7 ORNITHOLOGY

7.1 INTRODUCTION

1. This section of the ES Addendum presents information to address consultation responses, and consider further cumulative information in relation to ornithology. In addition, this section presents a discussion of the effects which may occur as a result of the most likely scenario. The assessment has been undertaken by MacArthur Green.

2. Specifically, this section of the ES Addendum provides further information to inform the ornithology assessment, including:

- Revised reference population estimates for some seabird species. The table presented in this ES Addendum (Table 7.2) replaces those provided in the Original ES;
- Presentation of outputs from stochastic population modelling used to estimate potential effects on the populations of fulmar, gannet, kittiwake, herring gull, great black-backed gull, guillemot, razorbill and puffin. This includes discussion of how significance of effect has been derived from probabilistic population model predictions. This is further to the assessment presented in the Original ES;
- Revised methods for estimating displacement effects for fulmar, gannet, kittiwake, guillemot, razorbill and puffin. These replace the assessment of displacement effects presented in the Original ES;
- Assessment of collision effects using the stochastic population models. This includes the collision mortality estimates presented in the Original ES (for information) and also updated collision estimates produced using the most up to date offshore collision model (Band 2012, offshore collision modelling tool, Option 3). The collision assessment for the following species: fulmar, gannet, kittiwake, herring gull and great black-backed gull replaces the assessment of collision effects presented in the Original ES. For all other species at risk of potential collisions the assessment in the Original ES remains valid;
- Consideration of non-breeding season collision effects for gannet, kittiwake, herring gull and great black-backed gull which is further to the assessment in the Original ES; and
- Assessment of potential cumulative effects on the basis of updated information now available for other wind farms which replaces the cumulative assessment presented in the Original ES.

3. It should be noted that the changes to the jack-up vessel footprints, the change to the OfTW Corridor and the change to the OfTW cable installation timescales included in the Amended Project, do not affect the worst case scenario in relation to the assessment of effects on ornithology and have, therefore, been scoped out of this assessment.

4. This section presents an addendum to Section 13: Wind Farm Ornithology of the Original ES. Where this section updates and replaces conclusions made in the Original ES, this is made clear. Where applicable reference is made to the Original ES throughout this section.

5. This ES Addendum does not apply to Section 25: OfTW Ornithology of the Original ES which has not been amended.

6. This section of the ES Addendum is supported by the following documents contained in Volume 4: Technical Annexes of this ES Addendum:

- Annex 7A: Population model outputs - Figures;
- Annex 7B: Population model outputs – Tables;
- Annex 7C: Note to support the use of a 99% avoidance rate for the Beatrice Offshore Wind Farm collision risk modelling.

7. This section includes the following elements:

- Consultation;
- Scope of Assessment;
- Baseline;
- Assessment Methodology;
- Assessment of Potential Effects;
- Mitigation Measures and Residual Effects;
- Assessment of Cumulative Effects;
- Statement of Significance;
- Habitats Regulations Assessment; and
- References.

7.2 CONSULTATION

8. Following the submission of the Original ES in April 2012, Beatrice Offshore Windfarm Ltd (BOWL) received consultation responses via Marine Scotland Licensing Operations Team (MS-LOT) from various statutory and non-statutory consultees. A summary of these responses in relation to ornithology is presented in Table 7.1. Reference is also provided as to where these issues are addressed within this ES Addendum if applicable.

Table 7.1: Summary of Original ES Consultation Responses and Project Response

Consultee	**Summary of Consultation Response**	**Project Response**	**Consultation Response Addressed**
Scottish Natural Heritage (SNH)	Provide a clear description and summary table of worst case development scenario for each receptor.	This has been provided in this ES Addendum.	Section 7.5.4 and Table 7.5
SNH	Present impact assessments for the 'most likely' scenario.	This has been provided in this ES Addendum.	Section 7.6.6
SNH	Provide discussion of 'total' impacts where required.	This has been provided in this ES Addendum. Note this only applies to three species (fulmar, gannet and kittiwake) as no other species were considered to be at sufficient risk of both sources of effect to justify inclusion in this assessment).	Section 7.6.4

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
SNH	Full workings of seabird collision risk modelling in respect of Special Protection Area (SPA) seabirds. Include most likely scenario as well as worst case scenario.	These were supplied to SNH in excel format as requested on 6th September 2012.	No further information presented in this ES Addendum.
SNH	Estimate seabird displacement using currently agreed methods.	Clarification of this comment was initially obtained at a meeting with SNH and MS-LOT on 4th September 2012. A subsequent meeting with SNH, MS-LOT, Marine Scotland Science (MSS), The Crown Estate (TCE), Joint Nature Conservation Committee (JNCC) and the Moray Firth Offshore Wind Developers Group (MDOWDG) (1st February 2013) further refined the requirements for the updated assessment. The methods used in the Original ES have been adapted for this ES Addendum to include turnover of individuals and a range of percentage displacement and breeding failures. Agreement on the modified methods was obtained from MSS and SNH in February 2013 by email.	Section 7.5.1
SNH	Rework seabird apportioning between SPAs following advice to be provided by SNH.	Clarification of this comment was obtained at a meeting with SNH and MS-LOT on 4th September 2012. After discussion of method used in the Original ES and supply of example spreadsheet to SNH on 4th September 2012 it was agreed that the method used generated identical results to those advocated by SNH and therefore no further work on this was required.	No further information presented in this ES Addendum
SNH	Seeking agreement on population modelling methods.	At a meeting with SNH, MS-LOT, MSS, TCE, JNCC and MFOWDG (1st February 2013) it was agreed that stochastic population models would be used in the ES Addendum to assess potential effects.	Section 7.5.3
SNH	Seeking agreement on reference population sizes.	Reference populations were discussed with SNH at a meeting on 4th September 2012. A table of the reference population sizes used in the Original ES was supplied to SNH on 31st October 2012 in order for them to determine if any needed to be amended for the ES Addendum. At a subsequent meeting with SNH, MSS, MS-LOT, TCE, JNCC and the MFOWDG (1st February 2013) SNH presented a revised table of reference populations. This was finalised and sent to BOWL by email on the 14th February 2013. These population estimates are the ones used in the ES Addendum.	Section 7.4.2 and Table 7.2

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
SNH	Seeking agreement on how to incorporate population trends in models.	Inclusion of population trends in population models was discussed with SNH at a meeting on 4th September 2012. It was agreed that incorporating trends into population models without a clear understanding of underlying mechanism will create artificial outputs. It was also agreed that the key outputs to consider from the population models are the relative changes predicted, rather than the absolute ones. Consequently it was agreed that no modifications were required. A section has been included in the ES Addendum to explain this.	Section 7.5.3
SNH	SNH/JNCC/MSS are discussing SPA impacts outside breeding season, which will need consideration.	At the meeting on 4th September 2012 SNH advised that they are still working on the methods for this assessment. It was agreed that further advice was unlikely to be available within the time frame for submitting the ES Addendum therefore no further action was required. At a subsequent meeting with SNH, MS-LOT, MSS, TCE, JNCC and the MFOWDG (1st February 2013) it was advised that collision effects outside the breeding season should be assessed for gannet, kittiwake, herring gull and great black-backed gull. This has been included in the ES Addendum.	Section 7.6.5
SNH	HRA lacks interpretation of impacts against conservation objectives in terms of maintaining 'population as viable component of the designated site'. Applies to great black backed gull, kittiwake, herring gull, gannet, guillemot, razorbill and puffin.	This has been provided in Annex 3B of this ES Addendum.	Annex 3B: Report to Inform an Appropriate Assessment
SNH	Habitat Regulations Assessment (HRA) needs to consider cumulative impacts of BOWL and Moray Offshore Renewables Limited (MORL) together.	This has been provided in Annex 3B of this ES Addendum.	Annex 3B: Report to Inform an Appropriate Assessment
SNH	Need to consider further indirect sandeel effects.	Further discussion on the potential effect of loss of habitat on sandeels has been provided. Further information on the potential distribution of sandeels in the Wind Farm Site together with seabird integration data is shown in Volume 10, Part 1, Biological Environment	Section 5.6.1.1 Section 5.4.2 Moray Firth Round 3 Zone ES 2012 (Vol 10, part

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
		Technical Appendices, Annex 4.3 C, Sandeel Survey of the ES for the Moray Firth Round 3 Zone Wind Farm (MORL, 2012). See also environmental information contained in MORL (2012).	1, Annex 4.3C)
MS-LOT	Clarification from SNH was sought by MS-LOT at meeting on 04/09/2012 on selection of avoidance rate for collision risk modelling. This was prompted by project use of 99% avoidance while SNH advise use of 98% for seabirds.	A technical note on the selection of appropriate avoidance rates for seabird collision risk modelling was submitted to SNH (5th December 2012). This note presented evidence to support the use of avoidance rates higher than 98%. At a subsequent meeting with SNH, MS-LOT, MSS, TCE, JNCC and the MFOWDG(1st February 2013) it was determined that MS-LOT would commission an independent review of avoidance rates for offshore collision risk modelling. At the time of this reporting in the ES Addendum this review was unavailable (Q2 2013). The report submitted to MS-LOT and SNH is supplied as an annex to this ES Addendum in support of the use of 99% as an appropriate avoidance rate for offshore collision risk assessment.	Annex 7C
MSS	To estimate turnover rates for assessing displacement impacts, consider time spent away from the colony.	Turnover method has been modified to incorporate this suggestion.	Section 7.5.1
MSS/ SNH	Collision mortality and population model outputs at an avoidance rate of 98% need to be provided.	These have been included in this ES Addendum.	Section 7.6.3
MSS	Include tables of changes in probability of decline in appendix	These have been included in Annex 7B.	Annex 7B
Royal Society for the Protection of Birds (RSPB)	Migration survey considered likely to have underestimated the number of flights.	We consider these methods, which were discussed with SNH and JNCC and approved by them prior to use, are robust and do provide representative data. Both organisations were also satisfied with the results obtained. At a meeting with the RSPB (6th March 2013) it was agreed that the methods were suitable for the assessment.	No further information presented in this ES Addendum.
RSPB	Consider failure to study flights using radar is a failure in particular with regards to flight height estimation.	A radar study was considered, however the limitations of the technology with respect to detection range, height assessment and species discrimination severely restrict the use and value of radar deployment for sites this far offshore. As such this technology was not considered likely to generate useful	No further information presented in this ES Addendum.

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
		data (considerable problems were encountered with this approach when used on the Beatrice Alpha drilling platform). Furthermore, flight height data are now available (SOSS-02) and these largely support the estimates obtained from the site specific surveys. At a meeting with the RSPB (6th March 2013) this was discussed and it was agreed that radar would not have been useful for this assessment.	
RSPB	Use of historic population estimates significantly underestimates impacts.	This is inaccurate as the most up to date population estimates available were used for all assessment of effects. While some of these may have dated from SPA designation, this is a reflection of the infrequency of population counts and is not something BOWL has any control over. Statements which imply all seabird populations in the region have undergone declines need to be backed by robust data, which to our knowledge is not possible. At a meeting with the RSPB (6th March 2013) the confusion over this point was cleared up and the reference populations as defined by SNH were discussed and agreed upon.	Section 7.4.2 and Table 7.2
RSPB	Unconvinced by displacement assessment. Consider that density dependence may be operating.	We consider the displacement assessment to be robust. As stated in the assessment, displacement could have a likely significant effect, however the assessment establishes that this is highly unlikely. We consider the argument that if density dependence is operating the effect could be much greater to be highly speculative. There is no evidence for density dependence operating on any of these seabird species, and it is unclear how such regulation might operate. Under such circumstances, we consider it highly inadvisable to attempt to base an assessment on unsupported assumptions. At a meeting with the RSPB (6th March 2013) this was discussed further, and the amended methods discussed. It was agreed that these would provide sufficient further information.	Section 7.6.2
RSPB	Consider that indirect effects mediated via impacts on sandeels have not been sufficiently covered.	Further discussion on the potential effect of loss of habitat on sandeels has been provided. Further information on the potential distribution of sandeels in the Wind Farm Site together with seabird integration data is shown in Volume 10,	Section 5.6.1.1 Section 5.4.2 Moray Firth Round 3 Zone ES

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
		Part 1, Biological Environment Technical Appendices, Annex 4.3 C, Sandeel Survey of the ES for the Moray Firth Round 3 Zone Wind Farm (MORL, 2012). See also environmental information contained in MORL (2012).	2012 (Vol 10, part 1, Annex 4.3C)
RSPB	Collision risk assessment should be based on 98% avoidance rate.	A technical note on the selection of appropriate avoidance rates for seabird collision risk modelling was submitted to SNH (5th December 2012). This note presents further evidence above that included in the original submission to support the use of avoidance rates higher than 98%. The content of this note is included in this ES Addendum. At a meeting with the RSPB (6th March 2013) this was discussed further. The report submitted to MS-LOT and SNH is supplied as an annex to this ES Addendum in support of the use of 99% as an appropriate avoidance rate for offshore collision risk assessment.	Annex 7C
RSPB	Consent should be conditional on use of remote sensing equipment (e.g. CCTV, infra-red cameras, radar, etc.)	These technologies are at very early stages of development and are not proven for use on offshore turbines. Making use of such untried equipment a condition of consent is unrealistic at the present time.	No further information presented in this ES Addendum.
RSPB	Potential for significant barrier effects on foraging auks needs further assessment, in particular to identify connectivity and estimate avoidance behaviour.	At a meeting with the RSPB (6th March 2013) this was discussed further in particular in relation to difficulties of assessing potential effects. No new information regarding this potential effect is available therefore no update to the assessment in the Original ES has been provided.	No further information presented in this ES Addendum.
RSPB	Potential lighting effects need to be more fully assessed.	At a meeting with the RSPB (6th March 2013) this was discussed further in particular in relation to difficulties of assessing potential effects. No new information regarding this potential effect is available therefore no update to the assessment in the Original ES has been provided.	N/A
RSPB	Extensive foraging trips may need to be considered, with individuals undertaking longer trips than previous estimates suggest.	Up to date tracking data has been considered wherever appropriate in the ES Addendum. However, we note that this statement and that regarding barrier effects are somewhat at odds since the longer trips undertaken by auks (which are the key species to which this comment refers) suggests that the additional energetic costs of diversions may be less pronounced than implied by the suggestion that	No further information presented in this ES Addendum.

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
		barrier effects may be likely significant effects.	
RSPB	Method to apportion birds among SPAs considered inconsistent with current SNH guidance.	This is incorrect. The method used in the Original ES was identical to the method being developed by SNH. At a meeting with the RSPB (6th March 2013) this was discussed further and it was agreed that in the absence of empirical data the approach used was reasonable. No further information presented in this ES Addendum.	N/A
RSPB	Reasons should be provided for not presenting stochastic population models for all species at risk of impact.	Stochastic models are now being used for assessing effects in this ES Addendum.	Section 7.5.3
RSPB	Cumulative impacts should consider all developments which may affect the level of population used in the assessment.	Consideration has been given to the appropriate geographical range used in the cumulative assessment for each species. MS-LOT, MSS and SNH have both agreed with the other developments included in the ES Addendum.	Section 7.8

7.3 SCOPE OF ASSESSMENT

9. Following consultation responses from and discussions with SNH, RSPB, MS-LOT and MSS the following additions and modifications to the assessment methodology presented in Section 13.2 of the Original ES have been made:

- Identification of the potential effects of displacement. On request from SNH, the number of individuals at risk of displacement during the breeding season has been updated to account for turnover of individuals. Furthermore, the number at risk now includes both birds on the water and those in flight. In the original assessment all displaced breeding birds were assumed to be unable to successfully raise young and the assessment was based on 100% displacement. MSS and SNH requested refinement of this assessment to consider a range of percentages of reproductive failure and a range of percentages of displacement (further details of the methods are provided in Section 7.5.1). Effects have been assessed using stochastic population models which generate results in probabilistic terms. Therefore the assessment of displacement presented in this ES Addendum updates and replaces that in the Original ES;
- Assessment of potential effects outside the breeding season was requested by MSS and SNH. It was agreed with MSS and SNH that this would be confined to potential collision effects on gannet, kittiwake, herring gull and great black-backed gull. The populations used for these assessments are not confined to those present at SPAs within foraging range since connectivity with SPAs

outside the breeding season is hard to determine and this would also fail to acknowledge the migrations undertaken by these species. The geographic range of populations included and the means by which collision effects have been assessed for this non-breeding assessment are provided. Therefore the assessment of non-breeding season effects presented in this ES Addendum is further to the assessment presented in the Original ES;

- Revised collision risk modelling has been undertaken using the most up to date method now available (Band 2012 Offshore collision tool, Option 3) and is presented in this ES Addendum. The effects (both for the Wind Farm alone and also in combination with the proposed Moray Firth Round 3 Zone) of collisions have been assessed using stochastic population models which generate results in probabilistic terms. Therefore, for the following species: fulmar, gannet, kittiwake, herring gull, great black-backed gull, the collision risk assessment presented in this ES Addendum replaces that in the Original ES and provides assessments based on the results of population modelling. For all other species at potential risk of collisions the assessments presented in the Original ES remain valid;
- Population effects of collision mortality estimates with avoidance rates of both 98% and 99% are provided, with the effect significance assessed on the basis of 99% (see Annex 7C for discussion of why this avoidance rate is considered appropriate);
- Assessment of potential combined effects ('total' effects) of collisions and displacement for applicable species. Those species for which combined effects are considered are: fulmar, gannet and kittiwake. No other species were both present in large numbers in the breeding season and recorded in large numbers at potential collision height. Therefore the assessment presented in the ES Addendum is a new section further to that presented in the Original ES;
- A discussion is included which details reasons why the population models are density independent and do not include any observed trends;
- Consideration of the predicted effects resulting from development of the 'most likely' scenario (as outlined in Section 4: Amended Project Description) is presented. The discussion of the most likely scenario presented in this ES Addendum is therefore a new section and does not update an equivalent one in the Original ES; and
- Updated cumulative totals and cumulative assessment. This includes revised bird effect estimates presented in the submission for the Moray Firth Round 3 Zone. As the data for this site were presented in relation to the three proposed phases of this development ('MacColl', 'Stevenson' and 'Telford') the same sub-divisions have been used in the cumulative assessment presented here. The cumulative assessment presented in the ES Addendum updates and replaces that provided in the Original ES.

10. Determining the significance of the displacement and collision effects estimated in this ES Addendum has been undertaken using stochastic population models. This followed industry best practice and was discussed with MSS and SNH. The stochastic population models generate probabilities of certain outcomes (e.g.

population decline) within specified time frames. Comparison of predictions generated under baseline conditions with those generated due to displacement from the Wind Farm or collision with turbines permits estimation of effect magnitude. The following thresholds were used previously (Triton Knoll), as advocated by JNCC and Natural England (NE), to define thresholds for likely significant effects on seabird populations from offshore wind farms. For an effect to be not considered likely significant effect in terms of the EIA Regulations it should cause no more than:

- A 10% increase in the likelihood of a 10% population decline;
- A 5% increase in the likelihood of a 20% decline; and
- A 2% increase in the likelihood of a 50% decline.

11. These thresholds do not represent a 'sliding scale' of effect thresholds, with increasing levels of magnitude or significance attributed to each, but are rather alternative measures for assessing an effect. Thus, an effect which triggers a likelihood of population decline greater than any one of these would be regarded as likely significant effect in terms of the EIA Regulations. Conversely, an effect which triggers a likelihood of an increase in the probability of decline which is less than all three of these would not be considered a likely significant effect (in EIA terms). The population model outputs for each effect assessed are presented as the probability of triggering declines of 10%, 20% and 50%, which are then discussed in relation to the above threshold values.

12. The changes to the jack-up vessel footprints, the change to the OfTW Corridor and the change to the OfTW cable installation timescales included in the Amended Project, do not affect the worst case scenario in relation to the assessment of effects on ornithology and have, therefore, been scoped out of this assessment.

7.4 BASELINE

7.4.1 STUDY AREA

13. The Study Area for the assessment of effects on birds was presented in Section 13.2.1 of the Original ES. The Study Area remains unchanged.

7.4.2 BASELINE CONDITIONS

14. With the exception of updates to some of the seabird reference populations (Table 7.2) the baseline conditions relating to the Study Area are unchanged from those presented in Section 13.3 of the Original ES. The baseline conditions remain unchanged.

15. Although in almost all cases the reference populations used in the Original ES have remained the same, Table 7.2 shows the populations for which further assessment has been requested by MSS and SNH.

Table 7.2: Reference Populations for Seabirds as agreed with SNH and MSS
(these populations are the ones used in this ES Addendum).

Species	**SPA**	**Population (pairs or individuals)**
Northern fulmar	East Caithness Cliffs	14,202 (prs.)
	Troup, Pennan & Lion's Head	1,600 (prs.)
	North Caithness Cliffs	13,950 (prs.)
	Hoy, Orkney	19,586 (prs.)
	Copinsay, Orkney	1,630 (prs.)
	Calf of Eday, Orkney	1,782 (prs.)
	Rousay, Orkney	1,030 (prs.)
	West Westray, Orkney	677 (prs.)
Black-legged kittiwake	East Caithness Cliffs	40,140 (prs.)
	Troup, Pennan & Lion's Head	14,896 (prs.)
	North Caithness Cliffs	10,147 (prs.)
	Hoy, Orkney	397 (prs.)
	Copinsay, Orkney	1,776 (prs.)
Great black-backed gull	East Caithness Cliffs	175 (prs.)
	Hoy, Orkney	28 (prs.)
Herring gull	East Caithness Cliffs	3,393 (prs.)
	Troup, Pennan & Lion's Head	1,597 (prs.)
Common guillemot	East Caithness Cliffs	158,985 (ind.)
	Troup, Pennan & Lion's Head	16,325 (ind.)
	North Caithness Cliffs	70,154 (ind.)
	Hoy, Orkney	9,020 (ind.)
Razorbill	East Caithness Cliffs	17,830 (ind.)
	Troup, Pennan & Lion's Head	2,601 (ind.)
	North Caithness Cliffs	2,466 (ind.)
Atlantic puffin	East Caithness Cliffs	274 (prs.)
	North Caithness Cliffs	7,071 (prs.)
	Hoy, Orkney	417 (prs.)
Gannet	Sule Skerry and Sule Stack	4,675 (prs.)
	Fair Isle	3,582 (prs.)
	North Rona and Sula Sgier	9,225 (prs.)
	Noss	9,767 (prs.)
	Forth Islands	48,065 (prs.)
	Hermaness, Saxa Vord & Valla Field	24,353 (prs.)

7.5 ASSESSMENT METHODOLOGY

7.5.1 DISPLACEMENT

7.5.1.1 Summary

16. The displacement assessment method was revised for this ES Addendum and used for the following species (as agreed with SNH): fulmar, kittiwake, gannet, guillemot, razorbill and puffin. For these species the assessment presented in the ES Addendum replaces that presented in the Original ES.

17. Details of the revised displacement method used for this ES Addendum assessment are provided in Section 7.5.1.2. In summary the approach was as follows:

(1) For each species assessed the number of individuals present within the Wind Farm Site during the breeding season was calculated as the average (across the two breeding seasons surveyed) peak total abundance (on water and in flight) multiplied by a correction factor to account for turnover (details of how this was derived are provided in each species section);

(2) The number of individuals calculated at (1) was multiplied by the estimated percentage of the population made up of breeding individuals obtained from population modelling;

(3) The number of individuals calculated at (2) was entered into the displacement table as the maximum (100% displaced, 100% failure to breed), with all other values in the table (lower displacement and lower breeding failure) derived from this number;

(4) Species sensitivity scores (e.g. Furness et al., 2013; Garthe & Hüppop, 2004) were used to estimate the probable displacement percentage. The disturbance score of between 1 and 5 provided by Furness et al (2013) was converted to a displacement percentage where 1 = 20% and 5= 100%. The predicted effect on each species' population resulting from this level of displacement and subsequent reduction in breeding success was estimated using the outputs from population modelling. Effects of displacement were modelled over the 25 year life of the wind farm, and the differences in the outputs obtained from effected and unaffected model scenarios were compared. The different measures considered were the change in the predicted probability of population decline and changes in the final population size achieved (i.e. that predicted for the 25th year of the simulation). This approach was discussed and agreed with MSS and SNH.

7.5.1.2 Method Details

18. In the original assessment, displacement effects were assessed on the basis of the peak breeding season number recorded for each species under consideration. SNH requested that this assessment be revised to make allowance for turnover, thereby increasing the number at risk of effect. By doing this the assumption is that all the breeding individuals which could potentially be making use of the site are included. In addition, MSS requested that the total number at risk of displacement

should include both birds on the water (as per the original assessment) and also birds in flight (included in this updated assessment).

19. A review of seabird foraging research revealed that individuals across a range of species show a high level of site fidelity with regards to selection of foraging areas (e.g. Brunnich's guillemot, Mehlum et al., 2001; pelagic cormorant, Kotzerka et al., 2011; kittiwake, Irons, 1998; gannet, Hamer et al., 2001; common tern, Becker et al., 1993). On this basis, it is plausible to assume that those individuals recorded during the surveys regularly use the site for foraging. Therefore, accounting for turnover requires estimation of the number of additional individuals which also make regular use of the site but which were not present during the surveys. This has been done here using species specific estimates of the number of foraging trips made by an individual per day and estimates of the average duration of foraging trips. This permits estimation of how many additional birds need to be included in the displacement assessment. For the current assessment we made use of both published estimates of foraging trip frequency obtained at other study sites and also, where available, the results of the tracking study conducted at colonies within the East Caithness Cliffs SPA for the MFOWDG (Bicknell et al., 2011).

20. To generate estimates of the total number of birds on the site at risk of displacement based on the survey data, an estimate of the number of birds in flight was added to the number of birds estimated to be on the water.

21. To estimate the number of birds in flight, snapshot data were used. At each snapshot location (at intervals of 500m) birds in flight were recorded within a nominal box 300m to a side. The number of snapshots conducted within the Wind Farm Site ranged between 115 and 144 (average = 126; variations due to small differences in the transect route), therefore, the combined area of snapshots ranged between 10.3km^2 and 13.0km^2. For each survey, the total number of each focal species recorded was divided by the total area of snapshots to estimate the density of flying birds. This density was multiplied by the total area from which birds could be displaced (proposed wind farm area plus turbine buffer; 140km^2) to estimate the number of birds at risk of displacement.

22. For each species, the total abundance of birds on the water and in flight was calculated for each breeding season month (these were species specific, as supplied by SNH) in each year (2010 and 2011). The displacement assessment used the average of the peak combined number from each year.

23. Allowance was made for the fact that turnover of birds on the site could mean a larger number of individuals could be at risk of displacement effects than the peak number seen during any particular survey. To estimate the number of individuals at risk of displacement including turnover, the peak on site abundance was multiplied by the proportion of time an individual was estimated to be away from the colony during a typical 24 hour period (i.e. the individual's availability time to be observed during surveys). The availability time was calculated as the product of the average number of foraging trips per day and the average duration of those trips, all divided by 24. For the current purposes this is likely to over-estimate individual availability, since this total time away from the colony includes travel

time to and from the wind farm site and also any 'loafing' time during which birds rest at or near the colony but not in the immediate vicinity of their egg/chick.

24. Thus, for a hypothetical species with a peak on site abundance of 100 which undertakes one foraging trip every three days lasting an average of 12 hours, the individual availability time would be:

availability time = (12*0.33)/24 = 0.167

and the total potential population using the site would be:

100/0.167 = 600

In this case, six times as many individuals (600) potentially make use of the site.

25. The percentage of individuals present on the Wind Farm Site considered to be breeding birds was estimated from the stable age distribution derived using the stochastic population models (see Section 7.5.3). As a worst case, each displaced breeding bird was considered to represent one half of a breeding pair which failed to breed. The estimated values represented the maximum number of breeding individuals at risk of displacement.

26. A matrix of the number of pairs which fail to breed, generated as combinations of percentages of displacement (10-100%) and breeding failure (10-100%), was supplied by MSS for this assessment. This matrix is presented for each species assessed. To generate a prediction of the percentage of each species expected to be displaced, the disturbance scores provided by Garthe and Hüppop (2004) and updated by Furness et al. (2013) was used. The disturbance score reported for each species was converted from a 1 to 5 scale to a percentage, with 1 = 20% and 5 = 100%. The scores reported by these authors were generated through discussion with experts in the field of seabird ecology and reflect many years of combined experience. Using the disturbance scores in this manner was therefore considered a robust method for generating predictions of displacement suitable for this effect assessment.

27. Breeding failure among the resulting displaced birds was assumed to be total (i.e. all of those birds displaced failed to breed).

28. The effect of this level of breeding failure was assessed using the population models. Discussion of how the outputs from the models were used to determine effects significance is provided in Section 7.5.2.

7.5.2 COLLISION METHODS

7.5.2.1 Summary

29. The collision risk modelling (CRM) methods presented in the Original ES used the most up to date CRM available at the time of the assessment (Band, 2011). This was a preliminary version of the onshore CRM adapted for use offshore as part of The Crown Estate's Strategic Ornithological Support Services (SOSS) programme. Further development of this model continued after the analysis for the Original ES

was conducted. This made use of associated projects conducted for SOSS-2[1]. In this ES Addendum we have made use of these updated methods for estimating collision risk for seabirds observed in the Wind Farm area (hereafter we will refer to this as Band, 2012[2]). The collision risk mortality estimates presented in the Original ES are also included for comparison (the calculations and results from the Original ES have been reviewed and accepted by SNH). The updated CRM uses the same input data from the boat surveys, but uses the flight distribution data presented in Cook et al. (2012)[3]. This permits evaluation of collision risk in relation to observed, species specific flight heights.

30. Since most seabird fly close to the sea surface, and those which fly within the rotor swept will do so not far above the lower edge of the rotor, using more detailed flight height distributions can considerably reduce the estimated number of rotor transits.

31. In the most recent CRM spreadsheet[4] three options for estimating collision mortality are provided. Option 1 was the method used in the Original ES. This uses the proportion of birds at rotor height derived from the boat surveys of the site. Option 2 applies the same basic model, however the proportion of birds at risk height are derived from the large dataset of observations made from surveys conducted a 32 existing, proposed or consented offshore wind farms. Option 3 uses the species specific flight height distributions derived from the pooled survey data and permits much finer calculation of risk in relation to rotor height.

32. While it is generally recommended that survey specific flight height data be used for CRM, sparse data are likely to mean that it is necessary to assume a uniform distribution of flights across the entire rotor swept airspace. By using the pooled data collated and analysed by Cook et al., (2012) this assumption is relaxed and more realistic analysis based on a finer scale understanding of flying heights can be undertaken. As an illustration, the great black-backed gull CRM makes use of almost 10 times as many observations of flight height than were made on the Beatrice site.

33. The assessment of potential collision effects presented in this ES Addendum is based on option 3 of the updated CRM and therefore utilises the advances in flight height distributions this delivers. Consequently, for the species included in the CRM section of this ES Addendum (fulmar, gannet, kittiwake, great black-backed gull and herring gull) the assessment of effects replaces that in the Original ES (Sections 13.2.7.2 and 13.4.2.4). For the other species assessed for collision risks in

[1]Web reference: http://www.bto.org/science/wetland-and-marine/soss/projects (accessed on 16th May 2013)
[2]Web reference
http://www.bto.org/sites/default/files/u28/downloads/Projects/Final_Report_SOSS02_Band1ModelGuidance.pdf (accessed on 16th May 2013)
[3] Web reference:
http://www.bto.org/sites/default/files/u28/downloads/Projects/Final_Report_SOSS02_BTOReview.pdf
(accessed on 16th May 2013)
[4] Web reference:
http://www.bto.org/sites/default/files/u28/downloads/Projects/Final_Report_SOSS02_Band2Tool.xlsm
(accessed on 17th May 2013)

the Original ES (Arctic skua, great skua, Arctic tern, guillemot and razorbill) the original assessment has not been updated and results remain unchanged (Original ES Sections 13.2.7.2 and 13.4.2.4) Use of the above CRM was discussed and agreed with MSS (by email 21st May 2013).

34. An avoidance rate of 99% was used for all species in the Original ES and this rate has also been used for this ES Addendum. However, effects on the populations to be expected at an avoidance rate of 98% are also provided. Marine Scotland are undertaking a review of avoidance rates for offshore collision risk modelling, however this was not available (as of 21st May 2013) for reference in this ES Addendum. A note prepared by MacArthur Green detailing evidence to support the adoption of a minimum avoidance rate of 99% was submitted to MS-LOT, MSS and SNH in November 2012. This note is included in Annex 7C in lieu of guidance on this matter.

35. A final consideration for the interpretation of collision mortality estimates for offshore wind farms relates to the potential for biased observations. Many species are known to be attracted to boats, including gannets and gulls (Spear et al., 2004, Borberg et al., 2006). In a comparison of offshore density estimates of gannet obtained from boat and aerial surveys it was found that boat derived estimates were up to seven times higher than spatially and temporally comparable aerially derived ones (WWT, 2012). Consequently, the collision estimates should be treated as a precautionary guide to the potential level of mortality due to collisions with turbine rotors, since the level of seabirds activity may well be considerably lower than that recorded by the boat surveys.

7.5.3 POPULATION MODELLING

36. The stochastic population models developed for this ES Addendum seabird effect assessment followed best practice methods, as described in WWT (2012). The models were based on the best available demographic data (Table 7.3).

37. Closed populations were assumed since there is no information on rates of exchange (i.e. immigration and emigration) between the breeding colonies being assessed. Similarly there is no information on which to base density dependent population regulation, hence the models are density independent. While this is clearly unrealistic in the longer term, for the benefits of short term modelling of small populations, the risks from violating this assumption were considered to be small.

38. The populations were modelled on an annual time step, with one year age classes up to adults which are a multi-age class for all individuals of this age and older. Only the final age class breeds and the models were based on a post-breeding census structure (i.e. each census of the modelled population occurs immediately after the breeding season).

39. Environmental stochasticity was modelled using the mean rates and the standard deviations as listed in Table 7.3. Survival rates were drawn from a beta distribution, and brood sizes from a stretched beta distribution. These distributions were used as they generate random numbers with characteristics appropriate to the

demographic rates (i.e. survival rates between 0 and 1, and brood sizes which lie between pre-defined limits).

40. Demographic stochasticity on survival was modelled using a binomial process, whereby the number of individuals which survive from one time step to the next was estimated using a binomial function (Akcakaya, 1991). Thus, the number of individuals alive at time t+1 is generated by a 'coin-toss' process, using the number of individuals alive at time t and the randomly generated survival rate for that time step (as described in the preceding point).

41. NB: The difference between environmental and demographic stochasticity can be thought of as follows: Environmental stochasticity generates random values for the probability of survival from one time step to the next. Demographic stochasticity generates random numbers of individuals which survive from one time step to the next for any given survival probability. Thus environmental stochasticity models variable environments (e.g. weather effects) while demographic stochasticity models the effects of chance, which are increasingly important as the population size falls.

42. Additional mortality was applied to each age class in proportion to their presence in the population. In order to reflect the fact that collision mortality would be more likely to operate as a per capita rate, rather than an absolute value, the total number killed at each time step was proportional to the population size. Thus, additional mortality remained at the same proportional level relative to the population size throughout the simulation, whether the population increased or decreased.

43. Displacement effects were modelled by reducing the breeding population size by twice the number of individuals predicted to be displaced. This accounted for the worst case scenario whereby each displaced individual represents a failed pair (this was a necessary step as the models are based on individuals, not pairs).

44. For each modelled range of effects (collision or displacement), the median population growth rate, probabilities of population decline within the simulated period and proportions of simulation which were smaller than the baseline median final population size (i.e. that achieved in the absence of additional mortality) were calculated across all simulations (10,000).

Table 7.3: Demographic Rates used in the Seabird Populations Models.

Species (ref.)	Age at First Breeding	Mean survival rates (standard deviation)					Fledglings/pr.	Brood Size Range (min-max)
		Adult	Year 1	Year 2	Year 3	Year 4		
Fulmar[1,2,3]	9	0.972 (0.067) [applies to all age classes up to 8]					0.19 (0.126)	0 - 1
Gannet[4,5,6]	5	0.919 (0.012)	0.42 (0.079)	0.829 (0.031)	0.891 (0.031)	0.895 (0.031)	0.697 (0.035)	0 - 2
Kittiwake[7,8,9]	5	0.876 (0.035)	0.79 (0.1)	0.79 (0.05)	0.79 (0.05)	0.79 (0.05)	0.65 (0.098)	0 - 2
Herring Gull[3,8,10]	4	0.898 (0.017)	0.82 (0.07)			N/A	0.42 (0.28)	0 - 3
Great Black-Backed Gull[2,3,,8,11,12,13,14]	5	0.93 (0.025)	0.82 (0.03)				0.74 (0.297)	0 - 2
Guillemot[3,15,16]	5	0.965 (0.01)	0.56 (0.014)	0.792 (0.03)	0.917 (0.017)	0.938 (0.017)	0.335 (0.113)	0 - 2
Razorbill[3,8,15,17, 18]	4	0.9 (0.028)	0.937 (0.028)			N/A	0.38 (0.085)	0 - 2
Puffin[3,8,19]	5	0.924 (0.01)					0.345 (0.111)	0 - 2
1 – Dunnet and Ollason, 1978; 2 – Maclean et al., 2007; 3 – Mavor et al., 2008; 4 – Wanless et al., 2006a; 5 – Nelson 2002; 6 – WWT, 2012; 7 – Coulson and White, 1959; 8 – Robinson, 2005; 9 – Frederiksen et al., 2004; 10 – Wanless et al., 1996; 11 – Garthe and Huppop, 2004; 12 - Calladine and Harris, 1996; 13-Reeves and Furness, 2002; 14 – Poot et al., 2011; 15 - Harris et al., 2007; 16 - Birkhead and Hudson, 1977; 17 - Lloyd and Perrins, 1977; 18 – Chapdelaine, 1997; 19 - Harris et al., 1997								

45. The initial population sizes for each species used in the assessment of effects during the breeding season were set as the combined totals in Table 7.2, as these represent all populations within foraging range. For the non-breeding season assessment of collision effects (gannet, kittiwake, herring gull and great black-backed gull only) the population size used in the models will be provided in the relevant section.

46. The population models used for this assessment were stochastic and density independent. Discussion of population modelling at the meeting with SNH on 4th September 2012 concerned a request by SNH that the models should incorporate realistic recent population trends. This argument is based on the premise that the baseline model for any given species should generate predictions which match the recent trend in the population of interest. While this is a reasonable request, it presupposes that the underlying reasons for such trends have been studied and are well understood.

47. This is rarely the case. Most population models are, of necessity, based on demographic rates derived either from different populations or at some time in the past (or often both). Indeed in many instances there are few data on which to base the trends themselves. Population change occurs due to a wide range of factors, some intrinsic (i.e. population regulation through competition for resources, often referred to as density dependence), some extrinsic (e.g. weather conditions), and these two also interact so that intrinsic effects may be greater during periods of unfavourable weather. Without knowing the main drivers of such changes (which is usually the case), simply modifying the survival or reproductive rates in order

that the population model generates a prediction in line with the estimated population trend without understanding what has really caused observed changes has the potential to render the model very unreliable as a predictive tool. In addition, some population change may be due to movements of individuals between locations (i.e. immigration and emigration), unrelated to change in demographic rates.

48. In such circumstances, the most robust approach for modelling is to avoid the temptation to include density dependence, since this is likely to be based on the premise that 'it must be present, therefore we will apply it', even if the mechanism is unknown. Furthermore this highlights that the most appropriate means for considering model outputs is relatively; for example the *change* in the population growth rate predicted to occur as a result of a given effect, not the absolute rate of change itself which has a high likelihood off being inaccurate. In this way, the onus on the absolute reliability of the model is eased and instead focus is directed towards assessment of the relative magnitudes of a range of predicted effects.

49. The above points were made during the discussion with SNH at a meeting on 4th September 2012 and it was agreed that on consideration of the above it was reasonable and defendable to assess effects using density independent models.

7.5.3.1 Determination of Significance of Effects from Population Model Outputs

50. To determine if the predicted effects of displacement (for breeding populations of fulmar, gannet, kittiwake, guillemot, razorbill and puffin) and collision (for breeding populations of fulmar, gannet, kittiwake, great black-backed gull, herring gull and non-breeding populations of gannet, kittiwake, great black-backed gull and herring gull) presented in this ES Addendum were likely significant or not in terms of the EIA Regulations, the increase in the probability of triggering population declines predicted by the population models (relative to the baseline prediction) was used. Table 7.4 provides a guide to the thresholds applied and the level at which a likely significant effect was concluded.

Table 7.4: Thresholds of Increase in Risk of Probability of Decline Below Specific Threshold Population Sizes and Level at which Effects were Assessed as Likely Significant Effects.

Population Decline Relative to Baseline	Increase in Probability		
	>2	>5	>10
10	Non-likely significant	Non-likely significant	Likely significant
20	Non-likely significant	Likely significant	Likely significant
50	Likely significant	Likely significant	Likely significant

51. The above thresholds of significance were defined by JNCC and Natural England (NE) for use in the assessment of the potential effects on Sandwich tern due to the proposed Triton Knoll offshore wind farm. They represent alternative thresholds of risk rather than a sliding scale, hence the only distinction obtained is likely

significant / non-likely significant (in term of the EIA Regulations). For this assessment, a period of 25 years has been used for all population simulations as this represents a reasonable compromise between generating useful predictions and minimising the propagation of errors due to uncertainty in demographic rates used.

52. This approach differs from that used in the Original ES, where a matrix of magnitude of effect and receptor sensitivity was used to derive levels of significance. Since this approach is not readily adaptable to the probabilistic outputs obtained from a stochastic population model, an alternative means to assign significance of effect was required. The approach described here was discussed with MS, SNH and JNCC, and was agreed as appropriate for use in this ES Addendum.

53. The increase in the probability that the final population size (i.e. after 25 years) will be smaller than the median baseline one has also been provided on request by MSS. However, these have not been used in the assessment of significance since considering effects in this way has no precedence for offshore wind farms. Furthermore, considering effects in this manner considerably amplifies their apparent magnitude. This occurs because even a small effect, which may only reduce the population growth rate by a small amount, can result in a large increase in the probability the population will be less than the baseline median value. Indeed, any effect will cause the final population size to be smaller than that predicted in the absence of the effect, thus this approach is considered to be too sensitive for reliable and robust assessment of effects.

7.5.4 WORST CASE SCENARIO

54. The parameters which define the worst case scenario for birds are provided in Table 7.5. These represent the worst case for collision risk modelling (the greatest total rotor swept volume), displacement (the greatest number of most closely spaced turbines) and indirect effects (gravity bases affect the greatest area of substrate, potentially reducing sandeel habitat). With the exception of collision risk for gannets, the worst case scenario remains unchanged from that presented in Section 13.2.7 of the Original ES. For gannets the worst case turbine option for collision risk is updated in this ES Addendum to the 7MW turbine option presented in the Original ES (Section 7.3.3). This difference is due to the unusual flight distribution for this species, as reported by Cook et al. (2012), which shows a small secondary peak in numbers at 108m, combined with use of the most up to date CRM (Section 7.5.2) which models collision risk in relation to rotor size and hub height.

7.5.5 MOST LIKELY SCENARIO

55. The aspects of the most likely scenario of relevance to the ornithology effect assessment relate to the number and size of the turbines, and at time of submission was expected to comprise 140 turbines larger turbines (higher hub height and greater rotor radius).

56. The key features with regards to potential ornithological effects of the worst case and most likely scenarios are presented in Table 7.5.

Table 7.5: Summary of Worst Case Scenario and Most Likely Scenario Wind Farm Parameters.

<table>
<tr><th rowspan="2">Scenario</th><th rowspan="2">Effect</th><th rowspan="2">Species</th><th rowspan="2">Turbine Number</th><th colspan="2">Turbine Specification</th><th rowspan="2">Turbine Spacing (m)</th><th rowspan="2">Turbine Foundation</th></tr>
<tr><th>Hub Height (m)</th><th>Rotor Diameter (m)</th></tr>
<tr><td>Worst Case</td><td>Displacement</td><td>All</td><td>277</td><td>79</td><td>107.2</td><td>642</td><td rowspan="3">Gravity base</td></tr>
<tr><td rowspan="2">Worst Case</td><td rowspan="2">Collision</td><td>All (except Gannet)</td><td>277</td><td>79</td><td>107.2</td><td>642</td></tr>
<tr><td>Gannet</td><td>142</td><td>107.9</td><td>165</td><td>990</td></tr>
<tr><td>Most Likely</td><td>All</td><td>All</td><td>140</td><td>102.4</td><td>154</td><td>985</td><td>Pin piles</td></tr>
</table>

7.6 ASSESSMENTOF POTENTIAL EFFECTS

7.6.1 SUMMARY OF ASSESSMENTS OF EFFECTS

57. Table 7.6 provides a reference to where the assessment of effects for specific species can be located within the Original ES and this ES Addendum.

Table 7.6: Location of Assessment of Effect (Original ES or ES Addendum) for each Receptor and Effect for which Further Assessment was Required by SNH.

<table>
<tr><th></th><th colspan="4">Effect</th></tr>
<tr><th>Receptor</th><th>Displacement</th><th>Collision</th><th>Combined</th><th>Non-Breeding Season</th></tr>
<tr><td>Fulmar</td><td>Replaced: ES Addendum, Section 58</td><td>Replaced: ES Addendum, Section 7.6.3.1</td><td>Replaced: ES Addendum, Section 7.6.4.1</td><td>N/A</td></tr>
<tr><td>Gannet</td><td>Replaced: ES Addendum, Section 7.6.2.2</td><td>Replaced: ES Addendum, Section 7.6.3.2</td><td>Further: ES Addendum, Section 7.6.4.2</td><td>Replaced: ES Addendum, Section 7.6.5.1</td></tr>
<tr><td>Kittiwake</td><td>Updated: ES Addendum, Section 7.6.2.3</td><td>Updated: ES Addendum, Section 7.6.3.3</td><td>Further: ES Addendum, Section 7.6.4.3</td><td>Replaced: ES Addendum, Section 7.6.5.2</td></tr>
<tr><td>Arctic skua</td><td rowspan="4">N/A</td><td>Original ES, Section 13.4.2.5</td><td rowspan="5">N/A</td><td rowspan="2">N/A</td></tr>
<tr><td>Great skua</td><td>Original ES, Section 13.4.2.5</td></tr>
<tr><td>Herring gull</td><td>Updated: ES Addendum, Section 7.6.3.4</td><td>Replaced: ES Addendum, Section 7.6.5.3</td></tr>
<tr><td>Great black-backed gull</td><td>Updated: ES Addendum, Section 104</td><td>Replaced: ES Addendum, Section 7.6.5.4</td></tr>
<tr><td>Guillemot</td><td>Replaced: ES Addendum, Section 7.6.2.4</td><td>N/A</td><td>N/A</td></tr>
</table>

	Effect			
Receptor	Displacement	Collision	Combined	Non-Breeding Season
Razorbill	Replaced: ES Addendum, Section 7.6.2.5	N/A	N/A	N/A
Puffin	Replaced: ES Addendum, Section 7.6.2.6			

7.6.2 DISPLACEMENT

58. The Original ES assessed displacement effects on the following species which were present in high numbers during the breeding season surveys; fulmar, kittiwake, guillemot and razorbill. In this ES Addendum, the assessments for these species have been replaced (e.g. to account for turnover of individuals), as described in Section 7.5.1. MSS and SNH requested the addition of gannet and puffin to the species assessed, hence these are also included in the ES Addendum.

7.6.2.1 Fulmar

59. The peak mean abundance of fulmar recorded on the water and in flight within the Wind Farm Site and turbine buffer was 1,156. The tracking study revealed that this species made an average of 0.4 foraging trips per day (n=16, sd=0.22), lasting on average 12.6 hours. The stable age distribution generated by the population model gave a breeding adult percentage of 63%.

60. Thus the estimated total number of individuals at risk of displacement was calculated as:

(1156 /((12.6/0.4) /24))*0.628 = 3,457

Table 7.7: Number of Fulmar Pairs Predicted to Fail for Combinations of Percentage Displacement and Percentage Breeding Failure.

Percentage Displaced	Equivalent Radial Avoidance Distance (m) from Turbines Separated by 642m	Percentage Individuals Fail to Breed				
		10	25	50	75	100
10	114.5	35	86	173	259	346
20	162.0	69	173	346	519	691
30	198.4	104	259	519	778	1037
40	229.1	138	346	691	1037	1383
50	256.1	173	432	864	1296	1729
60	280.6	207	519	1037	1556	2074
70	303.0	242	605	1210	1815	2420

Percentage Displaced	Equivalent Radial	Percentage Individuals Fail to Breed				
80	324.0	277	691	1383	2074	2766
90	343.6	311	778	1556	2333	3111
100	362.2	346	864	1729	2593	3457

61. Fulmar is considered to be at very low risk of disturbance due to offshore wind farms (Garthe and Huppop, 2004, Furness et al., 2013), with a score of 1 (out of 5). This was converted to a percentage displacement of 20%. Therefore a maximum displacement percentage of 20% was combined with a maximum breeding failure of 100% to give a total number of pairs which fail to breed of 691 (Table 7.7).

62. At this level of displacement, the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.8 (Annex 7A, Figure 1; Annex 7B, Tables 1 and 2).

Table 7.8: Predicted Increase in Probabilities of Fulmar Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)	Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)
10	<0.001	0.014
20	0.018	0.001
50	<0.001	<0.001

63. Thus at this level of displacement, the additional risk (above that predicted in the absence of displacement) of the population declining by more than 10% was less than 0.1%, by more than 20% was 0.18% and of more than 50% by less than 0.1%.

64. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4 and therefore are not likely significant in terms of the EIA Regulations for this high sensitivity species. This replaces the assessment in the Original ES (Section 13.4.2.2: small magnitude, minor significance).

7.6.2.2 Gannet

The peak mean abundance of gannet recorded on the water and in flight within the Wind Farm Site and turbine buffer was 151. In a review of seabird foraging trip frequency (Masden et al., 2010) adult gannets were reported to undertake an average of 1 trip per day, lasting an average of 19.3 hours (seabird.wikispaces.com). The stable age distribution generated by the population model gave a breeding adult percentage of 60%.

65. Thus the estimated total number of individuals at risk of displacement was calculated as:

(151 /((19.3/1) /24))*0.6 = 113

Table 7.9: Number of Gannet Pairs Predicted to Fail for Combinations of Percentage Displacement and Percentage Breeding Failure.

Percentage Displaced	Equivalent Radial Avoidance Distance (m) from Turbines Separated by 642m	Percentage Individuals Fail to Breed				
		10	25	50	75	100
10	114.5	1	3	6	8	11
20	162.0	2	6	11	17	23
30	198.4	3	8	17	25	34
40	229.1	5	11	23	34	45
50	256.1	6	14	28	42	57
60	280.6	7	17	34	51	68
70	303.0	8	20	40	59	79
80	324.0	9	23	45	68	90
90	343.6	10	25	51	76	102
100	362.2	11	28	57	85	113

66. Gannet is considered to be at low risk of disturbance due to offshore wind farms (Garthe and Huppop, 2004, Furness et al., 2012), with a score of 2 (out of 5). However SNH advised that they consider gannet to be at greater risk of disturbance by offshore wind farms than this, therefore a score of 3 was adopted, which was converted to a percentage displacement of 60%. Therefore, a maximum displacement percentage of 60% was combined with a maximum breeding failure of 100% to give a total number of pairs which fail to breed of 68 (Table 7.9).

67. At this level of displacement, the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.10 (Annex 7A, Figure 2; Annex 7B Tables 3 and 4).

Table 7.10: Predicted Increase in Probabilities of Gannet Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)	Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)
10	0	0.001
20	0	<0.001
50	0	0

68. Thus at this level of displacement there was no additional risk (above that predicted in the absence of displacement) of the population declining below the 10%, 20% or 50% thresholds.

69. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore the effect is not likely significant in terms of the EIA Regulations for this high sensitivity species. Gannet were not assessed for displacement effects in the Original ES, therefore this assessment is further to the Original ES ornithology assessment.

7.6.2.3 Kittiwake

70. The peak mean abundance of kittiwake recorded on the water and in flight within the Wind Farm Site and turbine buffer was 786. The tracking study revealed that this species made an average of 0.8 foraging trips per day (n=19, sd=0.29), lasting an average of 13.3 hours. The stable age distribution generated by the population model gave a breeding adult percentage of 54%.

71. Thus the estimated total number of individuals at risk of displacement was calculated as:

$$(786 / ((13.3/0.8) / 24))*0.54 = 961$$

Table 7.11: Number of Kittiwake Pairs Predicted to Fail for Combinations of Percentage Displacement from the Wind Farm Site and Percentage Breeding Failure.

Percentage Displaced	Equivalent Radial Avoidance Distance (m) from Turbines Separated by 642m	Percentage Individuals Fail to Breed				
		10	25	50	75	100
10	114.5	*10*	*24*	*48*	*72*	*96*
20	162.0	*19*	*48*	*96*	*144*	*192*
30	198.4	*29*	*72*	*144*	*216*	*288*
40	229.1	*38*	*96*	*192*	*288*	*384*
50	256.1	*48*	*120*	*240*	*360*	*481*
60	280.6	*58*	*144*	*288*	*432*	*577*
70	303.0	*67*	*168*	*336*	*505*	*673*
80	324.0	*77*	*192*	*384*	*577*	*769*
90	343.6	*86*	*216*	*432*	*649*	*865*
100	362.2	*96*	*240*	*481*	*721*	*961*

72. Kittiwake is considered to be at low risk of disturbance due to offshore wind farms (Garthe and Hüppop, 2004, Furness et al., 2013), with a score of 2 (out of 5). This was converted to a percentage displacement of 40%. Therefore a maximum displacement percentage of 40% was combined with a maximum breeding failure of 100% to give a total number of pairs which fail to breed of 384 (Table 7.11).

73. At this level of displacement, the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.12 (Annex 7A, Figure 3; Annex 7B, Tables 5 and 6).

Table 7.12: Predicted Increase in Probabilities of Kittiwake Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)	Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)
10	0.0019	0.023
20	<0.001	0.011
50	0	<0.001

74. Thus at this level of displacement, the additional risk (above that predicted in the absence of displacement) of the population declining by more than 10%, 20% or 50% was less than 0.2%.

75. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore the effect is not likely significant in terms of the EIA Regulations for this high sensitivity species. This replaces the assessment in the Original ES (Section 13.4.2.2: negligible magnitude, negligible significance).

7.6.2.4 Guillemot

76. The peak mean abundance of guillemot recorded on the water and in flight within the Wind Farm Site and turbine buffer was 5,187. The tracking study revealed that this species made an average of 0.66 foraging trips per day (n=21, sd=0.27) lasting an average of 13.7 hours. The stable age distribution generated by the population model gave a breeding adult percentage of 73%. Thus the estimated total number of individuals at risk of displacement was calculated as:

(5187 / ((13.7/0.66) /24))*0.73 = 10,023

Table 7.13: Number of Guillemot Pairs Predicted to Fail for Combinations of Percentage Displacement from the Wind Farm Site and Percentage Breeding Failure.

Percentage Displaced	Equivalent Radial Avoidance Distance (m) from Turbines Separated by 642m	Percentage Individuals Fail to Breed				
		10	25	50	75	100
10	114.5	*100*	*251*	*501*	*752*	*1002*
20	162.0	*200*	*501*	*1002*	*1503*	*2005*
30	198.4	*301*	*752*	*1503*	*2255*	*3007*
40	229.1	*401*	*1002*	*2005*	*3007*	*4009*
50	256.1	*501*	*1253*	*2506*	*3759*	*5012*
60	280.6	*601*	*1503*	*3007*	*4510*	*6014*
70	303.0	*702*	*1754*	*3508*	*5262*	*7016*
80	324.0	*802*	*2005*	*4009*	*6014*	*8018*
90	343.6	*902*	*2255*	*4510*	*6766*	*9021*
100	362.2	*1002*	*2506*	*5012*	*7517*	*10023*

77. Guillemot is considered to be at moderate risk of disturbance due to offshore wind farms (Garthe and Huppop, 2004, Furness et al., 2013), with a score of 3 (out of 5). This was converted to a percentage displacement of 60%. Therefore a maximum displacement percentage of 60% was combined with a maximum breeding failure of 100% to give a total number of pairs which fail to breed of 6,014 (Table 7.13).

78. At this level of displacement, the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.14 (Annex 7A, Figure 4; Annex 7B, Tables 7 and 8).

Table 7.14: Predicted Increase in Probabilities of Guillemot Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)	Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)
10	<0.001	0.17
20	0	0.043
50	0	0

79. Thus at this level of displacement, there was no additional risk (above that predicted in the absence of displacement) of the population declining by more than 10%, 20% or 50%.

80. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is not assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.4.2.2: negligible magnitude, negligible significance).

7.6.2.5 Razorbill

81. The peak mean abundance of razorbill recorded on the water and in flight within the Wind Farm Site and turbine buffer was 880. The tracking study revealed that this species made an average of 1.04 foraging trips per day (n=18, sd=0.35), lasting an average of 10.9 hours. The stable age distribution generated by the population model gave a breeding adult percentage of 69%.

82. Thus the estimated total number of individuals at risk of displacement was calculated as:

$$(880 / ((10.9/1.04) /24))*0.69= 1,280$$

Table 7.15: Number of Razorbill Pairs Predicted to Fail for Combinations of Percentage Displacement from the Wind Farm Site and Percentage Breeding Failure.

Percentage Displaced	Equivalent Radial Avoidance Distance (m) from Turbines Separated by 642m	Percentage Individuals Fail to Breed				
		10	25	50	75	100
10	114.5	*13*	*32*	*64*	*96*	*128*
20	162.0	*26*	*64*	*128*	*192*	*256*
30	198.4	*38*	*96*	*192*	*288*	*384*
40	229.1	*51*	*128*	*256*	*384*	*512*
50	256.1	*64*	*160*	*320*	*480*	*640*
60	280.6	*77*	*192*	*384*	*576*	*768*
70	303.0	*90*	*224*	*448*	*672*	*896*
80	324.0	*102*	*256*	*512*	*768*	*1024*
90	343.6	*115*	*288*	*576*	*864*	*1152*
100	362.2	*128*	*320*	*640*	*960*	*1280*

83. Razorbill is considered to be at moderate risk of disturbance due to offshore wind farms (Garthe and Hüppop, 2004, Furness et al., 2013), with a score of 3 (out of 5). This was converted to a percentage displacement of 60%. Therefore a maximum displacement percentage of 60% was combined with a maximum breeding failure of 100% to give a total number of pairs which fail to breed of 768 (Table 7.15).

84. At this level of displacement, the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.16 (Annex 7A, Figure 5; Annex 7B, Tables 9 and 10).

Table 7.16: Predicted Increase in Probabilities of Razorbill Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)	Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)
10	<0.001	0.388
20	0	0.31
50	0	0.003

85. Thus at this level of displacement, the additional risk (above that predicted in the absence of displacement) of the population declining by more than 10% was less than 0.1% and there was no risk of declines by more than 20% or 50%.

86. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect in terms of the EIA Regulations is assessed for this high sensitivity species. This replaces the assessment in the Original ES (Section 13.4.2.2: small magnitude, minor significance).

7.6.2.6 Puffin

87. The peak mean abundance of puffin recorded on the water and in flight within the Wind Farm Site and turbine buffer was 1603. There have been very few tracking studies of puffins, therefore empirical data are limited for this species. In a review of seabird foraging trip frequency (Masden et al., 2010) adult puffin were reported to undertake an average of 3 trips per day. A study on the Isle of May (Harris et al., 2012) found that tagged puffin undertook long (15-41 hours) and short trips (0.7-3.8 hours). Furness and Tasker (2000) reported that puffin have comparatively little spare time during chick rearing, and thus spend much of their time foraging. Combining the estimated 3 trips per day with the activity budget information and the foraging information, an average trip duration of 7 hours was estimated. This would give individuals a maximum of 3 hours non-foraging time per day. The stable age distribution generated by the population model gave a breeding adult percentage of 65%.

88. Thus the estimated total number of individuals at risk of displacement was calculated as:

$$(1603 / ((7/3) /24))*0.65= 1,196$$

Table 7.17: Number of Puffin Pairs Predicted to Fail for Combinations of Percentage Displacement from the Wind Farm Site and Percentage Breeding Failure.

Percentage Displaced	Equivalent Radial Avoidance Distance (m) from Turbines Separated by 642m	Percentage Individuals Fail to Breed				
		10	25	50	75	100
10	114.5	*12*	*30*	*60*	*90*	*120*
20	162.0	*24*	*60*	*120*	*179*	*239*
30	198.4	*36*	*90*	*179*	*269*	*359*
40	229.1	*48*	*120*	*239*	*359*	*478*
50	256.1	*60*	*150*	*299*	*449*	*598*
60	280.6	*72*	*179*	*359*	*538*	*718*
70	303.0	*84*	*209*	*419*	*628*	*837*
80	324.0	*96*	*239*	*478*	*718*	*957*
90	343.6	*108*	*269*	*538*	*807*	*1076*
100	362.2	*120*	*299*	*598*	*897*	*1196*

89. Puffin is considered to be at low risk of disturbance due to offshore wind farms (Garthe and Hüppop, 2004, Furness et al., 2013), with a score of 2 (out of 5). This was converted to a percentage displacement of 40%. Therefore a maximum displacement percentage of 40% was combined with a maximum breeding failure of 100% to give a total number of pairs which fail to breed of 478 (Table 7.17).

90. At this level of displacement, the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.18 (Annex 7A, Figure 6; Annex 7B, Tables 11 and 12).

Table 7.18: Predicted Increase in Probabilities of Puffin Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)	Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)
10	<0.001	0.60
20	0	0.53
50	0	0.002

91. Thus at this level of displacement, the additional risk (above that predicted in the absence of displacement) of the population declining by more than 10% was less than 0.1% and there was no risk of declines by more than 20% or 50%.

92. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect in terms of the EIA Regulations is assessed for this high sensitivity species. Puffin was not assessed for displacement effects in the Original ES, therefore this assessment is further to the Original ES ornithology assessment.

7.6.3 COLLISION EFFECTS

93. SNH reviewed the CRM data and results presented in the Original ES and confirmed they were correct (these were equivalent to option 1 in the most recent CRM method). The updated CRM presented in the ES Addendum uses the same survey data. However, flight height data for the revised assessment presented here were taken from Cook et al. (2012), which collated survey data across more than 30 wind farm sites. These data have been used to estimate collision risk using both Option 2 (same as Option 1, but uses more data to estimate the percentage of flights at risk height) and Option 3 (using all the available flight data to estimate collisions). The latter (Options 3) results are used in this assessment of effects and are presented alongside those obtained from Option 1 (Original ES) and also Option 2 for comparative purposes.

94. The potential effects of the estimated mortality levels on the breeding populations of each species assessed have been assessed in this ES Addendum using stochastic population models.

95. The following section presents the collision estimates from the Original ES (Option 1), and those obtained using Options 2 and 3, and the predicted increase in the probabilities of population decline obtained from the stochastic population models for fulmar, gannet, kittiwake, herring gull and great black-backed gull which result from the CRM Option 3 predictions. The outputs from the population models have been used to update the collision assessment in this ES Addendum for these species. Stochastic population models were not requested by SNH and MSS for any other species, therefore the collision assessments for Arctic skua, Great skua and Arctic tern remain unchanged from those in the Original ES (Section 13.4.2.5; note however that the original collision estimates for these species used Option 1 and thus would be expected to decrease under Option 3). Furthermore, the auk species were not reassessed since very low numbers of collisions were predicted for these species (primarily due to their low flight heights) and therefore there were no changes to the Original ES collision assessments for these species.

7.6.3.1 Fulmar

Table 7.19: 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
	Band (2007)	Breeding	799	16	8	4	1
	Band (2011) Option 1	Annual	2675	53	27	13	3
	Band (2011) Option 1	Breeding	1114	22	11	6	1
	Band (2012) Option 2	Annual	1030	21	10	5	1
	Band (2012) Option 2	Breeding	430	9	4	2	<1
	Band (2012) Option 3	Annual	633	13	6	3	1
	Band (2012) Option 3	Breeding	264	5	3	1	<1

96. The breeding season collision mortality (3 at 99% avoidance, 5 at 98% avoidance;) generated no detectable increase in the risk of population decline due to the very low numbers of collisions at either avoidance rate in relation to the population size (Table 7.19, Annex 7A, Figure 7; Annex 7B, Tables 13 and 14).

97. All of the increases in the risk of population decline obtained at an avoidance rate of 99% were below the thresholds defined in Table 7.4. Therefore a non-likely significant effects in terms of the EIA Regulations is assessed for this high sensitivity species. This replaces the assessment in the Original ES (Section 13.4.2.5: negligible magnitude, negligible significance).

7.6.3.2 *Gannet*

Table 7.20: 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
	Band (2007)	Breeding	3267	65	33	16	3
	Band (2011) Option 1	Annual	8686	174	87	43	9
	Band (2011) Option 1	Breeding	3583	72	36	18	4
	Band (2012) Option 2	Annual	1783	36	18	9	2
	Band (2012) Option 2	Breeding	736	15	7	4	1
	Band (2012) Option 3	Annual	2107	42	21	11	2
	Band (2012) Option 3	Breeding	869	17	9	4	1

98. The breeding season collision mortality (9 at 99% avoidance, 17 at 98% avoidance; Table 7.20) generated probabilities of an increase in the risk of population decline of less than 0.1% for all thresholds (Table 7.21, Annex 7A, Figure 8; Annex 7B, Tables 15 and 16).

Table 7.21: Predicted Increase in Probabilities of Gannet Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collisions on the Wind Farm site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	<0.001	<0.001	<0.001	<0.001
20	<0.001	<0.001	<0.001	<0.001
50	0	0	0	0

99. All of the increases in the risk of population decline obtained at an avoidance rate of 99% were below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species. This replaces the

assessment in the Original ES (Section 13.4.2.5: negligible magnitude, negligible significance).

7.6.3.3 Kittiwake

Table 7.22: 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
	Band (2007)	Breeding	4477	89	45	22	4
	Band (2011) Option 1	Annual	13166	263	132	66	13
	Band (2011) Option 1	Breeding	6200	124	62	31	6
	Band (2012) Option 2	Annual	6670	133	67	33	7
	Band (2012) Option 2	Breeding	3148	63	31	16	3
	Band (2012) Option 3	Annual	2210	44	22	11	2
	Band (2012) Option 3	Breeding	1043	21	10	5	1

100. The breeding season collision mortality (10 at 99% avoidance, 21 at 98% avoidance; Table 7.22) generated probabilities of an increase in the risk of population decline of less than 0.2% for all thresholds (Table 7.23, Annex 7A, Figure 9; Annex 7B, Tables 17 and 18).

Table 7.23: Predicted Increase in Probabilities of Kittiwake Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collisions on the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	0.001	0.002	0.003	0.002
20	<0.001	<0.001	0.002	<0.001
50	0	0	<0.001	<0.001

101. All of the increases in the risk of population decline obtained at an avoidance rate of 99% were below the thresholds defined in Table 7.4. Therefore a non-likely

significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.4.2.5: negligible magnitude, negligible significance).

7.6.3.4 Herring Gull

Table 7.24: 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
	Band (2007)	Breeding	2,024	40	20	10	2
	Band (2011) Option 1	Annual	49,353	987	494	247	49
	Band (2011) Option 1	Breeding	2,927	59	29	15	3
	Band (2012) Option 2	Annual	28656	573	287	143	29
	Band (2012) Option 2	Breeding	1698	34	17	8	2
	Band (2012) Option 3	Annual	16867	337	169	84	17
	Band (2012) Option 3	Breeding	1000	20	10	5	1

102. The breeding season collision mortality (10 at 99% avoidance, 20 at 98% avoidance; Table 7.24) generated small probabilities of an increase in the risk of population decline (Table 7.25, Annex 7A, Figure 10; Annex 7B, Tables 19 and 20).

Table 7.25 Predicted Increase in Probabilities of Herring Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collisions on the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	0.015	0.008	0.04	0.02
20	0.012	0.006	0.03	0.017
50	<0.001	<0.001	0.006	0.003

103. Thus the additional risk (above that predicted in the absence of displacement) of the population declining by more than 10% was 0.8%, by more than 20% was 0.6% and of more than 50% was less than 0.1%.

104. All of the increases in the risk of population decline were below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.4.2.5: small magnitude, minor significance).

7.6.3.5 Great Black-Backed Gull

Table 7.26: 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
	Band (2007)	Breeding	4264	85	43	21	4
	Band (2011) Option 1	Annual	30186	604	302	151	30
	Band (2011) Option 1	Breeding	6154	123	62	31	6
	Band (2012) option 2	Annual	20621	412	206	103	21
	Band (2012) option 2	Breeding	4199	84	42	21	4
	Band (2012) option 3	Annual	11929	239	119	60	12
	Band (2012) option 3	Breeding	2429	49	24	12	2

105. The estimated levels of breeding season collision mortality were 24 at 99% avoidance and 49 at 98% avoidance (Table 7.26) However, the number of breeding birds estimated to be in collision during the breeding season is almost certainly much smaller than these estimates. Over 20 % of great black-backed gulls observed during the boat surveys were aged (as either adults or immature birds) on the basis of plumage. Across all surveys the percentage of adult birds (i.e. breeding birds) was 39.5% while during the breeding months (May – August inc.) this was 37.5%. Therefore, only 37.5% of the individuals at risk of collision would be expected to be breeding adults, which equates to 9 individuals at 99% avoidance and 18 at 98% avoidance.

106. Furthermore, a proportion of these adults are likely to be non-breeding individuals. Compared to other seabird species such as skuas (Catry et al., 1998) and auks (Harris and Wanless, 1994), gulls typically have relatively large proportions of non-

breeders in a population. Calladine and Harris (1996) estimated that within a lesser black-backed gull colony at the Isle of May, east of Scotland, 34% of adults in 1993, and 40% in 1994 did not breed. This was considered to be a 'normal' period, unaffected by culling measures which occurred in some other years. These results are similar to those from other studies of gull populations. Kadlec and Drury (1968) estimated that 15-30% of adult North American herring gulls did not breed in any one year, and Pugesek and Diem (1990) estimated that 36% of Californian gulls did not breed in any given year. Samuels and Ladino (1984) estimated that 45% of herring gulls did not breed in a North American study.

107. It could therefore be reasonably concluded that as a conservative estimate, for every two breeding birds recorded, another non-breeding individual is present within the population. Since the breeding population estimate is based on breeding pairs, this effectively increases the East Caithness Cliffs SPA population from 350 individuals to around 525. This would mean that approximately one in three adult birds at risk of collision would be a non-breeder, assuming that all birds from the SPA use the site equally. In reality it is very likely that the proportion of non-breeders encountered will increase with distance offshore, since these individuals are not constrained by the demands of incubation and feeding chicks. Therefore non-breeders are more likely to spend longer periods of time farther away from the colony, and range more widely than breeders.

108. The predicted additional probabilities of population decline within 25 years relative to the baseline (no collision) and the predicted probabilities that the population will be smaller than the baseline after 25 years on the basis of mortality levels of 18 individuals (at 98% avoidance) and 9 individuals (at 99% avoidance) are provided in Table 7.27.

109. The breeding season collision mortality (9 at 99% avoidance, 18 at 98% avoidance) generated small increases in the probability of a population decline (Table 7.27, Annex 7A, Figure 11; Annex 7B, Tables 21 and 22). Thus at this level of collisions (at 99% avoidance), the additional risk (above that predicted in the absence of collisions) of a population decline of 10% was 1.5%, the increase in risk of a 20% decline was 0.1% and of a 50% decline was zero.

Table 7.27: Predicted Increase in Probabilities of Great Black-Backed Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collisions on the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	0.042	0.0148	0.589	0.389
20	0.006	0.001	0.661	0.365
50	0	0	0.334	0.079

110. All of the increases in the risk of population decline predicted at an avoidance rate of 99% were below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.4.2.5: small magnitude, minor significance).

111. It should be noted that the model predicts there to be a high risk of the population being smaller after 25 years due to collisions than in the absence of collisions (Table 7.27). This reflects the reduction in the population growth rate which occurs with increasing mortality. Thus, the population is predicted to increase at a lower rate due to collisions, which inevitably means the population size will be smaller after 25 years, hence the high probabilities in Table 7.27. However, the model predicts that growth remains positive on average until annual mortality exceeds 70 (and in 95% of simulations until mortality exceeds 50, Annex 7A, Figure 11). Thus these high increases in the probabilities of the population size being smaller after 25 years do not necessarily reflect population reduction, but rather slower potential growth.

7.6.4 COMBINED EFFECTS DURING THE BREEDING SEASON

112. SNH requested the inclusion of assessment of combined effects for those species assessed as at risk of both collision mortality and displacement during the breeding season. This is further to the assessment of effects presented in the Original ES.

113. Species assessed as at risk of displacement were fulmar, gannet, kittiwake, guillemot, razorbill and puffin. Species assessed as at risk of collision were: fulmar, sooty shearwater, gannet, shag, Arctic skua, Great skua, kittiwake, Great black-backed gull, herring gull, Arctic tern, guillemot and razorbill, although the predicted collision values for the two auk species were very low (guillemot: 13 per year at 99% avoidance; razorbill: 1 per year at 99% avoidance), and these species are therefore not considered to be at risk of combined effects. Hence combined assessment of effect is presented for fulmar, gannet and kittiwake.

114. The period considered for combined effects was the breeding season, since this is the only time when displacement is predicted to be of importance and the

individuals at risk of collision can be plausibly attributed to a breeding colony. Outside the breeding season collision mortality has the potential to be distributed amongst a much wider population, including passage migrants, the majority of which are unlikely to be at risk of breeding season displacement due to being beyond foraging range of their breeding colonies.

The assessment was undertaken using the same population models developed for the displacement assessment; displacement was modelled as reduced reproduction (as before) and collision mortality as reduced numbers of individuals. The mortality was applied in proportion to the age classes present in the population (i.e. collision mortality was not considered to be biased towards any particular age class). The number of individuals removed at each time step was also converted to a proportion, such that collision mortality remained at the same level relative to the population size.

7.6.4.1 Fulmar

115. Combining the breeding season collision mortality (3 at 99% avoidance, 5 at 98% avoidance; Table 7.19) with the predicted number of displaced breeding individuals (691, Table 7.8) the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement or collision) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.28.

Table 7.28: Predicted Increase in Probabilities of Fulmar Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from, and Collisions on, the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement and Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement and Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	<0.001	0.002	0.014	0.018
20	0.001	<0.001	0.011	0.014
50	<0.001	<0.001	<0.001	<0.001

116. Thus at this level of combined displacement and collision mortality (at an avoidance rate of 99%), the additional risk (above that predicted by the baseline model) of a population decline of 10% was 0.2%, of a decline of 20% was less than 0.1% and of a 50% decline was less than 0.1%.

117. All of the increases in the risk of population decline were below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations.

7.6.4.2 Gannet

118. Combining the breeding season collision mortality (9 at 99% avoidance, 17 at 98% avoidance; Table 7.20) with the predicted number of displaced breeding individuals (68, Table 7.9) the predicted change in population growth rate is given in Table 7.29.

Table 7.29: Predicted Increase in Probabilities of Gannet Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from, and Collisions on, the Wind Farm Site. .

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement and Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement and Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	0	0	0.001	0.003
20	0	0	<0.001	0.001
50	0	0	0	0

119. Thus at the predicted level of combined displacement and collision mortality (at an avoidance rate of 99%), there was no predicted risk of population decline below the 10%, 20% and 50% thresholds.

120. All of the increases in the risk of population decline were below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations.

7.6.4.3 Kittiwake

121. Combining the breeding season collision mortality (10 at 99% avoidance, 21 at 98% avoidance; Table 7.22) with the predicted number of displaced breeding individuals (385, Table 7.11) the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement or collision) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.30.

Table 7.30: Predicted Increase in Probabilities of Kittiwake Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from, and Collisions on, the Wind Farm Site.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement and Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement and Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	0.001	<0.001	0.022	0.037
20	<0.001	<0.001	0.008	0.016
50	0	<0.001	<0.001	<0.001

122. Thus at this level of combined displacement and collision mortality (at an avoidance rate of 99%), the additional risk (above that predicted by the baseline model) of a population decline of 10% was of less than 0.1%, of a decline of 20% was less than 0.1% and of a 50% decline was less than 0.1%.

123. All of the increases in the risk of population decline were below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations.

7.6.5 EFFECTS DURING THE NON-BREEDING SEASON

124. SNH requested the inclusion of assessment of collision effects outside the breeding season for those species assessed as at risk of collisions during this period. This is further to the assessment of effects presented in the Original ES. In agreement with SNH and MSS, no equivalent for displacement during the non-breeding season was considered necessary since seabirds are not constrained to the same extent outside the breeding season and therefore displacement effects are considered to be negligible.

125. Outside the breeding season seabirds typically disperse away from their breeding colonies. Some may remain in the region (e.g. black guillemot), while others may travel considerable distances (e.g. gannet). For the assessment of non-breeding season effects, for each species under consideration (gannet, kittiwake, herring gull and great black-backed gull) data on movements was used to estimate the total population against which collision effects were then assessed.

7.6.5.1 Gannet

126. Recent studies of gannet which breed at colonies around the British coast has found that none of the individuals tagged has remained in the North Sea over winter (WWT, 2012). This is supported by the very low numbers of gannet observed during boat surveys of the Wind Farm Site. Furthermore, birds present in winter are expected to originate from colonies further north, particularly from Norway. While birds tracked from the Bass Rock in the Firth of Forth head south for the

winter, a significant proportion (c. 40% in autumn and 70% in spring) travel round the north of Scotland and therefore may pass through the Wind Farm Site on passage.

127. Migration months (February to April and October to November) coincided with the peaks in predicted collisions, reflecting the patterns described above. Consequently, the number of birds at risk of collisions is likely to include the breeding populations assessed for the breeding season, plus birds from locations farther away which may pass through the Moray Firth. At the very least this will include a proportion of birds from the Bass Rock (48,000 pairs in 2004; WWT, 2012). Only including the breeding adults from this population, and applying the autumn northward passage proportion of 40% (Table 7.20) this would add 38,000 individuals to the population at risk.

128. The non-breeding season mortality estimate was 13 individuals (at 99% avoidance). Mortality of 9 assessed against a smaller population generated no likely significant effects, thus a mortality of 13 against a considerably larger population would also not generate a likely significant effect, and no further assessment was considered necessary.

129. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations.

7.6.5.2 Kittiwake

130. A tracking study of kittiwake has revealed that a large proportion of birds which breed in north western Europe spend their winters in the west Atlantic to the south of Newfoundland (Frederiksen et al., 2012). Furthermore, of the birds which remain in the North Sea over winter, only 45% originate from North Sea breeding colonies, with large influxes from colonies in the Barents Sea and Norwegian Sea. In total, 255,000 kittiwakes were estimated to be present in the North Sea over winter. No further sub-division is provided for these birds. This total is almost twice that used in the collision effects assessment for the breeding period. This assessment found no likely significant effect from a collision mortality of 10 individuals. Therefore, since the annual collision rate for kittiwake was 22 (at 99% avoidance), of which 12 occurred outside the breeding season (Table 7.22), and the population at risk is considerably larger than during the breeding season, no likely significant effects are predicted and no further assessment was considered necessary.

131. Therefore a non-likely significant effect in terms of the EIA Regulations is assessed for this high sensitivity species.

7.6.5.3 Herring Gull

132. During mid-winter herring gulls originating from Scandinavian colonies are known to be present along the east coast of the UK (Wright et al., 2012). A study conducted in the early 1980s in north east England found that around 30% of the birds present in November to February were of Scandinavian origin (Coulson et al., 1984). These months coincide with the peak months for estimated collisions; 80% of the annual

mortality was predicted during this period. The Norwegian population was estimated at between 150,000 and 200,000 in 2003 (Mitchell et al., 2004).

133. Outside the breeding season, British breeding herring gulls make comparatively smaller movements, however within the Moray Firth region there were an estimated 14,742 pairs at the time of the last census (Mitchell et al., 2004; sites include Orkney, Caithness, east coast Sutherland, east coast Ross & Cromarty, Inverness, Nairn, Moray and Banff and Buchan). Adding on Shetland birds increases this to 18,769, and given the northerly location it seems reasonable to assume that birds which breed here may move south in winter in a similar manner to Norwegian birds. If the proportions found previously (for Scandinavian birds in the UK) still apply, then the wintering population may be 30% larger again at 24,400. The reference population assessed for effects during the breeding season would represent approximately 20% of this total (9,980 pairs).

134. Using the non-breeding season collision mortality (159 at 99% avoidance, 317 at 98% avoidance; Table 7.24, Annual minus Breeding) generated small probabilities of an increase in the risk of population decline (Table 7.31, Annex 7A, Figure 12; Annex 7B, Tables 23 and 24).

Table 7.31: Predicted Increase in Probabilities of Herring Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collisions on the Wind Farm Site during the Non-Breeding Season.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	0.059	0.033	0.095	0.048
20	0.038	0.017	0.09	0.049
50	<0.001	<0.001	0.031	0.014

135. Thus at this level of collisions during the non-breeding season (at an avoidance rate of 99%), the increase in the probability of a population decline (above that predicted in the absence of collisions) by 10% was 3.3%, by 20% was 1.7% and by 50% was less than 0.1%.

136. All of the increases in the risk of population decline were below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations.

7.6.5.4 Great Black-Backed Gull

137. During winter great black-backed gull originating from Scandinavia are known to be present along the east coast of the UK (Wright et al., 2012). Indeed, Coulson et al. (1984) stated that almost all adults of this species present in north-eastern

England in winter are of Scandinavian origin. This pattern of movement matches the months when most birds were observed on the boat surveys and consequently a large proportion of the mortality; 64% was predicted to occur between September and February. The Norwegian population was estimated at 40,000 pairs in the early 1990s (Mitchell et al., 2004).

138. Outside the breeding season, British breeding great black-backed gulls make comparatively smaller movements, however within the Moray Firth region there were an estimated 8,864 pairs at the time of the last census (Mitchell et al., 2004; sites include Shetland, Orkney, Caithness, east coast Sutherland, east coast Ross & Cromarty, Inverness, Nairn, Moray and Banff and Buchan). It is not known what proportion of the populations from Scandinavia winter in Britain, however given the large numbers previously estimated to originate from these regions (Coulson et al., 1984) and that Birdlife[5] estimate the UK winter population at 43,000 individuals, a conservative estimate of the number of Norwegian origin which may pass through the Moray Firth in winter was taken as 10% of the population. Thus, combining the Moray Firth breeding birds (17,728 individuals) and 10% of the Norwegian ones (8,000 individuals), a total population of 25,728 was used for assessing non-breeding season collision effects. The reference population against which effects during the breeding season have been assessed would represent approximately 1.5% of this total (406 pairs).

139. Using the non-breeding season collision mortality (95 at 99% avoidance, 190 at 98% avoidance; Table 7.26, annual minus breeding season) generated small probabilities of an increase in the risk of population decline (Table 7.32, Annex 7A, Figure 13; Annex 7B, Tables 25 and 26).

Table 7.32: Predicted Increase in Probabilities of Great Black-Backed Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collisions on the Beatrice site during the Non-Breeding Season.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)		Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)	
	Avoidance Rate		Avoidance Rate	
	98%	99%	98%	99%
10	0.007	<0.001	0.129	0.062
20	0	<0.001	0.106	0.051
50	0	0	0.008	0.002

140. Thus at this level of collisions during the non-breeding season (at an avoidance rate of 99%), the increase in the probability of a population decline (above that predicted

[5] Web Reference: http://www.birdlife.org/datazone/userfiles/file/Species/BirdsInEuropeII/BiE2004Sp3220.pdf (accessed 30th April 2013).

in the absence of collisions) by 10% was 0.5%, by 20% was less than 0.1% and was zero for a decline of 50%.

141. All of the increases in the risk of population decline were below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations.

7.6.6 CONSIDERATION OF THE MOST LIKELY SCENARIO

142. Section 4: Amended Project Description presents the most likely scenario for the Amended Project. The key differences between the worst case scenarios and most likely scenario with respect to potential bird effects relate to the size and number of turbines, a summary of the relevant specifications for the worst case scenarios and most likely scenario are provided in Table 7.33.

Table 7.33: Summary of Key Differences with Respect to Potential Bird Effects between the Worst Case Scenarios and Most Likely Scenario.

Parameter	Worst Case (except Gannet collision)	Worst Case (Gannet collision)	Most Likely
Turbine Number	277	142	140
Rotor Diameter (m)	107.2	165	154
Minimum Turbine Spacing (m, separation)	642	990	985.6
Maximum Blade Swept Area (m^2)	9025.7	21,382	18,627
RPM (range)	4.8 - 13	5 - 11	5 - 11
Turbine Foundation	Gravity base	Gravity base	Pin piles

143. The assessment of effects presented above and in the Original ES is based on the assessment of the worst case scenarios. This section presents results for the collision risk assessment based on the most likely scenario for ornithology. No other sections have been quantitatively reassessed, since the response of foraging seabirds to fewer, more widely spaced turbines is difficult to quantify, although it is reasonable to suppose that any negative effects will be reduced.

144. The distance over which foraging birds would need to avoid turbines in order for 100% displacement from the worst case displacement scenario Wind Farm Site is 321m. At this radius the avoidance distances from adjacent turbines overlaps. At the minimum spacing defined for the most likely scenario, the equivalent avoidance distance is 492m, an increase in avoidance distance of 50%. On this basis it seems likely that displacement effects predicted for the worst case scenario would be considerably smaller for the most likely scenario. The revised displacement assessment presented in this ES Addendum based on the worst case scenario found no likely significant effects for breeding birds. Therefore the most likely scenario would be expected to have at worst the same level of (non-likely significant) effect, and most likely a lower level.

145. For all species except gannet, the reduction in the number of turbines in the most likely scenario (140 compared with 277) and reduction in a maximum rotation speed (11rpm compared with 13rpm) reduces the predicted number of collisions to approximately 60% of the number estimated for the worst case scenario (the actual ratio varies by +/-2% around 60% for each species due to variations in size and flight characteristics). Gannets have an unusual flight height distribution (Cook et al., 2012) with a small secondary peak in numbers at around 108m. This height coincides with the hub height (and hence elevated collision risk in the vicinity of the hub) of the 7MW turbine option (Original ES, Section 7.3.3). Thus for this species the Worst Case Scenario with respect to collision risk is 142 7MW turbines (as assessed in Section 7.6.3.2 of this ES Addendum).

146. To illustrate the differences in predicted collision mortality between the worst case scenarios and most likely scenario, the estimated reductions in breeding season mortality for the four species with the highest collision mortality are presented in Table 7.34.

Table 7.34: Comparison of Worst Case Scenario and Most Likely Scenario with Respect to Breeding Season Collision Mortality (at an avoidance rate of 99%) Effects for Gannet, Kittiwake, Herring Gull and Great Black-Backed Gull.

Breeding Season Collision Mortality at 99% Avoidance	Gannet	Kittiwake	Herring Gull	Great Black-Backed Gull
Worst Case Scenario	9	10	10	24
Most Likely Scenario	7	5	6.5	12

147. As can be seen, reductions in collision mortality lead to lower levels of predicted effect for all species. As an illustration, the predicted probability of a 10% decline in the great black-backed gull population caused through collision mortality (at an avoidance rate of 99%) in the worst case scenario was 1.5% (Table 7.27). This falls to 0.8% for the most likely scenario (Table 7.35).

Table 7.35: Predicted Increase in Probabilities of Great Black-Backed Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collisions on the Wind Farm Site during the Breeding Season using the Most Likely Scenario Number and Size of turbines.

<table>
<tr><th rowspan="3">Thresholds of Population Decline (% Reductions)</th><th colspan="2">Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)</th><th colspan="2">Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)</th></tr>
<tr><th colspan="2">Avoidance Rate</th><th colspan="2">Avoidance Rate</th></tr>
<tr><th>98%</th><th>99%</th><th>98%</th><th>99%</th></tr>
<tr><td>10</td><td>0.016</td><td>0.008</td><td>0.432</td><td>0.216</td></tr>
<tr><td>20</td><td>0.002</td><td><0.001</td><td>0.406</td><td>0.203</td></tr>
<tr><td>50</td><td>0</td><td>0</td><td>0.088</td><td>0.044</td></tr>
</table>

7.7 MITIGATION MEASURES AND RESIDUAL EFFECTS

148. Mitigation measures remain unchanged from those presented in Section 13.5 of the Original ES.

149. Residual effects therefore remain unchanged from those presented in Section 13.4 of the Original ES, or in Section 7.6 for species where an updated assessment has been provided.

7.8 ASSESSMENT OF CUMULATIVE EFFECTS

7.8.1 INTRODUCTION

150. The Original ES was submitted to MS-LOT in April 2012. At this time it was the first offshore wind farm application in Scottish Territorial Waters and the wider Moray Firth. As outlined in Section 3: EIA Process and Methodology, the information regarding cumulative projects, and specifically the neighbouring Moray Firth Round 3 Zone was assessed based on the information available at the time of assessment. This section updates the assessment of cumulative effects based on the amendments to the methodology and consultee responses presented in the Section 7.3, plus further and updated information on the Moray Firth Round 3 Zone as presented in the Moray Firth Round 3 Zone ES which was submitted to MS-LOT in August 2012.

151. This cumulative assessment of effects in this ES Addendum updates and supplements the assessment for the following species and effects;

- Fulmar (displacement, Section 7.8.6.2, Original assessment replaced);
- Gannet (displacement, Section 7.8.6.1; breeding season collision, Section 7.8.7.1; non-breeding season collision, Section 7.8.8.1, Original assessments replaced);
- Kittiwake (displacement, Section 7.8.6.3; breeding season collision, Section 7.8.7.2; non-breeding season collision, Section 7.8.8.2, Original assessments replaced);
- Herring gull (breeding season collision, Section 7.8.7.3; non-breeding season collision, Section 7.8.8.3, Original assessments replaced);
- Great black-backed gull (breeding season collision, Section 7.8.7.4; non-breeding season collision, Section 7.8.8.4, Original assessments replaced);
- Guillemot (displacement, Section 7.8.6.4, Original assessment replaced);
- Razorbill (displacement, Section 7.8.6.5, Original assessment replaced) and
- Puffin (displacement, Section 7.8.6.6, Original assessment replaced).

152. For all other receptors, the assessment presented in Section 13.9 of the Original ES remains unchanged.

153. This assessment of cumulative effects considers the effects of the Wind Farm and the Moray Firth Round 3 Zone giving consideration to the breakdown of the Moray Firth Round 3 Zone into stages, as outlined in the Moray Firth Round 3 Zone ES. As such the following assessment works through the following scenarios:

- Scenario 1: Wind Farm Project plus Moray Firth Round 3 Zone MacColl wind farm ;

- Scenario 2: Wind Farm plus Moray Firth Round 3 Zone MacColl and Stevenson wind farms;
- Scenario 3: Wind Farm plus Moray Firth Round 3 Zone MacColl, Stevenson and Telford wind farms.

7.8.2 STUDY AREA

154. The Study Area for the assessment of effects on birds was presented in Section 7.4.1 of the ES Addendum.

7.8.3 BASELINE

155. With the exception of updates to some of the seabird reference populations (Table 7.2) the baseline conditions relating to the Study Area are unchanged from those presented in Section 13.3 of the Original ES. The baseline conditions remain unchanged.

156. Although in almost all cases the reference populations used in the Original ES have remained the same, Table 7.2 shows the populations for which further assessment has been requested by Marine Scotland and SNH.

7.8.4 METHODOLOGY

157. The methods used for the assessment of the Wind Farm (Section 7.5) were used for the cumulative assessment. Differences in assessment methods between those used here and those used in the Moray Firth Round 3 Zone assessment mean that in some cases the figures presented in the Moray Firth Round 3 Zone assessment have been modified in order for them to be compatible with the Wind Farm's methodology. Thus, for the cumulative displacement assessment the estimated total number of individuals on site as reported in the Moray Firth Round 3 Zone ES were divided by the species specific estimates of foraging trip frequency (to account for turnover) and then multiplied by the species specific estimate of breeding adults to account for the presence of non-breeding birds (as detailed in the displacement methods and assessment, Section 7.5.1.2).

7.8.5 ASSESSMENT OF CUMULATIVE EFFECTS

158. A summary table of the number of individuals of gannet, fulmar, kittiwake, guillemot, razorbill and puffin predicted to be displaced from the Wind Farm Site and the three Moray Firth Round 3 Zone wind farms is provided below (Table 7.36).

Table 7.36: Summary of Number of Individuals Assessed as At Risk of Cumulative Displacement.

Species	Wind Farm	Cumulative Wind Farm Scenario - Displacement		
		Scenario 1	Scenario 2	Scenario 3
Gannet	68	125	148	169
Fulmar	691	998	1285	1516
Kittiwake	385	559	631	732
Guillemot	6014	8167	9757	10972
Razorbill	768	1214	1471	1726
Puffin	478	586	715	789

159. A summary table of the number of individuals of gannet, kittiwake, herring gull and great black-backed gull predicted to be in collision with turbines from the Wind Farm Site and the three Moray Firth Round 3 Zone wind farms during the breeding season is provided below (Table 7.37). Assessment of the predicted effects for each scenario is presented in Section 7.9.4.

Table 7.37: Summary of Number of Individuals Assessed as At Cumulative Collision Risk during the Breeding Season at Avoidance Rates of 98% and 99% Obtained using CRM Option 3.

Species	Wind Farm		Cumulative Wind Farm Scenario – Collision Risk					
			Scenario 1		Scenario 2		Scenario 3	
	98%	99%	98%	99%	98%	99%	98%	99%
Gannet	17	9	42	21	51	25	60	30
Kittiwake	21	11	74	37	104	52	125	63
Herring Gull	20	10	23	12	26	13	27	14
Great Black-Backed Gull	49	25	63	32	73	37	78	39

160. A summary table of the number of individuals of gannet, kittiwake, herring gull and great black-backed gull predicted to be in collision with turbines from the Wind Farm Site and the three Moray Firth Round 3 Zone wind farms during the non-breeding season is provided below (Table 7.38). Assessment of the predicted effects for each scenario is presented in Section 7.9.5.

Table 7.38: Summary of Number of Individuals Assessed as At Cumulative Collision Risk during the Non-Breeding Season at Avoidance Rates of 98% and 99% Obtained using CRM Option 3.

Species	Wind Farm		Cumulative Wind Farm Scenario – Collision Risk					
			Scenario 1		Scenario 2		Scenario 3	
	98%	99%	98%	99%	98%	99%	98%	99%
Gannet	25	13	46	23	54	27	61	31
Kittiwake	23	12	43	22	55	28	64	32
Herring Gull	317	159	347	174	368	184	380	190
Great Black-Backed Gull	190	95	229	114	256	128	269	135

7.8.6 DISPLACEMENT

7.8.6.1 Gannet

161. At the estimated levels of cumulative displacement (Table 7.36), the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.39.

Table 7.39: Predicted Increase in Probabilities of Gannet Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)		
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**
10	0	0	0	0.152	0.151	0.149
20	0	0	0	0.011	0.013	0.013
50	0	0	0	0	0	0

162. Thus at these levels of displacement none of the cumulative displacement scenarios generated an additional probability of population decline below the 10%, 20% or 50% thresholds.

163. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect in terms of the EIA Regulations is assessed for this high sensitivity species. Gannet were not assessed for displacement effects in the Original ES therefore this is further to the displacement assessment in the Original ES.

7.8.6.2 Fulmar

164. At the estimated levels of cumulative displacement (Table 7.36), the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.40.

Table 7.40: Predicted Increase in Probabilities of Fulmar Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)		
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**
10	0.014	0.015	0.009	0.024	0.032	0.025
20	0.007	0.009	0.007	0.018	0.026	0.021
50	0.001	<0.001	<0.001	0.003	0.007	0.005

165. Thus at these levels of cumulative displacement, the additional probability (above that predicted in the absence of displacement) of the population declining by more than 10% ranged between 1.4% for Scenario 1 to 1.5% for Scenario 2. The increase in the probability of decline below 20% increased from 0.7% (Scenario 1) to 0.9% (Scenario 2) and the increase in the probability of decline below 50% was less than 0.1% for all scenarios.

166. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.6.3 Kittiwake

167. At the estimated levels of cumulative displacement (Table 7.36), the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.41.

Table 7.41: Predicted Increase in Probabilities of Kittiwake Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.003	0.003	0.004	0.039	0.047	0.058
20	<0.001	<0.001	<0.001	0.022	0.023	0.033
50	0	0	0	<0.001	<0.001	<0.001

168. Thus at these levels of cumulative displacement, the additional probability (above that predicted in the absence of displacement) of the population declining by more than 10% was 0.3% for Scenario 1 and Scenario 2 and 0.4% for Scenario 3. There was less than 0.1% increase in the probability of decline for all other thresholds and scenarios.

169. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect in terms of the EIA Regulations is assessed for this high sensitivity species. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.6.4 Guillemot

170. At the estimated levels of cumulative displacement (Table 7.36), the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.42.

Table 7.42: Predicted Increase in Probabilities of Guillemot Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	<0.001	<0.001	0	0.23	0.29	0.34
20	0	0	0	0.07	0.09	0.12
50	0	0	0	0	0	0

171. Thus at these levels of displacement none of the cumulative displacement scenarios generated an additional probability of population decline below the 10%, 20% or 50% thresholds greater than 0.1%

172. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.6.5 Razorbill

173. At the estimated levels of cumulative displacement (Table 7.36), the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.43.

Table 7.43: Predicted Increase in Probabilities of Razorbill Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms..

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.002	0.001	0.002	0.57	0.64	0.67
20	0	0	0	0.54	0.67	0.76
50	0	0	0	0.001	0.003	0.007

174. Thus at these levels of displacement none of the cumulative displacement scenarios generated an additional probability of population decline below the 10%, 20% or 50% thresholds greater than 0.1%

175. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the

assessment in the Original ES (Section 13.9.3.2: small magnitude, negligible significance).

7.8.6.6 Puffin

176. At the estimated levels of cumulative displacement (Table 7.36), the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Table 7.44.

Table 7.44: Predicted Increase in Probabilities of Puffin Population Decline during 25 Year Simulation and in Final Year of Simulation due to Displacement from the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms..

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Displacement Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Displacement (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	<0.001	<0.001	0.001	0.68	0.72	0.74
20	0	0	0	0.67	0.80	0.85
50	0	0	0	0.007	0.002	0.003

177. Thus at these levels of displacement none of the cumulative displacement scenarios generated an additional probability of population decline below the 10%, 20% or 50% thresholds greater than 0.1%

178. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.7 COLLISION RISK – BREEDING SEASON

7.8.7.1 Gannet

179. At the estimated levels of cumulative breeding season collision mortality (Table 7.37), the predicted additional probabilities of population decline within 25 years relative to the baseline (no collision mortality) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Tables 7.45 and 7.46.

Table 7.45: Predicted Increase in Probabilities of Gannet Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 98%) during the Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0	0	0	0.002	0.004	0.008
20	0	0	0	<0.001	<0.001	<0.001
50	0	0	0	0	0	0

Table 7.46: Predicted Increase in Probabilities of Gannet Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 99%) during the Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0	0	0	<0.001	<0.001	<0.001
20	0	0	0	<0.001	<0.001	<0.001
50	0	0	0	0	0	0

180. Thus at these levels of cumulative collision mortality (at an avoidance rate of 99%) none of the cumulative scenarios generated an additional probability of population decline below the 10%, 20% or 50% thresholds of more than 0.1%.

181. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect in terms of the EIA Regulations is assessed for this high sensitivity species. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.7.2 Kittiwake

182. At the estimated levels of cumulative breeding season collision mortality (Table 7.37), the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Tables 7.47 and 7.48.

Table 7.47: Predicted Increase in Probabilities of Kittiwake Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 98%) during the Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.003	<0.001	<0.001	0.017	0.014	0.025
20	<0.001	<0.001	<0.001	0.012	0.014	0.015
50	0	0	0	<0.001	<0.001	<0.001

Table 7.48: Predicted Increase in Probabilities of Kittiwake Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 99%) during the Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.001	0.002	0.002	0.008	0.014	0.016
20	<0.001	<0.001	<0.001	0.007	0.010	0.011
50	0	0	0	<0.001	<0.001	<0.001

183. Thus at these levels of cumulative collision mortality (at an avoidance rate of 99%) none of the cumulative scenarios generated an additional probability of population decline below the 10%, 20% or 50% thresholds of more than 0.2%.

184. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.7.3 Herring Gull

185. At the estimated levels of cumulative breeding season collision mortality (Table 7.37), the predicted additional probabilities of population decline within 25 years relative to the baseline (no displacement) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Tables 7.49 and 7.50.

Table 7.49: Predicted Increase in Probabilities of Herring Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 98%) during the Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.031	0.034	0.035	0.056	0.062	0.063
20	0.021	0.024	0.024	0.043	0.047	0.048
50	<0.001	<0.001	<0.001	0.012	0.014	0.014

Table 7.50: Predicted Increase in Probabilities of Herring Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 99%) during the Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.016	0.017	0.019	0.029	0.032	0.034
20	0.011	0.012	0.013	0.022	0.024	0.026
50	<0.001	<0.001	<0.001	0.06	0.007	0.007

186. Thus at these levels of cumulative collision mortality (at an avoidance rate of 99%) the increase in the probability of decline by more than 10% increased from 1.6% for Scenario 1 to 1.9% for Scenario 3, the probability of decline by more than 20% increased from 1.1% for Scenario 1 to 1.3% for Scenario 3 and the probability of decline by more than 50% was less than 0.1% for all scenarios.

187. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.7.4 Great Black-Backed Gull

188. The estimated levels of cumulative breeding season collision mortality were 32, 37 and 39 (Table 7.37). However, the number of breeding birds estimated to be in collision during the breeding season is almost certainly much smaller than these estimates. Over 20 % of great black-backed gulls observed during the boat surveys were aged (as either adults or immature birds) on the basis of plumage. Across all surveys the percentage of adult birds (i.e. breeding birds) was 39.5% while during the breeding months (May – August inc.) this was 37.5%. Therefore, only 37.5% of

the individuals at risk of collision would be expected to be breeding adults, which equates to 12, 14 and 15 individuals for each cumulative Scenario.

189. Furthermore, a proportion of these adults are likely to be non-breeding individuals. Compared to other seabird species such as skuas (Catry et al., 1998) and auks (Harris and Wanless, 1994), gulls typically have relatively large proportions of non-breeders in a population. Calladine and Harris (1996) estimated that within a lesser black-backed gull colony at the Isle of May, east of Scotland, 34% of adults in 1993, and 40% in 1994 did not breed. This was considered to be a 'normal' period, unaffected by culling measures which occurred in some other years. These results are similar to those from other studies of gull populations. Kadlec and Drury (1968) estimated that 15-30% of adult North American herring gulls did not breed in any one year, and Pugesek and Diem (1990) estimated that 36% of Californian gulls did not breed in any given year. Samuels and Ladino (1984) estimated that 45% of herring gulls did not breed in a North American study.

190. It could therefore be reasonably concluded that as a conservative estimate, for every two breeding birds recorded, another non-breeding individual is present within the population. Since the breeding population estimate is based on breeding pairs, this effectively increases the East Caithness Cliffs SPA population from 350 individuals to around 525. This would mean that approximately one in three adult birds at risk of collision would be a non-breeder, assuming that all birds from the SPA use the site equally. In reality it is very likely that the proportion of non-breeders encountered will increase with distance offshore, since these individuals are not constrained by the demands of incubation and feeding chicks. Therefore non-breeders are more likely to spend longer periods of time farther away from the colony, and range more widely than breeders.

191. The predicted additional probabilities of population decline within 25 years relative to the baseline (no collision) and the predicted probabilities that the population will be smaller than the baseline after 25 years on the basis of mortality levels of 24 to 30 individuals (at 98% avoidance) and 12 to 15 individuals (at 99% avoidance) are provided in Tables 7.51 and 7.52.

Table 7.51: Predicted Increase in Probabilities of Great Black-Backed Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 98%) during the Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.061	0.074	0.080	0.635	0.641	0.645
20	0.010	0.013	0.015	0.746	0.768	0.778
50	0	0	0	0.567	0.739	0.825

Table 7.52: Predicted Increase in Probabilities of Great Black-Backed Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 99%) during the Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.023	0.029	0.032	0.471	0.510	0.530
20	0.003	0.004	0.004	0.470	0.534	0.566
50	0	0	0	0.149	0.211	0.242

192. Thus at these levels of cumulative collision mortality (at an avoidance rate of 99%) the increase in the probability of decline by more than 10% was 2.3% for Scenario 1, 2.9% for Scenario 2 and 3.2% for Scenario 3. The probability of decline by more than 20% increased from 0.3% for Scenario 1 to 0.4% for Scenario 3 and the probability of decline by more than 50% was zero for all scenarios.

193. None of these increases in the risk of population decline exceed the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.8 COLLISION RISK – NON-BREEDING SEASON

7.8.8.1 Gannet

194. At the estimated levels of non-breeding season cumulative non-breeding season collision mortality (Table 7.38), the predicted additional probabilities of population decline within 25 years relative to the baseline (no collision mortality) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Tables 7.53 and 7.54.

Table 7.53: Predicted Increase in Probabilities of Gannet Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 98%) during the Non-Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0	0	0	0.003	0.006	0.009
20	0	0	0	<0.001	<0.001	<0.001
50	0	0	0	0	0	0

Table 7.54: Predicted Increase in Probabilities of Gannet Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 99%) during the Non-Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0	0	0	<0.001	<0.001	<0.001
20	0	0	0	<0.001	<0.001	<0.001
50	0	0	0	0	0	0

195. Thus at these levels of cumulative collision mortality (at an avoidance rate of 99%) during the non-breeding season none of the cumulative scenarios generated an additional probability of population decline below the 10%, 20% or 50% thresholds of more than 0.1%.

196. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.8.2 Kittiwake

197. At the estimated levels of non-breeding season cumulative collision mortality (Table 7.38), the predicted additional probabilities of population decline within 25 years relative to the baseline (no collision mortality) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Tables 7.55 and 7.56.

Table 7.55: Predicted Increase in Probabilities of Kittiwake Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 98%) during the Non-Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	<0.001	0.001	0.001	0.004	<0.001	<0.001
20	<0.001	<0.001	<0.001	0.004	0.002	0.002
50	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table 7.56: Predicted Increase in Probabilities of Kittiwake Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 99%) during the Non-Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.001	0.001	0.001	0.01	0.013	0.011
20	<0.001	<0.001	<0.001	0.006	0.007	0.007
50	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

198. Thus at these levels of cumulative collision mortality (at an avoidance rate of 99%) during the non-breeding season none of the cumulative scenarios generated an additional probability of population decline below the 10%, 20% or 50% thresholds of more than 0.1%.

199. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.8.3 Herring Gull

200. At the estimated levels of non-breeding season cumulative collision mortality (Table 7.38), the predicted additional probabilities of population decline within 25 years relative to the baseline (no collision mortality) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Tables 7.57 and 7.58.

Table 7.57: Predicted Increase in Probabilities of Herring Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 98%) during the Non-Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.068	0.065	0.066	0.113	0.127	0.134
20	0.038	0.042	0.045	0.11	0.121	0.127
50	0.001	0.001	0.001	0.034	0.037	0.039

Table 7.58: Predicted Increase in Probabilities of Herring Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 99%) during the Non-Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.037	0.037	0.037	0.061	0.064	0.066
20	0.015	0.016	0.016	0.053	0.057	0.06
50	<0.001	<0.001	<0.001	0.018	0.018	0.017

201. Thus at these levels of cumulative collision mortality (at an avoidance rate of 99%) during the non-breeding season the increase in the probability of decline by more than 10% was 3.7% for all three scenarios, the probability of decline by more than 20% was 1.5-1.6% for all three scenarios and of a decline of more than 50% was less than 0.1% for all three scenarios.

202. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.8.8.4 Great Black-Backed Gull

203. At the estimated levels of non-breeding season cumulative collision mortality (Table 7.38), the predicted additional probabilities of population decline within 25 years relative to the baseline (no collision mortality) and the predicted probabilities that the population will be smaller than the baseline after 25 years are provided in Tables 7.59 and 7.60.

Table 7.59: Predicted Increase in Probabilities of Great Black-Backed Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 98%) during the Non-Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.005	0.0007	0.011	0.153	0.179	0.187
20	<0.001	<0.001	<0.001	0.123	0.146	0.156
50	0	0	0	0.013	0.016	0.019

Table 7.60: Predicted Increase in Probabilities of Great Black-Backed Gull Population Decline during 25 Year Simulation and in Final Year of Simulation due to Collision Mortality (at an avoidance rate of 99%) during the Non-Breeding Season on the Wind Farm Site and the Moray Firth Round 3 Zone Wind Farms.

Thresholds of Population Decline (% Reductions)	Additional Probability of Population Decline during 25 yr. Simulation Relative to No Collisions Scenario (used for effect assessment)			Increase in the Probability Population will be Smaller than 25 yr. Median Size Obtained with No Collisions (not used for effect assessment but included at request of MS)		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
10	0.001	0.004	0.004	0.078	0.086	0.091
20	<0.001	<0.001	<0.001	0.063	0.066	0.072
50	0	0	0	0.006	0.007	0.008

204. Thus at these levels of cumulative collision mortality during the non-breeding season the increase in the probability of decline by more than 10% was less than 0.4% for all three scenarios. The probability of decline by more than 20% was less than 0.1% for all scenarios and there was no increase in the probability of decline by more than 50%.

205. All of these increases in the risk of population decline are below the thresholds defined in Table 7.4. Therefore a non-likely significant effect is assessed for this high sensitivity species in terms of the EIA Regulations. This replaces the assessment in the Original ES (Section 13.9.3.2: small magnitude, minor significance).

7.9 HABITATS REGULATIONS ASSESSMENT (HRA)

206. Annex 3B presents a report to inform an appropriate assessment in respect of Natura 2000 designations for which birds form part of the qualifying interest or conservation objectives of the designation.

7.10 STATEMENT OF SIGNIFICANCE

207. Population models have been used in this ES Addendum to generate probabilistic predictions for effects. Three alternative thresholds for increase in the risk of a population decline have been applied (Table 7.4). The outputs obtained in this manner do not lend themselves to the estimation of effects defined on a sliding scale of magnitude of effect and significance. Therefore, the results of the modelling have been used to determine if effects are either likely significant or non-likely significant in terms of the EIA Regulations, according to the predicted increases in the probability of population decline in relation to the thresholds (Table 7.4). This approach differs from that used in the Original ES (Section 13.2.6.3), which estimated finer scales of effect magnitude and consequently significance.

208. Displacement during the breeding season of breeding adults resulting in subsequent breeding failure was not found to cause any likely significant effects on the seabird populations which have been recorded on the Wind Farm Site, either alone or cumulatively with the Moray Firth Round 3 Zone.

209. Collision risk during the breeding season was not found to cause any likely significant effects on the seabird populations which have been recorded on the Wind Farm Site, either alone or cumulatively with the Moray Firth Round 3 Zone.

210. Collision risk during the non-breeding season was not found to cause any likely significant effects on the seabird populations which have been recorded on the Wind Farm, either alone or cumulatively with the Moray Firth Round 3 Zone.

211. A summary of the effects discussed in this ES Addendum is provided in Table 7.61.

Table 7.61: Summary of Ornithology Effect Assessment using Worst Case Scenarios. The increase in the risk of a 10% population decline is provided for each effect assessed *(NB: the assessments also considered the increase in risk of declines of 20% and 50%, see text for details)*

Effect	**Receptor**	**Scenario (effect assessment and predicted increase in probability of 10% decline in population size)**				**Rationale**
		Wind Farm	**Cumulative Scenario 1**	**Cumulative Scenario 2**	**Cumulative Scenario 3**	
Displacement	Fulmar	Non-likely significant (<0.1%)	Non-likely significant (1.4%)	Non-likely significant (1.5%)	Non-likely significant (0.9%)	Risks of population decline all less than minimum thresholds for significance.
	Gannet	Non-likely significant (0%)	Non-likely significant (0%)	Non-likely significant (0%)	Non-likely significant (0%)	Risks of population decline all less than minimum thresholds for significance.
	Kittiwake	Non-likely significant (0.1%)	Non-likely significant (0.3%)	Non-likely significant (0.3%)	Non-likely significant (0.4%)	Risks of population decline all less than minimum thresholds for significance.
	Guillemot	Non-likely significant (<0.1%)	Non-likely significant (<0.1%)	Non-likely significant (<0.1%)	Non-likely significant (0%)	Risks of population decline all less than minimum thresholds for significance.
	Razorbill	Non-likely significant (<0.1%)	Non-likely significant 0.2%)	Non-likely significant (0.1%)	Non-likely significant (0.2%)	Risks of population decline all less than minimum thresholds for significance.
	Puffin	Non-likely significant	Non-likely significant	Non-likely significant	Non-likely significant	Risks of population

Effect	Receptor	Scenario (effect assessment and predicted increase in probability of 10% decline in population size)				Rationale
		Wind Farm	Cumulative Scenario 1	Cumulative Scenario 2	Cumulative Scenario 3	
		(<0.1%)	(<0.1%)	(<0.1%)	(0.1%)	decline all less than minimum thresholds for significance.
Collision (breeding season; at an avoidance rate of 99%)	Fulmar	Non-likely significant (0%)	N/A			Risks of population decline all less than minimum thresholds for significance.
	Gannet	Non-likely significant (<0.1%)	Non-likely significant 0%)	Non-likely significant 0%)	Non-likely significant 0%)	Risks of population decline all less than minimum thresholds for significance.
	Kittiwake	Non-likely significant 0.2%)	Non-likely significant (0.1%)	Non-likely significant 0.2%)	Non-likely significant (0.2%)	Risks of population decline all less than minimum thresholds for significance.
	Herring gull	Non-likely significant (0.8%)	Non-likely significant (1.6%)	Non-likely significant (1.7%)	Non-likely significant (1.9%)	Risks of population decline all less than minimum thresholds for significance.
	Great black-backed gull	Non-likely significant (6.7%)	Non-likely significant (2.3%)	Non-likely significant (2.9%)	Non-likely significant (3.2%)	Risks of population decline all less or equal to minimum thresholds for significance (NB: risks of decline of 20% and 50% much less than thresholds).
Combined Effects (breeding season)	Fulmar	Non-likely significant 0.2%)	N/A			Risks of population decline all less than

Effect	Receptor	Scenario (effect assessment and predicted increase in probability of 10% decline in population size)				Rationale
		Wind Farm	Cumulative Scenario 1	Cumulative Scenario 2	Cumulative Scenario 3	
						minimum thresholds for significance.
	Gannet	Non-likely significant (<0.1%)	N/A			Risks of population decline all less than minimum thresholds for significance.
	Kittiwake	Non-likely significant (<0.1%)	N/A			Risks of population decline all less than minimum thresholds for significance.
Collision (non-breeding season; at an avoidance rate of 99%)	Gannet	Non-likely significant (0%)	Non-likely significant (0%)	Non-likely significant (0%)	Non-likely significant (0%)	Passage population potentially very large but no. collisions small.
	Kittiwake	Non-likely significant (<0.1%)	Non-likely significant (0.1%)	Non-likely significant (0.1%)	Non-likely significant (0.1%)	Over-wintering and passage population very large, but no. collisions small.
	Herring gull	Non-likely significant 3.3%)	Non-likely significant (3.7%)	Non-likely significant (3.7%)	Non-likely significant (3.7%)	Risks of population decline all less than minimum thresholds for significance.
	Great black-backed gull	Non-likely significant (<0.1%)	Non-likely significant (0.1%)	Non-likely significant (0.4%)	Non-likely significant (0.4%)	Risks of population decline all less than minimum thresholds for significance.

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