively, the birds recorded on the Moray Firth Round 3 Zone Eastern Development Area may in fact be non-breeders, which are more likely to remain at sea during the breeding season and may also be excluded from more preferred foraging locations closer to the breeding colonies by the more dominant breeding birds. Thus, it seems plausible that a large proportion of the birds observed within the Moray Firth Round 3 Zone Eastern Development Area are non-breeders. Therefore, the current assessment, based on displacement of breeding birds, is likely to over-estimate the effects on the breeding population. Therefore, the effect on the East Caithness Cliffs SPA razorbill breeding population caused by complete displacement from the wind farm sites is considered likely to be of a small magnitude and of no greater than negligible significance.

235. For the remaining species observed on the combined Wind Farm Site and the Moray Firth Round 3 Zone Eastern Development Area, the effects of displacement are assessed to result in small magnitudes of change resulting in negative effects of no greater than negligible or minor significance which are not significant for all species. For those species assessed without population modelling (gannet, shag, Arctic skua, great skua, great black-backed gull, herring gull, Arctic tern and puffin) this was on the basis that the proportion of the breeding population within foraging range seen on the Wind Farm Sites was small (gannet, shag, great skua, herring gull, puffin), or that the species was considered to be very unlikely to avoid wind farms (Arctic skua, great black-backed gull, Garthe and Hüppop 2004). The apparent presence of breeding Arctic tern on the Wind Farm Sites is considered to be misleading, since this species has a mean maximum foraging range of 12 km and a maximum recorded range of 20 km. This species was only recorded on the Moray Firth Round 3 Zone Eastern Development Area during the breeding season, and there are no breeding colonies within range of this site. Thus, the birds observed are not considered to be part of breeding populations within the wider region but rather non-breeding birds, such as immatures. Thus no cumulative effect on breeding birds is predicted for Arctic tern.

236. For non-breeding season displacement effects, a similar process was undertaken, however the populations against which the effects were considered included passage and wintering birds (see Annex 13A). For all species small magnitudes of change are assessed resulting in negative effects of no greater than negligible to minor significance.

Barrier Effects

237. Barrier effects are deemed to be minimal for most migratory species, with many taking far-field avoidance of wind farms with minimal effects on energy budgets (Speakman et al., 2009). For these species it is anticipated that qualitative assessments are sufficient. Where effects are expected to be significant (e.g. for avoidance of multiple wind farms on a migration route or regular avoidance such as where the wind farms lie between feeding areas and roosting sites) quantitative assessments, incorporating estimates of elevated energy demands are considered (Masden et al., 2009). These will be undertaken on a species specific basis (Masden et al., 2010).

238. There is a paucity of evidence in the scientific literature as to whether seabird movements are affected or inhibited by the presence of offshore wind farms. Energetic effects are likely to be subtle and difficult to measure on individuals' fitness or reproductive success (Masden et al., 2010). It has been shown that some species such as divers and sea ducks avoid wind farms and take evasive detours, thereby potentially increasing energy expenditure (Petersen et al., 2005). Although this effect may be negligible when passing around one wind farm, if a series of wind farms are arranged to present a continuous barrier that requires one large detour or many smaller detours, then an individual's longer trip duration will reduce time spent foraging or roosting, or increase its migration length.

239. Any effects are likely to be greater on birds that regularly commute around a wind farm compared to passage migrants that pass the sites once per season.

240. The risk to highly mobile species such as gannet and fulmar, the populations of which may include a proportion of breeding birds which could theoretically make repeat movements through the region, might be greater than that for migrants undertaking more direct singular passage routes through the area. However, the wide ranging behaviour of these species means that deviations of even tens of kilometres around sites are unlikely to be associated with any significant cost in energetic terms.

241. Although not such a wide ranging species during the breeding season, during the winter the populations of great black-backed gull observed during surveys were thought likely to include a mixture of migrants and resident birds (which breed within the region). This suggests a reduced risk of a barrier effect than if only breeding individuals making repeat foraging trips through the sites were involved. Moreover, there is currently no evidence to suggest that large gulls are likely to be vulnerable to barrier effects (Petersen et al., 2006).

242. The Moray Firth Round 3 Zone Western Development Area was not considered in this cumulative assessment as there is currently no information on which areas of the site will be developed. While this additional development has the potential to contribute to a cumulative barrier effect, given the conclusions of the assessment without this wind farm it seems unlikely that a larger magnitude effect would result from its presence.

243. Overall therefore, small magnitudes of change are predicted, resulting in negative effects of no greater than negligible significance.

The Risk of Collision with Turbines

244. Cumulative collision risk is calculated by summing collision numbers from each individual wind farm. The total number is then presented as a percentage of the relevant population or populations (e.g. local, regional, national) and also a percentage change in background mortality rate. This is important, as most seabirds are relatively long-lived and slow breeding, with the consequence that their population growth rates are typically most sensitive to changes in adult survival. Where effects are expected to be significant, these are discussed in the context of the life history of the species. In order that collision risk estimates from the two wind farm sites are comparable, the same methods of calculation were used. These followed the recently revised Band model for offshore wind farms (Band 2011).

245. Direct comparison of the collision risks predicted by the wind farms that are operational or in construction can be problematic due to the differing assumptions made in the calculations used in the different studies, and limited amount of species data presented in ESs (see Maclean et al., 2009). However the assessments conducted for projects within the Moray Firth were conducted in a more uniform manner, and therefore, were more easily comparable. In all cases the results

presented were estimated using the Band (2011) model, with site-specific estimates of the proportion of birds at risk height.

246. Only those species for which collision estimates were provided for the Moray Firth Round 3 Zone Eastern Development Area are included in the cumulative impact discussed here. At the time of this assessment, no collision estimates were available from other proposed wind farm sites within the foraging range of any species under consideration. There is potential for a cumulative effect in combination with offshore wind farms beyond the Moray Firth. However, the large distance from the Moray Firth to the proposed wind farms in the Firths of Tay and Forth, coupled with the small size of the Aberdeen offshore wind farm and the large combined seabird population sizes which would be included in a cumulative assessment of all these sites suggest that the significant population level impacts are extremely unlikely. The Moray Firth Round 3 Zone Western Development Area was not considered in this cumulative assessment as there are currently no data with which to estimate collision mortality.

247. The results of the predicted effects for the Wind Farm Site and the Moray Firth Round 3 Zone Eastern Development Area are presented as percentages of the populations. Combined seabird mortality due to projected collisions with the turbines on these two sites is low across all species on a regional level, with fewer than 1% of the regional 1% threshold breeding population predicted to be killed for gannet and kittiwake and just over 2% for herring gull and great black backed gull (see Table 13.29). However, since most of the predicted mortality for both gull species occurred during winter, mortality should be assessed against considerably larger populations. The Great Britain winter great black backed gull population estimate is 71,000 to 81,000 (Banks et al., 2007). Assessing the cumulative collision mortality against this population gives an estimated additional mortality of 0.6%. For herring gull the Great Britain population is estimated to be 262,938. Assessing the cumulative collision mortality against this population gives an additional mortality of 0.2%.

Table 13.29 Cumulative predicted collision mortality and the effects on the annual mortality rates for species at risk of collision on both Moray Firth wind farm sites

Species	Annual collision mortality		Regional		GB	
	Wind Farm	Moray Firth Round 3 Zone	Population size	Additional mortality (%)	Population size	Additional mortality (%)
Gannet	132	160	66,630	0.4	679,659	0.04
Kittiwake	132	186	80,280	0.4	733,670	0.04
Great black-backed gull	302	104	17,902	2.3	71,000	0.6
Herring gull	494	143	29,260	2.2	262,938	0.2

248. Consequently, cumulative collision risk effects are predicted to be small for all the target species for which collision risk for both sites have been considered, including those with high conservation sensitivity. Therefore, small magnitudes of change were assessed for gannet, kittiwake, herring gull and great black-backed gull, resulting in negative effects of minor significance.

Cumulative Indirect Effects

249. The potential for cumulative operational effects is assessed following an approach similar to that used for estimating disturbance and displacement. This incorporates assessments of the possible changes to prey distributions and abundance, derived from studies conducted elsewhere.

Cumulative Indirect Effects on the Distribution of Prey and Foraging Habitat

250. There is some evidence that submerged wind farm foundation structures can provide suitable micro-habitats for invertebrates (e.g. molluscs, crustaceans) and fish (Linley et al., 2007). This may possibly include species that would otherwise be limited in the region by a lack of suitable habitat. As such, wind farms may increase the regional number and distribution of some invertebrates and fish, potentially enhancing prey availability for some bird species. However, the attraction of fish species to foundation structures could have an indirect negative effect on piscivorous bird species by attracting shoals of prey fish, which then attract birds increasing the potential for collision with turbines. While there is the potential for both positive and negative indirect effects on birds through habitat creation or alteration around foundation structures, there is currently insufficient evidence to draw any conclusions on the issue especially on a cumulative scale. Therefore small magnitudes of change are assessed, resulting in negative effects of no greater than minor significance.

251. The Moray Firth Round 3 Zone Western Development Area was not considered in this cumulative assessment, however given the conclusions based on the other developments above, it is not considered that a significant cumulative effect will result from the addition of this development.

Proposed Offshore Wind Farms Outside the Moray Firth

252. Quantitative assessment of the potential combined effects of the proposed development and those proposed for development in the Firths of Forth and Tay and off Aberdeen is not possible here since no data are available for those developments. The potential for cumulative effects on seabirds with these sites will vary between species and also with different times of year. Passage species may encounter several sites, however at such times effective population sizes are typically large and drawn from numerous sites both nationally and internationally, complicating impact prediction. During the breeding season, only the most far ranging species have the potential to encounter more than one wind farm area. Only two species are known to regularly undertake foraging trips of sufficient distance to bring them into this category: fulmar and gannet. However, this far ranging nature further complicates assessment, since the effective populations at risk become much greater with the inclusion of all possible breeding colonies

located within the mean maximum range. This complication notwithstanding, the predicted cumulative effects of wind farm sites beyond the Moray Firth on these two species are not expected to be significant. Therefore small magnitudes of change are assessed for these high sensitivity species, resulting in negative effects of minor or no significance

Other Developments and Activities in the Marine Environment

253. The identified non wind farm activities occurring in the Moray Firth area are also considered when accounting for all possible cumulative effects on species. However, such assessments are problematic due to the differences in level of data capture, and typically only a qualitative assessment is therefore possible.

Oil and Gas Exploration and Production

254. Although there is oil and gas exploration activity in the wider Moray Firth area, no data are available on the disturbance or displacement which these activities may have on birds. For the purposes of this assessment it is assumed that the current baseline incorporates any effects due to existing oil and gas activities. In addition, Section 11: Wind Farm Fish and Shellfish Ecology found no evidence to suggest that current or planned oil and gas activities would have any significant effects on prey species.

OfTW and Moray Firth OFTO

255. Cables, where buried, are likely to have a negligible effect on the habitat supporting seabirds, and repair of cable breakages is expected to have very minimal effects on the seabird population either through direct disturbance to the birds or damage to the seabed. Any effects from their installation are however considered to be localised and short-term and so will be unlikely to cause additional significant effects to any species (see Section 25: OfTW Ornithology for full discussion of cable laying methods and the predicted effects on birds). Therefore negligible magnitudes of change are assessed, resulting in negative effects of no greater than negligible significance.

Shipping (including dredging of channels)

256. Any shipping activities are unlikely to cause any cumulative effects on gulls, skuas or gannets due to their low sensitivity to such disturbance and flexibility of habitat choice (Garthe and Hüppop 2004).

257. It is likely that the existing seabird populations, including auks, are already adapted to shipping operations, and any increased effects would be short-term and temporary. It is expected that any increase in cumulative displacement effects would only be potentially significant when there was a concentration of activity in a single year during the breeding season within the main foraging areas for a species. It is, therefore, concluded that combining the offshore wind farms with the ongoing effects of dumping and extraction will not create cumulative effects that are significant. It follows that existing populations of all species are habituated to some extent to the other commercial vessel movements in the area, and so any effects of shipping are incorporated into the baseline survey results. Therefore negligible

magnitudes of change are assessed, resulting in negative effects of no greater than negligible significance.

Commercial Fisheries

258. The Wind Farm Site has been identified as of low importance for commercial fisheries (Section 16: Wind Farm Commercial Fisheries). However, the Moray Firth Round 3 Zone Eastern Development Area is of greater importance for scallop dredging.

259. Fishing may potentially be precluded from both the Wind Farm Site and the Moray Firth Round 3 Zone Eastern Development Area. This could benefit the fish and shellfish communities, thereby also potentially benefiting the seabirds which prey upon them. If overall fishing intensity remains the same (i.e. through re-distribution of effort), then the baseline survey results will likely include any effects that are currently detrimentally affecting the condition of species in the area.

260. Any redistribution in commercial fishing activity may lead to species such as gulls and gannets following fishing vessels away from the turbine areas, and so may reduce potential collision risk. Overall, therefore negligible magnitudes of change are assessed, resulting in neutral or possibly positive effects of negligible significance.

13.9.4 MITIGATION MEASURES (POST CUMULATIVE ASSESSMENT)

261. The cumulative assessment did not identify any likely significant effects which require mitigation and hence no further mitigation is proposed to that presented in Section 13.5. The only mitigation measures appropriate with regards to effects on birds are those already performed as best practice within industry standards.

13.9.5 RESIDUAL EFFECTS (POST CUMULATIVE ASSESSMENT)

262. No specific mitigation has been identified for ornithological effects in relation to the cumulative effects during the construction, operational or decommissioning phases of the Wind Farm. Therefore residual effects are those identified in the cumulative assessment above.

13.10 HABITATS REGULATIONS APPRAISAL

263. In addition to the assessment of sensitive receptors to the proposed Wind Farm in relation to the requirements for EIA, a Habitats Regulations Appraisal (HRA) has also been conducted. The technical report which has informed the HRA is provided at Annex 13B and a Report to Inform and Appropriate Assessment will follow this ES.

264. The requirements of the HRA are focussed on the qualifying features of European designated sites of conservation importance (often referred to as Natura 2000 sites). With regard to birds, such sites are called SPAs. Where a proposed development could affect an SPA there is a requirement for the Competent Authority to determine whether the proposal will have a Likely Significant Effect (LSE) on the conservation objectives of any connected SPAs (alon and in combination), and if so, then make an Appropriate Assessment of the implications of the proposal on the

SPA's conservation objectives. An LSE on an SPA is defined by the European Court as an effect "likely to undermine its conservation objectives". This definition provides a coarse filter for SPA and species selection to identify those features for which a more detailed assessment under the Habitat Regulations is required. It should be noted that this is distinct from the determination of significant effects under the EIA Regulations as presented above.

265. The conservation objectives for SPAs primarily offer site-based protection, however the key one with regard to offshore wind farm developments is the maintenance of the populations of qualifying bird species as viable components of the SPA. Therefore, the determination of LSEs due to the proposed Wind Farm has been conducted with regard to the potential effects on the populations of SPA qualifying species which have been recorded on the Wind Farm Site. Seabird SPAs are designated for breeding seabird populations, therefore it is these breeding populations against which the assessment has been conducted.

266. Central to such assessments is the question of connectivity between the Wind Farm Site and the SPAs within the region. Outside the breeding season such connectivity is extremely difficult to establish, since most seabird species disperse widely from their breeding colonies. During the breeding season, the demands of reproduction are such that breeding adults are much more constrained in the areas over which they forage. Estimates of foraging range are available for many species and these permit initial selection of SPAs on the basis of distance to the Wind Farm Site. However, for species which are qualifying features of more than one SPA within foraging range of the Wind Farm Site this could potentially create a situation with SPAs located at widely different distances from the Wind Farm Site being assessed as equivalent in terms of risk of LSEs. Therefore, further refinement of the SPAs and species was undertaken. This used distance, SPA population size and the proportion of the total area within the species' foraging range which is sea to apportion the Wind Farm Site peak breeding season abundance amongst the candidate SPAs (details of this process are provided in the HRA).

267. Once the peak Wind Farm Site population was apportioned amongst possible SPAs, it was then possible to estimate the percentage of each SPAs population present on the Wind Farm Site. If more than 1% of the SPA's population was estimated to be present on the Wind Farm Site that population was considered to be at risk of an LSE. A threshold of 1% was used as this confers a precautionary level in line with the typical range of natural variation observed in seabird demographic rates. To illustrate, in the case of gannet (a comparatively well studied species), the estimated standard deviation on adult survival between 1959 and 2002 was 1.2% (Wanless et al., 2006). Adult survival is the demographic rate to which long-lived, slow breeding species such as seabirds are most sensitive to changes in, with the consequence that it tends to vary the least of all demographic rates (for example, equivalent estimates of the standard deviation on reproduction and juvenile survival for gannet are 3.5% and 7.8%). The gannet population from which these estimates are derived has undergone steady growth over the period of study. Given this, in combination with the period of study, it is highly unlikely that

smaller standard deviations on adult survival would be obtained for any other seabird species. Furthermore, the gannet population has maintained positive population growth (approx. 2% per year) while its demographic rates have varied by more than 1%. Therefore, it is reasonable to state that if fewer than 1% of an SPA's population is present on the Wind Farm Site, the risk to the population of an LSE is sufficiently small that it can be regarded as negligible.

268. Those SPA species for which an LSE has been identified will be assessed in further detail in the Report to Inform an Appropriate Assessment which will follow this ES, however a summary of the outputs of the process of identifying LSEs for all SPAs and species under consideration is provided here (Table 13.30). For each SPA, only those qualifying species for which the Wind Farm Site lies within foraging range are included. For seabirds and wildfowl, the percentage of the SPA population estimated to be at risk of an effect was derived from the combined abundance and collision mortality estimates for the Wind Farm Site and the Moray Firth Round 3 Zone Eastern Development Area. The potential effects considered were displacement, collision mortality and barrier to movement, however the risk of the latter leading to an LSE for any of the SPA species under consideration was assessed as negligible and therefore this has been omitted from Table 13.30 (note that barrier effects are considered in greater detail in the Report to Inform an Appropriate Assessment).

Table 13.30 SPA qualifying species for which an assessment for Likely Significant Effects (LSE) has been undertaken. Assessment considered displacement and collision mortality. Those SPA species for which an LSE was considered possible are highlighted.

SPA	Species	SPA population, percentage considered to be at risk of:		Likely Significant Effect identified?
		Displacement	Collision mortality	
East Caithness Cliffs	Fulmar	8.2	<0.1	Y
	Great cormorant	0	0	N
	European shag	0.6	0	N
	Herring gull	2.7	1.1	Y
	Great black-backed gull	21.1	27.2	Y
	Kittiwake	8.2	0.3	Y
	Guillemot	12.0	0.01	Y
	Razorbill	30.3	0	Y
	Atlantic puffin	>100	0	Y
Moray and Nairn Coast	Pink-footed goose	NA	0	N
	Greylag goose	NA	0	N
	Redshank	NA	0	N
Dornoch Firth and Loch Fleet	Greylag goose	NA	0	N
	Wigeon	NA	0	N
	Bar-tailed godwit	NA	0	N
Troup,	Fulmar	0.3	<0.01	N

SPA	Species	SPA population, percentage considered to be at risk of:		Likely Significant Effect identified?
		Displacement	Collision mortality	
Pennan and Lion's Head	Herring gull	0.01	0.06	N
	Kittiwake	0.3	0.01	N
	Guillemot	0.8	<0.01	N
Inner Moray Firth	Greylag goose	NA	0	N
	Red-breasted merganser	NA	0	N
	Bar-tailed godwit	NA	0	N
	Redshank	NA	0	N
Loch of Strathbeg	Whooper swan	NA	0.2	N
	Pink-footed goose	NA	<0.1	N
	Greylag goose	NA	0.1	N
	Teal	NA	0	N
	Goldeneye	NA	0	N
Cromarty Firth	Whooper swan	NA	0	N
	Greylag goose	NA	0	N
	Bar-tailed godwit	NA	0	N
North Caithness Cliffs	Fulmar	1.2	<0.01	Y
	Kittiwake	1.2	0.04	Y
	Guillemot	1.7	<0.01	Y
	Razorbill	4.3	0	Y
	Atlantic puffin	35.7	0	Y
Hoy	Fulmar	0.3	<0.01	N
	Arctic skua	25.4	5.1	Y
	Great skua	13.7	0.3	Y
	Kittiwake	0.3	0.01	N
	Great black-backed gull	0.6	0.7	N
	Guillemot	0.4	<0.01	N
	Atlantic puffin	9.1	0	Y
Copinsay	Fulmar	0.2	<0.01	N
	Great black-backed gull	0.4	0.6	N
	Kittiwake	0.2	0.01	N
	Guillemot	0.3	<0.01	N
Rousay	Fulmar	0.1	<0.01	N
Calf of Eday	Fulmar	0.1	<0.01	N
West Westray	Fulmar	<0.1	<0.01	N
Fair Isle	Fulmar	<0.1	<0.01	N
	Gannet	0.3	0.1	N
Forth Islands	Fulmar	<0.1	<0.01	N
	Gannet	0.2	<0.1	N
Hermaness, Saxa Vord and Valla	Fulmar	<0.1	<0.01	N
	Gannet	<0.1	<0.1	N

SPA	Species	SPA population, percentage considered to be at risk of:		Likely Significant Effect identified?
		Displacement	Collision mortality	
Field				
North Rona and Sula Sgeir	Fulmar	<0.1	<0.01	N
	Gannet	0.2	<0.1	N
Noss	Fulmar	<0.1	<0.01	N
	Gannet	0.1	<0.1	N
Sule Skerry and Sule Stack	Gannet	0.5	0.2	N

13.11 STATEMENT OF SIGNIFICANCE

269. This Section has assessed the likely significance of effects of the Wind Farm on birds within the Moray Firth region. A range of site specific surveys were undertaken, the results of which, in combination with previously collected data, were used to inform the assessment.

270. No effects of greater than minor significance were assessed for any phase (construction, operation and decommissioning) of the development of the Wind Farm. Therefore no significant in terms of the EIA Regulations were identified.

271. Cumulative effects of the Wind Farm in combination with other developments within the region were also assessed. These considered the same development phases and range of potential effects. No effects of greater than minor significance were identified, and these are not significant in terms of the EIA Regulations.

13.12 REFERENCES

272. Band, W. (2011). Using a Collision Risk Model to Assess Bird Collision Risks for Offshore Windfarms.

273. Band, W., Madders, M. and Whitfield, D. P. (2007). Developing field and analytical methods to assess avian collision risk at wind farms. In Birds and Wind Farms. de Lucas, M., Janss, G. F. E. and Ferrer, M. (Eds). Quercus, Madrid.

274. Banks, A.N., Burton, N.H.K., Calladine, J.R. and Austin, G.E. (2007).Winter gulls in the UK: population estimates from the 2003/04-2005/06 Winter Gull Roost Survey. BTO Research Report No. 456 to English Nature (now Natural England), the Countryside Council for Wales, Scottish Natural Heritage, the Environment and Heritage Service (Northern Ireland), the Joint Nature Conservation Committee and Northumbrian Water Ltd. BTO, Thetford.

275. BirdLife International (2004) Birds in the European Union: a status assessment. Wageningen, The Netherlands: BirdLife International.

276. Birdlife International (2012). Seabird wikispaces website, http://seabird.wikispaces.com/ accessed January 2012.

277. Blew, J., Hoffman, M., Nehls, G. and Hennig, V. (2008). Investigations of the bird collision risk and the responses of harbour porpoises in the offshore wind farms Horns Rev, North Sea, and Nysted, Baltic Sea, in Denmark. Part I: Birds. BioConsult SH.

278. Caltrans (2001). Fisheries Impact Assessment, Pile Installation Demonstration Project for the San Francisco - Oakland Bay Bridge, East Span Seismic Safety Project PIDP EA 01208, Caltrans Contract 04A0148, Task Order 205.10.90, PIDP 04-ALA-80.0.0/0.5.

279. Camphuysen, C J, Fox, A D and Leopold, M F. (2004) Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K: A comparison of ship and aerial sampling for marine birds, and their applicability to offshore wind farm assessments. Report commissioned by COWRIE (Collaborative Offshore Wind Research into the Environment). Available at: www.offshorewindfarms.co.uk.

280. Cook, A.S.C.P., Wright, L.J. and Burton, N.H.K. (2011). A review of methods to estimate the risk of bird collisions with offshore windfarms. Draft report of work carried out by the British Trust for Ornithology on behalf of the Crown Estate

281. Desholm, M. and Kahlert, J. (2005) Avian collision risk at an offshore wind farm. Biology Letters 1, 296-298.

282. Drewitt, A L and Langston, R H W. (2006) Assessing the impacts of wind farms on birds. Ibis, 148: 29-42.

283. Eaton MA, Brown AF, Noble DG, Musgrove AJ, Hearn R, Aebischer NJ, Gibbons DW, Evans A and Gregory RD (2009) Birds of Conservation Concern 3: the

population status of birds in the United Kingdom, Channel Islands and the Isle of Man. British Birds 102, pp296-341.

284. Fijn R.C. (2011) Flight patterns of seabirds in an offshore wind farm in the Netherlands. Oral presentation at the 11th International Conference of the Seabird Group, Plymouth.

285. Garthe, S. and Hüppop, O. (2004) Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology 41(4): 724-734.

286. Hamer K.C., Phillips R.A., Wanless, S., Harris, M.P. and Wood A.G (2000). Foraging ranges, diets and feeding locations of gannets Morus bassanus in the North Sea: evidence from satellite telemetry. Mar. Ecol. Prog. Ser 200: 257-264

287. Harris, M.P. (1989). Variation in the correction factor used for converting counts of individual Guillemots *Uria aalge* into breeding pairs. Ibis 131: 85-93..

288. Hüppop, O., Dierschke, J., Exo, K.M., Fredrich, E. and Hill, R. (2006). Bird migration studies and potential collision risk with offshore wind turbines. Ibis 148: 90-109.

289. IEEM (2010) Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal. Institute of Ecology and Environmental Management, London

290. Kerlinger, P. and Curry, R. (2002). Desktop Avian Risk Assessment for the Long Island Power Authority Offshore Wind Energy Project. Prepared for AWS Scientific Inc. and Long Island Power Authority.

291. King, S., Maclean, I.M.D., Norman, T., and Prior, A. (2009) Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE. Available from www.offshore.co.uk

292. Krijgsveld, K.L., Lensink, R., Schekkerman, H., Wiersma, P., Poot, M.J.M., Meesters, E.H.W.G. and Dirksen, S. (2005). Baseline studies North Sea wind farms: fluxes, flight paths and altitudes of flying birds 2003-2004. National Institute for Coastal and Marine Management, The Hague.

293. Leonhard, S.B. and Pedersen, J. (2006) Benthic communities at horns Rev before, during and after construction of Horns Rev Offshore Wind Farm, Vattenfall report number: Final report/annual report.

294. Leopold, M.F. and Camphuysen, C.J. (2007). Did the pile driving during the construction of the Offshore Wind Farm Egmond aan Zee, the Netherlands, impact local seabirds? Report CO62/07. Wageningen IMARES Institute for Marine Resources and Ecosystem Studies.Lindeboom, H.J., Kouwenhouven, H.J., Bergman, M.J.N., Bouma, S., Brasseur, S., Daan, R., Fijn, R.C., de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld., Leopold, M. and Scheidat, M. (2011) Short term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, 6, 1-13.

295. Lindeboom, H.J., Kouwenhoven, H.J., Bergman, M.J.N., Bouma, S., Brasseur, S., Daan, R., Fijn, R.C., de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K.L., Leopold, M. and Scheidat, M. (2011). Short-term

ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environ. Res. Lett. 6 (2011) 035101 (13pp), doi:10.1088/1748-9326/6/3/035101.

296. Linley, E A S, Wilding, T A, Black, K, Hawkins, A J S and Mangi, S. (2007) Review of the reef effects of offshore wind farm structures and their potential for enhancement and mitigation. Report from PML Applications Ltd. and the Scottish Association for marine science to the Department for Business, Enterprise and Regulatory Reform (BERR). Contract No. RF CA/005/0029p: 132pp.

297. Longcore, T., Rich, C., (2004). Ecological light pollution. Frontiers in Ecology and the Environment, 2(4), pp. 191-198.

298. MFOWDG (2011) Moray Firth Offshore Wind Developers Group: Cumulative Impacts Assessment Discussion document. Report to MORL and BOWL and Scottish Natural Heritage Commissioned Report No. 459

299. Maclean, I M D, Wright, L J, Showler, D A and Rehfisch, M M. (2009) A Review of Assessment Methodologies for Offshore Wind farms. British Trust for Ornithology Report Commissioned by Cowrie Ltd. (COWRIE METH-08-08) ISBN: 978-0-9557501-6-8.

300. Masden, E A, Haydon, D T., Fox. A D and Furness, R W. (2010) Barriers to movement: Modelling energetic costs of avoiding marine windfarms amongst breeding seabirds. Marine Pollution Bulletin (in press).

301. Masden, E. A., Haydon, D. T., Fox, A. D., Furness, R. W., Bullman, R., and Desholm, M. (2009) Barriers to movement: impacts of wind farms on migrating birds. ICES Journal of Marine Science, 66: 746-753.

302. Mitchell, P.I., Newton, S.F., Radcliffe, N. and Dunn, T.E. (2004) Seabird Populations of Britain and Ireland: Results of the Seabird 2000 Census (1998-2002). T & AD Poyser. London.

303. Petersen, I K, Christensen, T K, Kahlert, J, Desholm, M and Fox, A D. (2006) Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. NERI Report commissioned by DONG Energy and Vattenfall A/S. National Environmental Research Institute, Ministry of the Environment (Denmark), 161pp.

304. Pettersson, J. (2005) The impact of offshore wind farms on bird life in Southern Kalmar Sound, Sweden. Report to Swedish Energy Agency.

305. Skov, H, Durinck, J, Leopold, M F and Tasker, M L. (2007) A quantitative method for evaluating the importance of marine areas for conservation of birds. Biological Conservation, 136, 362-371.

306. SNH (2008) Proposed marine extension to East Caithness Cliffs Special Protection AREA (SPA), Case for extension.

(http://www.snh.org.uk/pdfs/directives/b269970.pdf)

307. SNH 2010. Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model (http://www.snh.gov.uk/docs/B721137.pdf accessed 16.12.2011)

308. Snow, D. W. and Perrins, C. M. (1998). The Birds of the Western Palearctic concise ed. Oxford University Press.

309. Speakman, J., H. Gray, and L. Furness. (2009) University of Aberdeen Report on Effects of Offshore Wind Farms on the Energy Demands on Seabirds. Department of Energy and Climate Change, UK Government, Report URN 09D/800, 23 pp.

310. Stone, C J, Webb, A, Barton, C, Ratcliffe, N, Reed, T C, Tasker, M L, Camphuysen, C J and Pienkowski, M W. (1995) An atlas of seabird distribution in north-west European waters. Joint Nature Conservation Committee, Peterborough, UK: 326pp.

311. Tasker, M L, Webb A, Hall, A J, Pienkowski, M W and Langslow, D R. (1987) Seabirds in the North Sea. Final report of phase 2 of the Nature Conservancy Council Seabirds at Sea Project November 1983-October 1986. Nature Conservancy Council, Peterborough.

312. Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J. L., Strindberg, S., Hedley, S. L., Bishop, J. R.B., Marques, T. A. and Burnham, K. P. (2010). Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology 47, 5-14

313. Thomsen, F, Lüdemann, K, Kafemann, R and Piper, W. (2006) Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg, Germany on behalf of COWRIE Ltd.: 62pp. Available from www.offshorewind.co.uk.

314. Trapp, J. L. (1998). Bird kills at towers and other man-made structures: an annotated partial bibliography (1960-1998). U. S. Fish and Wildlife Service web report.

315. Trinder M. (2011) The potential consequences of elevated mortality on the population viability of whooper swans in relation to wind farm developments in Northern Scotland. Scottish Natural Heritage Commissioned Report No. 459.

316. Trinder, M., Mitchell, C., Swann, B. and Urquhart, C. (2010) Status and population viability of Icelandic graylag geese Anser anser in Scotland, Wildfowl 60, 64-84.

317. Trinder, M., Rowcliffe, M., Pettifor, R., Rees, E., Griffin, L., Ogilvie, M. and Percival, S. (2005). Status and population viability analyses of geese in Scotland. Scottish Natural Heritage Commissioned Report No. 107 (ROAME No. F03AC302).

318. Tulp, I., Schekkerman, H., Larsen, J.K., van der Winden, J., van de Haterd, R.J.W., van Horssen, P., Dirksen, S. and Spaans, A.L. (1999). Nocturnal flight activity of seaducks near the windfarm Tunø Knob in the Kattegat. Bureau Waardenburg project No. 98.100, report No. 99.64.

319. Wernham, C.V., Toms, M., Marchant, J. Clark, J., Siriwardena, G. and Baillie, S. (eds) (2002). The migration atlas: movements of the birds of Britain and Ireland. T. & A.D. Poyser, London.

320. Winkelman, J.E. (1995). Bird/wind turbine investigations in Europe. Proc. National Avian-Wind Power Meetings, Denver Colorado, 20-21 July 1994. Pp. 43-48.

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