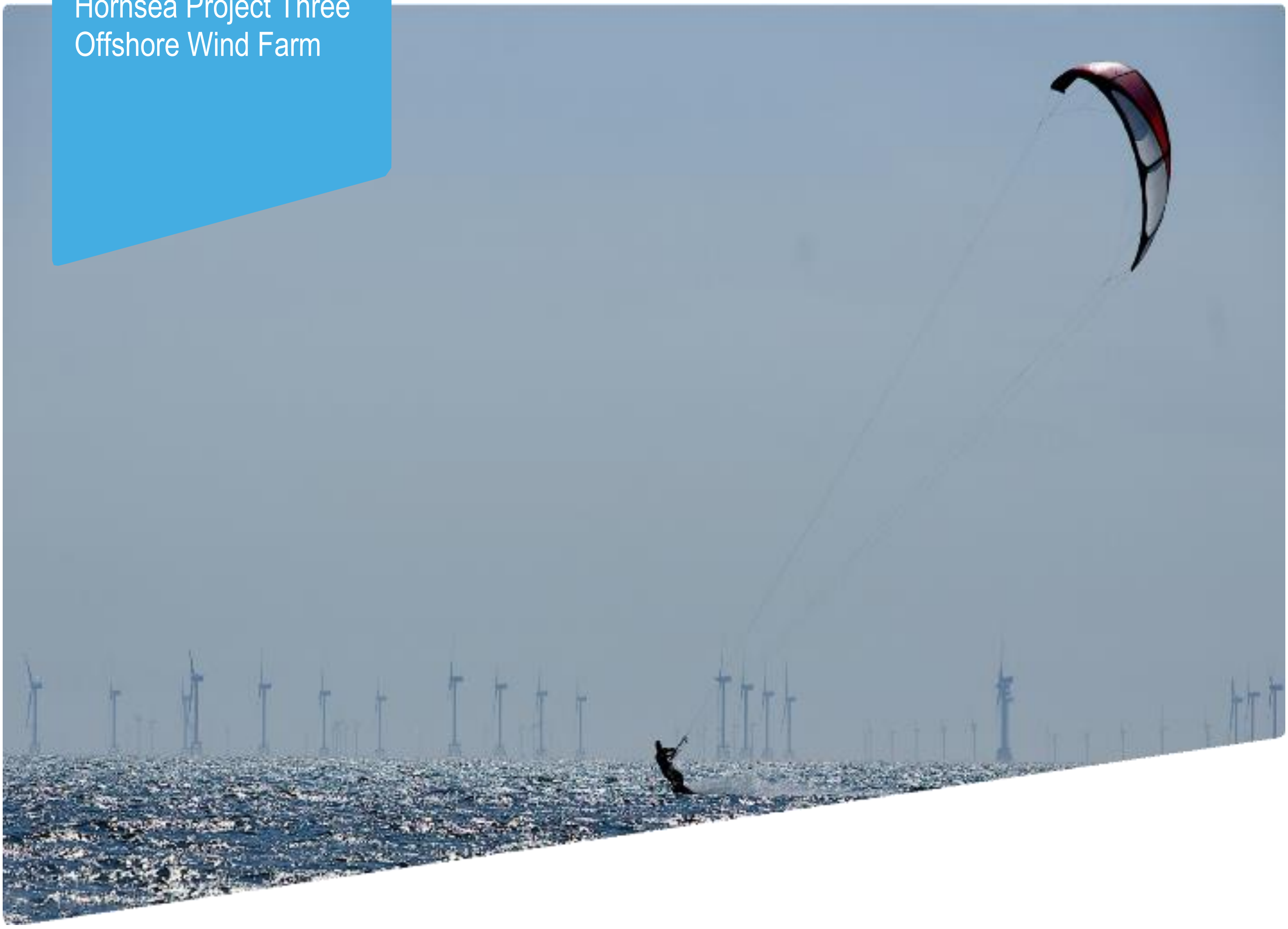
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Appendix 9 to Deadline 10 submission – Hornsea Project Two Kittiwake Collision Risk

Date: 1st April 2019

Hornsea 3
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Hornsea Offshore Wind Farm

Project Two

Kittiwake Collision Risk: Review of Core Assumptions

Appendix DD to the Response submitted for Deadline IV

Application Reference: EN010053

20 October 2015

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1 Kittiwake Collision Risk: Review of Core Assumption

1.1 Introduction

1.1.1 This Clarification Note has been prepared in respect of the application for a development consent order (DCO) to the Secretary of State under the Planning Act 2008 ('the Application') by SMartWind Ltd on behalf of Optimus Wind Ltd and Breesea Ltd (the 'Applicant') for the Hornsea Project Two Offshore Wind Farm (the 'Project').

1.1.2 Within the Issue Specific Hearing on 15th September 2015, Natural England stated that with respect to collision risk on the kittiwake feature of Flamborough and Filey Coast pSPA (FFC pSPA) and Flamborough Head and Bempton Cliffs SPA (FHBC SPA) they are currently unable to conclude beyond reasonable scientific doubt that this level of impact would not be an Adverse Effect on Site Integrity (AEoSI) from the Project alone. Natural England was therefore also unable to conclude no AEoSI for the Project in combination with other plans and projects.

1.1.3 Within the Issue Specific Hearing the Applicant confirmed that both bodies will continue to explore the issue of kittiwake collision risk and are committed to providing further information through the examination (Appendix Y of the Applicant's response to Deadline III, Statement of Common Ground between the Applicant and Natural England). This Clarification Note therefore aims to provide information on latest discussions between the Applicant and Natural England and explore the uncertainty and/or precaution in the various analyses undertaken that underpin the positions of the two parties.

1.2 Overview of assessment and review of key parameters

1.2.1 To inform their respective positions various parameters are included at different stages of a collision risk assessment. Assumptions are made within these stages often resulting in differing views between the Applicant and Natural England. A summary of these key areas are highlighted below – these are all explored within this Clarification Note:

- Age structure of the kittiwake population at Hornsea Project Two: how many birds are breeding adults apportioned to the FFC pSPA
- Flight heights of kittiwakes and subsequent collision risk
- Phenology of the regional kittiwake population
- Collision Risk Modelling avoidance rates used for kittiwake
- Choice of Band (2012) collision risk model Option
- Inclusion of projects within the In combination assessment
- Impact of non-SPA kittiwake colonies on the in combination assessment

1.2.2 Initially a series of five stages are applied to the collision risk assessment of the Project alone that investigates the parameters listed above.

1.3 Applicant's position

1.3.1 The Applicant detailed their position with respect to kittiwake collision risk in the Clarification Note: Apportioning of predicted kittiwake mortality to the Flamborough and Filey Coast pSPA population Appendix P of the Applicant's Response to Deadline IIA.

1.3.2 Under the Applicants advocated scenarios within the assessment of kittiwake collision risk 6.2 collisions per annum apportioned to FFC pSPA from Project Two alone are predicted. Key aspects of in the development of this position are as follows:

a) Application of Natural England's advised foraging range from FFC pSPA of 156 km (see paragraph 57 of Natural England's Relevant Representation)
b) Breeding season apportioning of 38% to FFC pSPA based on data on population age structure given in Furness (2015).
c) Post- and pre-breeding apportioning of 6.3% and 8.4% respectively based on Furness (2015) updated with most contemporary population data from FFC pSPA
d) Phenology and subsequent apportioning based on Furness (2015) 'core' seasons for kittiwake.
e) Application of kittiwake flight height data collected specifically for Hornsea Project Two
f) Focus on Option 4 of Band (2012) Collision Risk Model with a 98% avoidance rate.

1.3.3 In combination with other projects a total of 145.8 collisions per annum apportioned to the pSPA are predicted. Key aspects of in the development of this position are as follows:

a) Projects included in assessment as advised by Natural England
b) Review of consented capacity of projects against baseline collision risk modelling – and subsequent correction to figures where necessary.
c) Phenology and subsequent apportioning based on Furness (2015) 'core' seasons for kittiwake.
d) For sites within the foraging range advised by Natural England, 100% of kittiwake apportioned to FFC pSPA in the breeding season (again, as advised by Natural England)
e) Breeding season apportioning of 19.3% from Dogger Bank Creyke Beck A and B based on the consent decision of that project.
f) No inclusion of any project in the breeding season that is outside of Natural England's advised foraging range (156km)
g) Post- and pre-breeding apportioning of 6.3% and 8.4% respectively for all projects based on Furness (2015) updated with most contemporary population data from FFC pSPA
h) Application of Extended Band (2012) Model results where available
i) Where only Basic Band (2012) Model results available, application of an avoidance rate of 99.2% based on Cook *et al.*, (2014).

1.3.4 The full breakdown of the Applicants in combination assessment including collisions apportioned to the pSPA from each project considered is included in Appendix 1.

1.4 Natural England's position

1.4.1 As requested by Natural England, the Clarification Note: Apportioning of predicted kittiwake mortality to the Flamborough and Filey Coast pSPA population (Appendix P of the Applicant's response to Deadline IIA), included detail of their position in parallel to that of the Applicant. Natural England provided minor updates to this within their response to Deadline III and has since provided an a full breakdown of data (see Appendix 2 of this note).

1.4.2 With respect to the Project alone, Natural England's position is that 134.7 collisions per annum (129.2 in the breeding season) are apportioned to FFC pSPA. Key aspects in the development of this position are as follows:

a) Foraging range of 156 km based on mean-maximum FAME data from 2012 (n = 9 kittiwakes tracked)[1].
b) Apportioning of 94.6% kittiwakes in the breeding season based on data on age of kittiwakes collected boat based surveys for the Project.
c) Post- and pre-breeding apportioning of 5.4% and 7.2% respectively based on Furness (2015).
d) Phenology and subsequent apportioning based on information on presence of adult birds within the pSPA.
e) Non-acceptance of the application of the Band (2012) Extended Model for kittiwake
f) Non-acceptance of the Hornsea Project Two flight height data and therefore limiting Band (2012) Model Option choice to Option 2 (using generic flight height data from Johnston *et al*., 2014).

1.4.3 In combination with other projects Natural England predict a total of 503.1 collisions per annum apportioned to the pSPA. Key aspects of in the development of this position are as follows:

a) Review of consented capacity of projects against baseline collision risk modelling – and subsequent correction to figures where necessary[2].
b) Phenology and subsequent apportioning based on information on presence of adult birds within the pSPA.
c) Apportioning percentages to FFC pSPA during the breeding season of: 100% for any project falling within mean maximum foraging range (Thaxter et al (2012) or 156 km foraging range suggested by 2012 FAME data.
d) Post- and pre-breeding apportioning of 5.4% and 7.24% respectively based on Furness (2015).

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[1] Updated since Natural England's Deadline III submission to use a definition of 'connectivity with FFC pSPA through FAME data.

[2] Natural England also query the correction factor applied to collision risk estimates from Moray offshore wind farm. The Applicant refers the reader to the documents referenced in Appendix N and Appendix P of the Applicant's submission at Deadline 2a, specifically Natural Power (2013). This document states that the original CRM for Moray offshore wind farm incorporated 139 x 3.6 MW turbines for the three individual wind farms (Telford, MacColl and Stevenson) that form the Moray offshore wind farm (i.e. 417 turbines). The three projects were ultimately consented for 62 turbines each giving a total of 186 turbines and representing a 55% reduction in the number of turbines incorporated into collision risk modelling.

e) Basic Band Model Option 1 outputs with 98.9% avoidance rate are used except for Dogger Bank Creyke Beck and Dogger Bank Teesside where Natural England agreed use of Option 2 with the Applicant of those projects.

f) Apportioning percentages to FFC pSPA during the breeding season are: 100% for any project falling within mean maximum foraging range cited in Thaxter et al (2012) (or the 156 km put forward by Natural England) or e and supported by evidence of connectivity by the fame 156 km data alone.

g) With regards Digger Bank Creyke Beck and Dogger Bank Teesside which are beyond the maximum foraging range cited in Thaxter *et al. (*2012) and show little or no connectivity through FAME data; apportioning percentages follow that presented by Forewind in their respective applications and subsequently accepted by Natural England.

h) The Applicant has queries over the numbers presented by Natural England within their breakdown of their Deadline 3 submission (as presented in Appendix 2 of this note); the Applicant will aim to resolve these queries with Natural England before the Issue Specific Hearing.

1.5 Stage 1 – Kittiwake population age structure in the breeding season and apportioning to FFC pSPA

Overview

1.5.1 Within the Clarification Note Appendix P submitted art Deadline IIa and the subsequent Issue Specific Hearing the Applicant detailed their position on a 38% of apportioning of breeding adult kittiwake to FFC pSPA in the breeding season. Natural England did not agree with this position, primarily because the data that informed the approach (Furness, 2015) is based on the non-breeding season.

1.5.2 Natural England advocate a 94.6% breeding season apportioning of breeding adult kittiwake based on baseline survey data collected for Project Two. The Applicant considers that the application of a 94.6% breeding adult proportion is over-precautionary and significantly over-estimates the number of collisions attributable to the FFC pSPA kittiwake population during the breeding season.

1.5.3 The discrepancy between the respective positions of the Applicant and Natural England is substantial with respect to breeding season apportioning. Within this section of the Clarification Note, a review is undertaken of an approach to provide further guidance on potential age structure in the kittiwake population present at the Project in the breeding season. This attempts to provide common ground between the two parties and to guide the interpretation of potential collision risk.

1.5.4 Data collected during baseline boat-based surveys appear to indicate that the majority of birds at the Project site are adult birds. Of 22,870 birds for which age was recorded, 93.5% were recorded as adult birds, if it is assumed that the breeding season is April to July as advocated by Natural England. Natural England's apportioning in the breeding season as submitted at Deadline III accounts for data from May-July only (resulting in the 94.6% figure). For clarity, this Note indicates Natural England's apportioning position at 93.5%.

Literature review

1.5.5 As has already been detailed within Appendix P of the Applicant's response to Deadline IIA, the identification of kittiwake age classes at sea is difficult and in most cases impossible. Whilst one year old kittiwakes can be easily identified due to differences in plumage, second and third year birds, which have not yet reached the age of first breeding, cannot (Coulson, 2011; Olsen and Larsson, 2003). Further to this, it is not possible to identify adult birds which may be non-breeders from those that are breeding at FFC pSPA.

1.5.6 The preceding discussion on first-time breeders provides evidence that supports the assertion of assigning 93.5% of kittiwakes at the Project site to breeding adult birds is likely to be a gross overestimate. Moreover, a minimum of 4% of adult male birds miss a breeding season at North Shields, Tyneside, whereas females do so about half again as frequently with a recorded maximum of approximately 13% (Coulson 2011). It is not possible to identify adult birds which may be non-breeders from those that are breeding at FFC pSPA. There is though no evidence to suggest that non-breeding adults, irrespective of where they last bred or attempted to do so, are not represented at the Project site. It is evident that use of the proportion of 93.5% as adults present at the Project site is a very precautionary upper limit.

1.5.7 The proportion of immatures of other species (namely auks) in the North Sea has been estimated by the Applicant using figures from Furness (2015), as presented in the HRA Report (Doc ref No. 12.6). These assessments use the proportions of immature birds present in the North Sea during non-breeding seasons and apply these proportions in the breeding season. As such, the proportion of immature birds in the North Sea in the pre-breeding season is applied to the breeding season. The use of this approach for kittiwake is considered precautionary by the Applicant as the population of immatures present in the North Sea during the non-breeding season is likely to be lower than that present in the breeding season (Coulson, 1966; Wernham *et al.,* 2002).

1.5.8 Natural England query the validity of incorporating immature birds from Russian, Norwegian and Faroese colonies into the non-breeding population of birds in the North Sea. There is however evidence to suggest that foreign immatures may be present in the North Sea during the breeding season (Coulson, 1966).

1.5.9 Although, Coulson (1966) states that immature kittiwake show a closer association with their natal colony in the breeding season, this needs to be considered in terms of the long distance movements of kittiwake. In the non-breeding season, many young kittiwake from UK and Norwegian colonies migrate into the north Atlantic reaching Greenland and the eastern coast of North America (Coulson, 2011). As such, a bird showing a closer association with its natal colony may still be hundreds of miles from that colony as described in Coulson (1966). The data presented show that, for first winter and first summer kittiwakes, 51% and 77% of recoveries are up to 500 miles from the natal colony. However, in the second winter, second summer and third winter, although a large majority of birds are located within 500 miles of the natal colony, the distribution of birds is bimodal, with an increased proportion of birds located between 1,750 and 2,500 km from the natal colony (Coulson, 1966). Coulson (1966) summarises: "*there are clearly two distinct types of birds; those which have an extensive dispersal and which remain well away from their natal area until the third and fourth summer while the other group consists of those which have a more limited dispersal and which show a homing towards their natal colony in the second and third summer.*"

1.5.10 In the breeding season, it is a reasonable assumption (when ignoring the issue of the spatial heterogeneity of available food) that for a seabird colony of a given size, the further it is away from the Project site, the lower its likely contribution to the birds present at that site. Kittiwakes as 'central place foragers', need to optimise their time spent away from the nest and energy expended in foraging. Density of breeding adult birds can therefore be expected to be greater closer to the colony and decline with distance away from it. BirdLife's Seabird Foraging Range Database provides cumulative frequency and proportion of birds found foraging at different distances from a colony for kittiwake. The latter indicates that 95% of foraging trips occur within 60 km of the colony (Figure 1.1). This infers that only 5% of foraging trips would occur beyond this distance with the percentage decreasing up to a maximum foraging range of 120 km.

Figure 1.1: Cumulative frequency and proportion of birds found foraging at different distances from colony (Birdlife International, 2014[3]).

1.5.11 The duration of foraging trips and maximum foraging range of many seabird species are a function of both prey abundance (Hamer *et al.,* 1993; Lewis *et al.,* 2006; Riou *et al.,* 2006; Thaxter *et al.,* 2012). and colony size (Lewis *et al.,* 2001; Forero *et al.,* 2002; Ainley *et al.,* 2003; Wakefield *et al.,* 2013) with the effect of food abundance greater than that of colony size.

1.5.12 As such, it can be surmised that foraging trips will be of shorter duration at colonies where food availability allows high productivity. This assertion suggests that long foraging ranges of kittiwakes recorded at some colonies in northern Scotland,

[3] Seabirdwikispaces.com

where breeding productivity is low, do not translate to colonies on the east coast of England where low food availability and poor breeding success have not been recorded during the JNCC monitoring period of 1986 to 2013. Daunt *et al.* (2002) suggest that central place foragers, such as seabirds, will have an upper limit associated with potential foraging range, set by time constraints associated with breeding productivity. This upper limit is estimated at 73 km based on the flight speed of kittiwake and time required to catch prey for birds from the Isle of May. This information indicates that foraging trips of kittiwake from the FFC pSPA are more likely to occur closer to the colony with less than 5% of foraging trips interacting with the Project site.

Revised analysis

1.5.13 The preceding text has already seriously questioned the validity of assigning 93.5% of kittiwakes at the Project site to breeding adult birds when the latter statistic actually represents a cohort of unknown aged birds that does not include one year olds. What is certain is that an unknown proportion of the cohort of unaged 'adult type' kittiwakes at the Project site will include two and three year old birds. It is also known that of 22,870 birds for which age was recorded, 6.5% were recorded as one year old birds. Furthermore one year old birds show less affinity for visiting the colony than older immatures prior to first-time breeding (Coulson 2011). It is therefore reasonable to conclude one year old birds distribution during the breeding season will show no greater affinity to the sea area within proximity to the colony, including the Project site, than would older immatures. Therefore as an absolute minimum, the proportion represented of each year class of immatures at the Project site will be equally as large as for one year old birds i.e. 6.5% of the 22,870 birds for which age was recorded.

1.5.14 Whilst maintaining the proportion represented of each year class of immatures at the Project site, mortality reduces the absolute number of birds present from each successive year class of kittiwake. In calculating the number of two and three year old kittiwakes at the Project site, the analysis uses survival rates of each immature age class of kittiwake that follows the Model KI1 of Appendix M of the Applicant's response to Deadline IIA (Reference REP2A-015) i.e. 0.79 for juveniles, and set at 0.85 for one year olds and 0.87 for two year olds.

1.5.15 Table 1.1 presents the calculations underpinning the analysis which concludes with the proportion of 83.0% as breeding adults present at the Project site. It should be however emphasised that though the analysis is suggested to be a step closer to the real situation than the use of 93.5% as the proportion of breeding adults present at the Project site, this is still a highly precautionary upper limit. The analysis does not account for the greater affinity for visiting the colony prior to first-time breeding that immatures show with increasing age and therefore likewise adjacent sea area, which can be expected to result in more birds at the Project site with each successive age class of immature birds.

Table 1.1: Estimated breeding season contribution of FFC pSPA birds to total predicted to be present on the Hornsea Project Two using immature proportions as calculated from survival rates and numbers of one year old birds recorded at the Project site.

Successive steps of the analysis	Formulas used (using the parameters identified in first and third columns)	Value
(a) Survival rate of juvenile birds		0.79
(b) Survival rate of one year old birds		0.85
(c) Survival rate of two year old birds		0.87
(d) % of kittiwakes at project site assigned to one year old birds		6.54%
% of kittiwakes at project site assigned to other immature age classes: (e) two year old (f) three year old	e = [{(1 x a) x b} / a] x d f = ([{(1 x a) x b} x c] / a) x d	5.56% 4.84%
(g) % of kittiwakes at project site assigned to adults	g = 100% - (d + e + f)	**83.0%**

Summary of Stage 1

1.5.16 It is therefore considered that a breeding season apportioning percentage of 83.0% to FFC pSPA can be seen as the very maximum ceiling appropriate for Project Two. This is seen to be overly precautionary due to the following:

- Does not account for adults in the population not breeding in a given year (paragraph 1.5.6) – this could account for a further reduction of c5%
- A likelihood of a greater proportion of older age classes of immature birds showing affinity with the colony (paragraph 1.5.14)
- FAME data indicates that the majority of foraging flights are close to the colony and data given by BirdLife[4] suggests that only up to 5% of birds are likely to travel as far as the Project (paragraph 1.5.10)
- Immature birds are not likely to be evenly distributed within the North Sea and will show aggregations near to foraging resources. If the area within which the Project lies is seen to be notable for kittiwake foraging; immatures will be present in number.

1.5.17 The Applicant therefore considers that is appropriate to consider scenarios between their advocated apportioning rate of 38% up to a maximum of 83%; with a significant likelihood that the true value lies towards the former.

1.5.18 Table 1.2 presents the outcome of Stage 1 of the analysis and its implications on Natural England's calculation of mortality. Under Natural England's advocated

[4] http://www.birdlife.org/worldwide/news/birdlife-international-seabird-foraging-range-database

Band (2012) option and associated avoidance rate, an apportioning value of 83.0% represents 113.2 collisions in the breeding season (118.6 annually).

Table 1.2: Change in breeding season collision risk from Project Two alone taking into account Stage 1 including consideration of additional immature age classes

Stage 1	
Alternative approach – Stage 1 (83% @ Option 2)	**113.2**
% Change due to Alternative Approach	**-12.3%**

1.5.19 The analysis presented for stage 1 also applies to Hornsea Project One, where currently an overly precautionary 100% apportioning value is applied in the in-combination assessment. This is fully detailed in Section 1.11.

1.6 Stage 2 – kittiwake flight height at Project Two and determination of PCH (Potential Collision Height)

Overview

1.6.1 While the Applicant's position has remained that the Extended Band (2012) Model should be used for kittiwake, Natural England in addition to disagreeing with this position, also disagree with applying the Project flight height data to inform the Basic (Band (2012) Model i.e. Option 1.

1.6.2 Option 1 applies a simple Potential Collision Height (PCH) value to the model which indicates the number of birds above the minimum point above sea level. The use of boat-based (or aerial) surveys allows for site-specific data to be collected which may indicate site-specific trends. If it were expected that site-specific data would return identical results to those available from published literature (e.g. Johnston *et al.,* 2014) then it would be significantly more efficient to apply the data already published.

1.6.3 Natural England have stated that the data collected at the Project site produced an 'odd' result for kittiwake in that it was outside of confidence limits presented in Johnston *et al.* (2014). Natural England have also stated that the methodology applied to collecting flight height data at the Project was not standard in applying 5 m intervals and were not aware of any similar approaches used to inform other offshore wind applications.

1.6.4 . Any deemed inaccuracies associated with bird flight heights are only significant at heights associated with the lower rotor height of a turbine. At this height incorrect assignment of a bird to a flight height band above or below the lower rotor height would affect the resulting PCH value. However, potential errors associated with the incorrect assignment are not limited to boat-based surveys undertaken for the project but are associated with the collection of flight height data regardless of the flight height bands being used. The use of five metre bands does, however in the

Applicants view, increase confidence in the PCH values obtained. For those birds recorded at lower flight heights (e.g. <20 m) there is a higher degree of confidence that these birds are outside of the rotor swept area. Such confidence cannot be obtained by using flight height bands representing below, within or above rotor height as there is no indication as to what height within these bands a bird was flying.

Project Two flight height data

1.6.5 During the first Issue Specific Hearing for the Project questions were raised as to the accuracy of flight height data collected during site-specific surveys, with discussion centred on the methodology used to collect flight height data.

1.6.6 The extensive boat-based survey programme for the Project yielded abundant data that is considered fully adequate to robustly characterise the flight height behaviour of birds for the purpose of collision risk assessment. PCH values for Subzone 2 transects have been calculated on an annual basis in order to provide a sample size that is sufficient to provide an accurate representation of bird behaviour at the site. A total of 100 individual species records have previously been considered sufficient to allow for the calculation of PCH values considered representative of bird behaviour (Natural England, 2013).

1.6.7 Data used to provide flight height of birds was collected during surveys of Subzone 2 and the Hornsea Zone between March 2011 and February 2013. Flying birds were recorded in a number of height bands, starting at 0 – 2.5 m above sea level, and in increments of 5 m above this. Overall, approximately 95% of all birds were recorded flying below 22.5 m in height, the closest division of a height band to the minimum rotor height.

1.6.8 It has been suggested by Natural England that the approach used to collect flight height data, specifically the height band divisions used, were non-standard. Natural England stated that the normal methodology uses flight bands representing ‘below rotor height’, ‘within rotor height’ and ‘above rotor height’ and that they were unaware of other projects utilising the approach employed by the Applicant.

1.6.9 Research undertaken by the Applicant investigating the methodology employed by different offshore wind farm projects to collect flight height data reveals that the assertions made by Natural England are misleading. Information was found for 26 projects of which the methodology for only 8 could be correctly described as below, within and above rotor height (Table 1.3). Many projects used more detailed height bands with many (eight) using height bands of five metres or less (including some projects that incorporated one metre bands) for at least part of the flight height profile.

1.6.10 PCH values are used within Option 1 of the Band (2012) collision risk model. There are a number of projects in Table 1.3 for which Natural England have used Band (2012) Option 1 numbers in the in-combination assessment for kittiwake. These include projects which have used flight height bands with a similar or finer resolution than that used for Hornsea Project Two (Blyth Demonstration, Galloper, London Array and Neart na Gaoithe). There are also a number of projects where it is unlikely that the flight height bands used are consistent with rotor parameters (Aberdeen, Beatrice, Moray, Race Bank, Triton Knoll and Westermost Rough).

Table 1.3: Review of flight height band application for baseline surveys of offshore wind projects.

Project	Survey period	Surveyor	Flight height bands applied
Aberdeen	February 2007 - April 2008	n/a	0-2 m, 2-10 m, 10-25 m, 25-50 m, 50-100 m, 100-200 m, > 200 m
Atlantic Array	April 2009 – March 2011	ECON	< 20 m, 20-120 m, > 120 m
Beatrice	October 2009 – September 2011	IECS	< 20 m, 20-150 m, 150-200 m, > 200 m
Blyth Demonstration	July 2010 – November 2011	n/a	Below 10 m heights estimated to 1 m bands; between 10-20 m heights estimated to 2 m bands; between 20-50 m heights estimated to 5 m bands; above 50 m heights estimated to 10 m bands
Burbo Bank Extension	April 2011 – September 2011	CMACS	0-30 m, 31-140 m > 140 m
Dogger Bank projects (Creyke Beck and Teesside A & B)	January 2010 – January 2012	Gardline	Varied over time: Feb-Nov 2010: 0-20 m, 20-180 m, >180 m; Dec 2010-Feb 2011 – addition of 20-25 m band; Feb 2011-onwards: addition of 25-50 m band
Galloper	2008 – 2010	ESS	Nearest 5 m band from 5-40 m, nearest 10 m band from 40-100 m
Gwynt y Môr	February 2003 – March 2005	n/a	< 1 m, 1-20 m, > 20m
Hornsea Project One	March 2010 – February 2012	Cork Ecology	Nearest 5 m band

Project	Survey period	Surveyor	Flight height bands applied
Inch Cape	September 2010 – September 2012	Natural Power	5 m bands up to 50 m, 10 m bands up to 100 m, 50 m bands above 100 m
London Array	October 2002 – March 2005		Below 10 m heights estimated to 1 m bands; between 10-20 m heights estimated to 2 m bands; between 20-50 m heights estimated to 5 m bands; above 50 m heights estimated to 10 m bands
Moray	April 2010 – March 2012	Natural Power	< 5 m, 5-10 m, 10-20 m, 20-200 m, 200-300 m, > 300 m
Navitus Bay	December 2009 – November 2011	ESS	Nearest 5 m band
Neart na Gaoithe	November 2009 – October 2011	Cork Ecology	Nearest 5 m bands below lower rotor height (22.5 m) and above 22.5 m
Ormonde	May 2004 – April 2005	n/a	Below 10 m heights estimated to 1 m bands; between 10-20 m heights estimated to 2 m bands; between 20-50 m heights estimated to 5 m bands; above 50 m heights estimated to 10 m bands
Race Bank	December 2005 – November 2007	n/a	0 m, 0-20 m, 20-120 m, >120 m
Rampion	Two years from March 2010	ESS	0-2 m, 2-10 m, 10-25 m, 25-50 m, 50-100 m, 100-200 m, >200 m
Seagreen Alpha and Bravo	December 2009 – November 2011	ECON	< 20 m, 20-120 m, > 120 m
Sheringham Shoal	March 2004 – February 2006	n/a	0-20 m, 20-100 m, 100-250 m, >250 m

Project	Survey period	Surveyor	Flight height bands applied
Triton Knoll	January 2008 – December 2009	ECON	0 m, 20 m, 20-120 m, >120 m
Walney 1 & 2	May 2004 – September 2005	n/a	< 5 m, 5-15 m, 15-100 m, > 100 m
Walney Extension	June 2011 – November 2012	CMACS	Initial surveys: 0-30 m, 30-140 m, > 140 m March 2012 onwards: 0-22m, 22-30 m, 30-222 m, > 222 m
Westermost Rough	August 2004 – July 2006	IECS	0-2 m, 2-10 m, 10-15 m, 15-25 m, 25-50 m, 100-200 m, > 200 m

1.6.11 In order to calculate the proportion of birds at potential collision height (PCH), data from five metre bands were grouped into ten metre bands for analysis. All flight height observations were treated as if they are taken at mean sea level. At mean sea level, minimum rotor height is 24.08 m which is not coincident with the flight height bands used during boat-based surveys (this height is contained within the 22.5 m to 32.5 m flight height band used for analysis). Therefore, in order to determine the number of birds above minimum rotor, and as such PCH, the proportion of the 22.5 m to 32.5 m height band above minimum rotor height was calculated (84.2%) and applied to the number of birds recorded within the 22.5 m to 32.5 m height band. This approach assumes birds are evenly distributed within the 22.5 m to 32.5 m height band, an approach considered to be precautionary with the distribution of birds more likely to be skewed towards the lower heights within the height band (Johnston *et al*., 2014).

1.6.12 The use of finer resolution height bands has the potential to increase confidence in associated PCH predictions. For example, if a seabird is assigned to the 0-2.5 metre flight height band there is considered to be a high degree of confidence that that bird is outside of the rotor swept area. If data were recorded in broad flight height bands that simply represented ‘below rotor height’, ‘within rotor swept area’ and ‘above rotor height’, this level of confidence is lost.

1.6.13 Flight height data was collected in five metre bands and it is considered that resolution to this scale does not undermine confidence in the resulting PCH values. The key aspects of the calculation of a PCH value are those height bands which intersect with the lower rotor height. Errors in the recording of flight height at this point can result in under or over-estimations of PCH. However, the use of 5 metre resolution height bands does not increase the likelihood of such errors.

1.6.14 As is detailed above the post-processing and calculation of PCH values is considered to be precautionary when knowledge pertaining to the vertical distribution of birds across water is considered.

1.6.15 In order to provide confidence in the PCH values calculated for the Project, a sensitivity analysis has been conducted incorporating flight height data that falls below the lower rotor height (24.08 m) of turbines that were incorporated into the CRM.

1.6.16 Figure 1.2 presents the cumulative percentage of kittiwake recorded in each flight height during boat-based surveys. A total of 77% of birds recorded were observed flying below 12.5 m with this increasing to 95.6% at 22.5 m. Because these flights are generally less than 10 m above the surface of the water, it seems unlikely that surveyors would wrongly attribute flights as being lower than rotor height, and therefore it is considered that there is high confidence in the survey data.

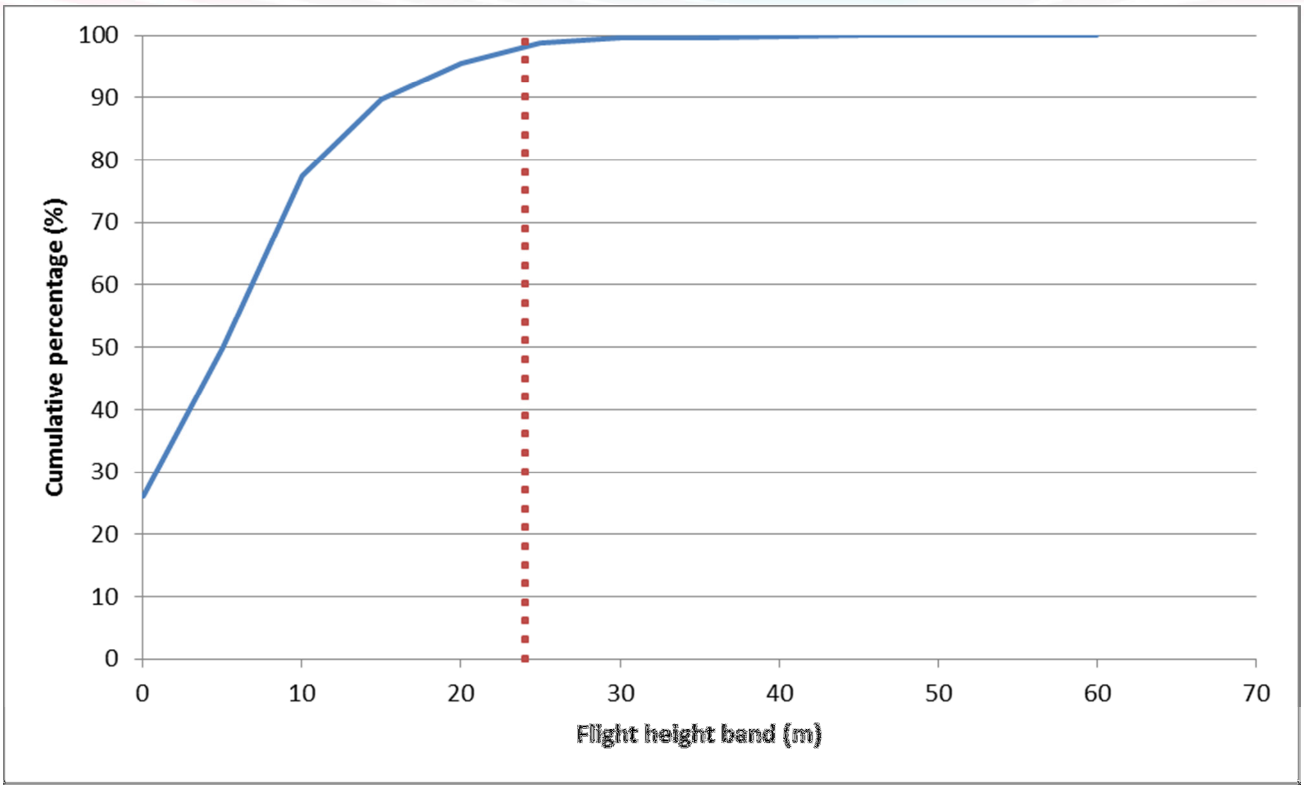

Figure 1.2: Number of birds in each flight height band recorded during boat-based surveys of Subzone 2 and 4 km buffer (red line indicates lower rotor height)

1.6.17 Natural England have previously stated that the Applicant should consider an appropriate way to account for the uncertainty in the flight height data collected during boat-based surveys.

1.6.18 In order to account for perceived uncertainty in the calculation of PCH values, analysis has been undertaken which re-analyses flight height data. This has been conducted by including additional bands into the PCH calculation (Table 1.4). The first sensitivity analysis assumes that all birds in the flight height bands 22.5 m and above are at risk of collision, with the second analysis assuming all birds above 20 m are at risk of collision. The second analysis has been calculated assuming that birds are evenly distributed throughout the 17.5 m to 22.5 m height band. This is precautionary as it does not take into account the decreasing abundance of birds with increasing height.

Table 1.4: PCH sensitivity analysis incorporating additional flight height bands

Flight height bands included	PCH value (%)
Current (all birds above 24.08 m)	3.79
All birds above 22.5 m	4.41
All birds above 20 m	7.31

1.6.19 Based on the information presented this Section (Section 1.6) which discusses the flight height bands used for previous projects, the Applicant considers, that the PCH value calculated assuming all birds above 22.5 m are at risk of collision allows for consideration of uncertainty in PCH values. This band is the closest division of a height band to the minimum rotor height. As such, collision risk estimates using Option 1 of Band (2012) have been re-calculated incorporating the appropriate value in Table 1.4.

Review of kittiwake PCH in recorded at offshore wind projects

1.6.20 Greater confidence in data analysis such as the calculation of PCH is usually associated with higher sample sizes. Considering the assertion made that the kittiwake PCH values for Project Two are 'odd' the Applicant has reviewed other projects (Table 1.5). The highest sample sizes recorded for kittiwake are Hornsea Project One (37,325 birds), Teesside (12,217 birds), Neart na Gaoithe (4,914 birds), Aberdeen (2,791 birds) and Moray (2,123 birds). All of these projects, except Aberdeen, have PCH values that are below the lower confidence limit of data presented in Johnston *et al.* (2014).

1.6.21 Further to this, the flight height bands used to collect data at these projects (Table 1.5) are unlikely to be consistent with the lower rotor height at these projects. The PCH value calculated for Teesside for example was calculated assuming that all birds above 15 m would be at risk of collision. This is likely to represent a significant overestimate of PCH for a site where the PCH value is already low. Many of the projects included in Table 1.5 that recorded low PCH values for kittiwake have been included, without question, in the In combination assessment for Project Two by Natural England.

Table 1.5: Kittiwake PCH values and associated sample sizes from data sets collected for UK offshore wind projects

Project	Sample size	PCH (%)
Aberdeen	2,791	18.56
Atlantic Array	-	11.9
Beatrice	55	13.3
Blyth Demonstration	Aerial = 125	Aerial = 26 Boat-based = 12 Vantage point = 7
Dogger Bank projects (Creyke Beck and Teesside A & B)	n/a	20
Galloper	n/a	5.3 – 13.9
Gwynt y Môr	603 – 1,353	5.3 – 13.9

Hornsea Project One	37,325	2.8
Inch Cape	Breeding = 1,508 Non-breeding = 873	Breeding = 0.4 Non-breeding = 9.2
Kentish Flats Extension	n/a	Boat-based 2005-2007 = 2 Boat-based 2009-2010 = 3
Moray	2,123	4.6
Navitus Bay	50	10
Neart na Gaoithe	4,914	6
Ormonde	n/a	19
Race Bank	n/a	9.72
Rampion	1,008	14
Teesside	12,217	4
Triton Knoll	n/a	11.2
Walney 1 & 2	601	15.5
Walney Extension	203	33
Westermost Rough	328	14

1.6.22 The PCH values included in Table 1.5 are presented graphically in Figure 1.3. Also included in the figure are generic PCH values (including confidence limits) which are calculated using the supporting information from Johnston *et al.* (2014). The generic PCH values are calculating using a rotor swept area of 22-150 m. This provides a rotor swept area that includes the main risk area for birds (i.e. lower rotor heights), includes the rotor swept areas of all projects included in Table 1.5 and is therefore precautionary as it is likely to be larger than the rotor swept areas at any of the projects in Table 1.5.

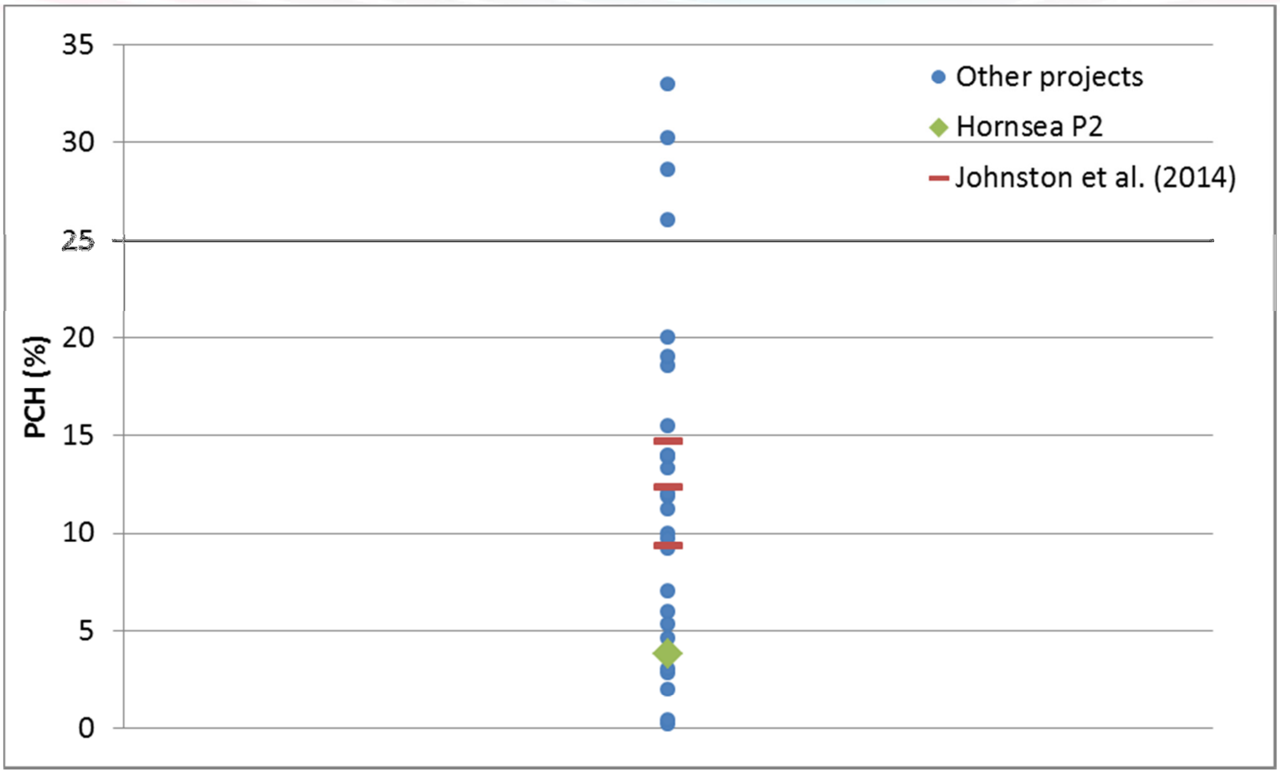

Figure 1.3: Kittiwake PCH values from all projects included in Table 1.5.

1.6.23 Figure 1.3 clearly shows that PCH values from the majority of projects fall outside of the confidence limits associated with the generic PCH value calculated from Johnston *et al.* (2014). There are a large number of PCH values which are below the lower confidence limit than within it.

Applicability of generic data

1.6.24 It is accepted that the Project PCH values for a number of species, including kittiwake, fall outside of the confidence limits associated generic data presented in Johnston *et al.*, (2014). However, there are several explanations why this may be so.

1.6.25 The Band (2012) guidance states the following in relation to generic flight height data from Cook *et al*. (2012) which preceded Johnston *et al*. (2014):

"Caution is needed in deploying this generic data. It is entirely possible that the ecological circumstances of a particular site differ from those sites used to generate the generic data, and hence the bird behaviours and flight heights may not be well represented by the generic data".

1.6.26 An example given by Band (2012) refers to the proximity of a project to breeding colonies. Of the 32 projects from which data were obtained for use in Johnston et al. (2014), only one is an offshore site and therefore potentially comparable to Project Two.

1.6.27 The data presented in Johnston et al. (2014) and those calculated by the Applicant are likely to be incompatible and therefore comparisons made are misleading. The PCH values in Johnston *et al*. (2014) are calculated using a theoretical rotor swept area ranging from 20-120 m while the PCH values presented by the Applicant represent a rotor swept area of 24.08- 150.08 m. The use of a 20-120 m rotor swept area does not represent the turbine parameters that could be used at any offshore wind farm. The lower rotor height of a turbine at an offshore wind farm cannot be below 22 m for navigational safety reasons (Davies and Band, 2012). As such the use of a 20 m lower rotor height, as in Johnston et al. (2014) represents a likely over-estimate of PCH.

Summary of Stage 2

1.6.28 The Applicant considers that site specific flight height data collected for Project Two is completely adequate to inform the assessment and in particular for application in Option 1 of Band (2012). Key reasons underpinning this position are as follows:

- Data collected did not follow an unusual methodology;
- Site specific data in this case should be seen as the primary indicator of local conditions;
- Any observer error in assigning flight heights has a negligible effect on PCH calculation;
- PCH value for kittiwake at Project Two is not an outlier when considering a range of datasets; and
- Generic data for kittiwake PCH is not directly comparable to Project Two.

1.6.29 The Applicant therefore considers that is appropriate to consider Option 1 as valid within the assessment of kittiwake collision risk.

1.6.30 Table 1.6 presents the outcome of Stage 2 and its implications on Natural England's calculation of kittiwake mortality from Project Two alone. Under Natural England's advocated apportioning rate of 93.5% (updated from 94.6 to account for the inclusion of April within the breeding season) 49.5 collisions are predicted for the breeding season (51.7 annually), which represents a change of 61.6%.

1.6.31 Where Stages 1 and 2 are combined with therefore, a breeding season apportioning value of 83.0% at Option 1, 44.0 collisions are predicted in the breeding season (46.1 annually) which represents a change of 65.9%.

Table 1.6: Change in breeding season collision risk from Project Two alone taking into account of site-specific flight height data and Option 1.

Stage 2 : Use of PCH to inform Option 1 in the breeding season Project Two	
Stage 2 (93.5% apportioning @ Option 1)	**49.5**
% Change due to Stage 2	**-61.6%**
Stages 1- 2 additively (83% breeding adult proportion; Option 1)	**44.0**
% Change due to Stages 1-2	**-65.9%**

1.7 Stage 3 – Phenology

1.7.1 . The breeding season defined for kittiwake in the Offshore Ornithology ES chapter (Doc ref No. 7.2.5) and HRA Report (Doc ref No. 12.6) is May to July. The seasons used for kittiwake were defined based on information in Furness (2015) following consultation with Natural England during Section 42. Furness (2015) is aimed at defining the extent of non-breeding seasons (i.e. for kittiwake the post-breeding and pre-breeding seasons). It is considered that the migration-free breeding season of May to July presented in Furness (2015) more accurately represents the occurrence of kittiwake in offshore areas. This breeding season extent is similar to that presented in Kober *et al.* (2010) which defines breeding seasons for species within the British Fishery Limit. It is the Applicant's view that the breeding season defined for kittiwake (May to July) represents the core period during which impacts may disproportionately affect the breeding population at Flamborough and Filey Coast pSPA. During this period the foraging range of breeding kittiwake at the colony will be constrained due to the necessity to provision young.

1.7.2 When considering the possibility of including April as part of the breeding season for kittiwake as detailed within Natural England's position, it is important to consider the wider movements of kittiwake in the North Sea, and the destination of these birds. A proportion of these birds will be returning to FFC pSPA, however, a larger proportion will be migrating through the North Sea to colonies further north. Spring migration through UK waters is completed by May (Furness, 2015; Forrester *et al.,* 2007) with migration peaking during March and April. In England, the majority of birds return to breeding colonies between March and April (Brown and Grice, 2005).This would indicate that not all kittiwake would be expected to be present at the pSPA during March and April and therefore these months are more accurately described as pre-breeding months.

1.7.3 Further to this, it is considered highly unlikely that birds will be attending eggs or provisioning young during April meaning that birds will be less restricted in terms of foraging range. The Applicant notes that this has already been considered and addressed within the apportioning exercise undertaken for kittiwake with the definition of a pre-breeding season which covers January to April. During this period, the population of kittiwake in the North Sea was calculated as 639,742 individuals. This population includes 53,424 breeding adults from the pSPA representing 60% of the total pSPA population. Therefore the apportioning exercise already presented assumes that 60% of the pSPA population is at the colony throughout the pre-breeding season the Applicant considers this a precautionary assumption.

Summary

1.7.4 The approach applied by the Applicant for the pre-breeding season in the HRA Report (Doc ref No. 12.6) incorporates seasonal definitions from Furness (2015) which are based on a substantial body of evidence.

1.7.5 The Applicant considers that the definition of kittiwake phenology is based primarily on the likelihood of patterns observed in offshore areas (i.e. at the Project site) not from breeding colonies. During the pre-breeding period large numbers of kittiwake, including birds from FFC pSPA, migrate through the North Sea to reach breeding colonies. It is therefore considered ecologically inappropriate to apportion 100% of birds at the Project site to the pSPA during April.

1.7.6

1.7.7 Table 1.7 presents the outcome of Stage 3 and its implications on Natural England's calculation of kittiwake mortality from Project Two alone. Under Natural England's original advocated apportioning rate 94.6 to account for the exclusion of April within the breeding season) 104.5 collisions are predicted for the breeding season (111.8 annually), which represents a change of 19% (16.8% for annual figures).

1.7.8 When Stages 1, 2 and 3 are combined with therefore, a breeding season apportioning value of 83.0% at Option 1, 35.6 collisions are predicted in the breeding season (38.5 annually) which represents a change of 72.4% (71.4 % for annual figures).

Table 1.7: Change in kittiwake breeding season definitions within Natural England's collision risk prediction from Project Two alone

Stage 3 : Application of kittiwake breeding season of May-July for Project Two	
Stage 3 (May – Jul, 94.6% apportioning @ Option 2)	**104.5**
% Change due to Stage 3	**-19.0**
Stages 1- 3 additively (May – Jul, 83% breeding adult proportion; Option 1)	**35.6**
% Change due to Stages 1-3	**-72.4**

1.8 Stage 4 – Avoidance rates applied for Kittiwake in the Basic Band Model

1.8.1 An extensive research project on avoidance rates used within collision risk modelling commissioned by Marine Scotland and awarded to the British Trust for Ornithology (BTO) was published in 2014 (Cook et al., 2014). This document was submitted for the Project on the request of the ExA as Appendix X to the Applicant's response at Deadline I, alongside the SmartWind & Forewind (2013) (Appendix Z) which provides a similar review.

1.8.2 Cook et al., (2014) identify five key species, including kittiwake, for which they aimed to determine appropriate avoidance rates for use within both the Basic and Extended Band (2012) models. For kittiwake it is concluded with respect to the Basic Band Model:

"No consistent evidence of macro-avoidance was found for black-legged kittiwake. It was not possible to derive species-specific within-windfarm avoidance rates for black-legged kittiwake (section 5.3). However, as black-legged kittiwake have similar wing morphologies (wingspan, wing:body aspect ratio, wing area: Robinson 2005, Alerstam et al. 2007), flight speeds (Alerstam et al. 2007) and flight altitudes (Cook et al. 2012, Johnston et al. 2014b) to black-headed and common gulls, which contribute the majority of records for the small gulls group, the within-windfarm avoidance rates derived for the small gulls group were considered appropriate for this species. A total avoidance rate of 0.992 (i.e. 99.2%) is thus recommended for the basic Band model."

1.8.3 A joint SNCB response to Cook *et al.* (2014) was issued in November 2014. The SNCBs supported the recommendations on avoidance rates except with regards to kittiwake. The SNCBs state that:

"The SNCBs consider that the principles applied to northern gannet avoidance rate recommendations in the face of lack of species-specific data (i.e. application of the lowest "all gull" alternative rate derived by the review) should also be applied to black-legged kittiwake avoidance rates. The report includes kittiwake within the 'small gull' category, the data for which are predominantly derived from common gulls and black-headed gulls. Indeed, no species-specific data for kittiwakes are represented within the 'small gull' category at all.

While the report provides a theoretical argument towards the inclusion of kittiwakes within the 'small gull' category, there are equally arguments that could be put forward in support of their treatment as part of the 'large gull' category (i.e. typical flight speeds and generally more marine behaviour). Consequently, we feel these somewhat subjective arguments should be discounted in favour of a more consistent and precautionary approach with regards the treatment of other species lacking species-specific within windfarm avoidance rate data (namely gannets).

Therefore, we recommend that, until such time as it is possible to calculate a species-specific avoidance rate for kittiwakes, they are classed under the more generic (and precautionary) 'all gull' category".

1.8.4 Therefore the SNCBs, including Natural England, advocate a 98.9% avoidance rate contra the 99.2% recommended by Cook *et al*. (2014). The Applicant however, strongly supports the assumptions applied by Cook and suggests that a 99.2% avoidance rate is most appropriate for use in the Basic Band Model.

1.8.5 The assertion made by the SNCBs that there are arguments that kittiwake could be treated as part of the 'large gull' category by quoting typical flight speeds and more marine behaviour can be challenged. Kittiwake mean flight speed has been measured in two standard references as being at 13.1 m/s (Alerstam et al. 2007; Pennycuick 1997). Studies have found that herring gull (a 'large' gull) mean flight speed is between 11.8 Pennycuick 2001) and 13.4 m/s (Pennycuick 2013). However, for common gull (a 'small' gull species which has a slightly large wing span than kittiwake) mean flight speeds also range from 11.8 to 13.4 m/s from the same literature. It is quite clear that flight speed cannot be used as a justification for treating kittiwake as part of a large gull category. On morphological grounds it is clear that kittiwake represents a 'small gull'.

1.8.6 The SNCBs also refer to kittiwakes more maritime behaviour than other 'small gulls' which is accurate. However, the data used by Cook *et al.* (2014) to determine 'within wind farm avoidance' is from onshore wind farms; and kittiwake clearly differs in foraging strategy from large gull species (Coulson 2011); the Applicant therefore believes that there is no apparent reason for applying an 'all gull' based rate to kittiwake on behavioural grounds. The most appropriate avoidance rate metric to be applied for kittiwake is the small gull rate as suggested by Cook et al. (2014).

1.8.7 The recommendation given by Cook *et al.,* (2014) which is an avoidance rate of 0.992 against that advocated by Natural England (0.989) translates as a 27.27% difference in predicted collisions (Table 1.8).

1.8.8 Table 1.8 shows the outcome of Stage 4 and its implications on Natural England's calculation of kittiwake mortality from Project Two alone. Under Natural England's advocated apportioning rate of 93.5%, 92.7 collisions are predicted for the breeding season (96.6 annually), which represents a change of 28.1% (28.1% for annual figures).

1.8.9 Where Stages 1-4 are combined with therefore, a breeding season apportioning value of 83.0% at Option 1 at an avoidance rate of 99.2%, 25.9 collisions are predicted in the breeding season (28.0 annually) which represents a change of 79.9% (79.2% for annual figures).

Table 1.8: Stage 4 of the assessment; alternative avoidance rate applied within the Basic Band Model.

Stage 4 : Alternative Basic Model Avoidance Rate – Project Two alone	
Stage 4 (April – Jul, 93.5% apportioning @ Option 2; 99.2% AR)	**92.7**
% Change due to Stage 3	-28.1
Stages 1- 4 additively (May – Jul, 83% breeding adult proportion; Option 1; 99.2% AR)	**25.9**
% Change due to Stages 1-4	-79.9

1.8.10 Natural England have utilised Basic Band Models for all projects included in their in-combination position (Appendix 2). Therefore, the implications of a 27.7% reduction when applying a 99.2% avoidance rate (as for Project Two alone) is discussed for other projects in Section 1.11.

1.9 Stage 5 – Application of the Extended Band Model

1.9.1 The Band (2012) model incorporates two approaches to calculating the risk of collision referred to as the 'Basic' and 'Extended' versions of the model. A key difference between these versions is the extent to which they account for the flight height patterns of seabirds (Band 2012):

"13. Taking account of bird flight height distribution. Seabirds mostly fly at relatively low heights over the sea surface. The height distribution varies from species to species and may depend on the site and its ecology and related bird behaviour. The basic model considers the risk only to birds flying at risk height (above the minimum and below the maximum height of the rotors) and of these, only those which pass through the rotors. However within these limits it assumes a uniform distribution of bird flights. There are three consequences of a skewed distribution of flights with height:

- *the proportion of birds flying at risk height decreases as the height of the rotor is increased;*
- *more birds miss the rotor, where flights lie close to the bottom of the circle presented by the rotor; and*
- *the collision risk, for birds passing through the lower parts of a rotor, is less than the average collision risk for the whole rotor.*

This guidance now includes, in addition to the basic model, an extended model (March 2012) which enables flight height distributions to be incorporated in the calculation, for use in circumstances where flight height data is available and adequately robust."

1.9.2 As the Basic version of the model simply assumes a uniform distribution of birds at potential collision risk height (PCH), a key input variable is the proportion of birds observed at PCH. All those birds though are assumed to be at a similar risk of collision. The model variant referred to as Option 1 is, therefore, the simplest and most approximate indicator of likely collision risk.

1.9.3 The Extended version of the model takes account of the flight height distribution of seabirds and calculates the differential risk to these at 1 metre intervals. This model variant requires more detailed information on the flight height distribution of birds. Option 3 of the model makes use of a series of 'generic' flight height distributions included in the model and based on the work of Cook et al. (2012).

1.9.4 With respect to the use of the different options of the model the guidance indicates (Band 2012 paras 63 & 64):

"63. Caution is needed in deploying this generic data. It is entirely possible that the ecological circumstances of a particular site differ from those in the sites used to generate the generic data, and hence bird behaviours and flight heights may not be well represented by the generic data. Before using generic data, consideration should be given to whether

- *is the site survey data compatible with the generic data? Does it indicate that the generic data reasonably represents the observations at this site?*
- *are there particular ecological circumstances which might be expected to lead to non-standard behaviour, e.g. proximity to breeding sites?*

64. A collision risk assessment for a specific site should not be based solely on the use of generic data. Where generic data is used, it is recommended that the collision risk for three different options is stated:

- *Option(i) - using the basic model, ie assuming that a uniform distribution of flight heights between lowest and highest levels of the rotors; and using the proportion of birds at risk height as derived from site survey.*
- *Option (ii) - again using the basic model, but using the proportion of birds at risk height as derived from the generic flight height information.*
- *Option (iii) - using the extended model, using the generic flight height information.*

The spreadsheet supporting this guidance provides for the calculation of all three options. ***If site survey information is sufficient to generate a flight height distribution, this should be used as an Option (iv) as well****."*

1.9.5 In this case has been argued by the Applicant that there are sufficient survey data to inform a site-specific understanding of the flight height distributions of key species at risk of collision, in particular kittiwake. The combination of the Extended version of the model with site-specific flight height data produces as accurate a prediction of the risk to seabirds as is possible with current information and risk assessment tools. In contrast. the Basic version of the model only approximates collision rates, in a highly precautionary way, because, amongst other things, it fails to fully take account of the way that birds are distributed over the sea surface.

1.9.6 It is noted in SOSS-02 that the avoidance rates used with the Basic version of the Band (2012) model may not be appropriate for use with the Extended version of the model. Collision risk modelling using Options 3 and 4 of the model has been criticised by Natural England (and others) because it is unclear what avoidance rate should be applied. Although, as highlighted by Natural England, Cook et al (2014) concluded that they could not currently recommend an avoidance rate for kittiwake to be used within the Extended Model Appendix Z of the Applicants Deadline I response also considers what precautionary avoidance rates should be used. This paper concludes on the basis of a comparison of the rates predicted by the Basic version of the model and the directly observed levels of avoidance at coastal and offshore wind farms that an avoidance rate of 98% is sufficiently precautionary.

1.9.7 Table 1.9 shows the outcome of Stage 5 and its implications on Natural England's calculation of kittiwake mortality from Project Two alone. Under Natural England's advocated apportioning rate of 93.5%, 71.0 collisions are predicted for the breeding season (74.0 annually), under Option 3. Under Option 4 utilising a Project specific flight height distribution for kittiwake, 15.6 collisions are predicted for the breeding season (16.3 annually).

1.9.8 Where Stages 1, 3 and 5 are combined with therefore, a breeding season apportioning value of 83.0% at Option 3 at an avoidance rate of 98%, 51.1 collisions are predicted in the breeding season (55.1 annually) which represents a change of 60.4% (59.0% for annual figures). Where Option 4 is utilised 11.2 collisions are predicted for the breeding season (12.1 annually) which represents a 91.3% reduction (91.0% annually) from Natural England's Deadline III submission.

Table 1.9: Stage 5 of the assessment; alternative avoidance rate applied within the Basic Band Model.

Stage 5 : Extended Band model	
Stage 5 (April – Jul, 93.5% apportioning @ Option 3; 98% AR)	**71.0**
Stage 5 (April – Jul, 93.5% apportioning @ Option 4; 98% AR)	**15.6**
% Change due to Stage 3 (Option 3)	-45.0
% Change due to Stage 3 (Option 4)	-87.9
Stages 1, 2, 3 and 5 additively (May – Jul, 83% breeding adult proportion; Option 3; 98% AR)	**51.1**
Stages 1, 2, 3 and 5 additively (May – Jul, 83% breeding adult proportion; Option 4; 98% AR)	**11.2**
% Change due to Stages 1, 3 and 5	-60.4
% Change due to Stages 1, 3 and 5	-91.3

1.10 Summary of stages 1 – 5 Project Two alone

1.10.1 Table 1.10 Presents a summary of stages 1 – 5 applied to collisions risk estimates from Project Two alone, taking Natural England's Deadline III submission as a starting point. The Table presents the collision estimates for each season relevant to kittiwake an indicates the additive effect the of each stage in turn.

1.10.2 The Applicant's position (Appendix 1 of this clarification Note) most closely resembles Stage 5. The notable difference being the advocated 38% breeding season apportioning by the Applicant versus the precautionary 83 % implemented in Stage 1 and carried forward to Stage 5.

1.10.3 Several of the Stages applied to Project Two collision estimates also apply to projects considered in combination; these are therefore investigated in Section 1.11.

Table 1.10: Summary of stages 1-5 – kittiwake collision risk from Project Two alone

Stage	Key Parameters	Breeding	Post-breeding	Pre-breeding	Annual
Natural England Deadline III submission	93.5% breeding season apportioning Band Model Option 2 (generic PCH) April – July breeding season 98.9% avoidance rate	127.4	3.8	1.6	132.9
1	83% breeding season apportioning Band Model Option 2 (generic PCH) April – July breeding season 98.9% avoidance rate	113.2	3.8	1.6	118.6
2	83% breeding season apportioning Band Model Option 1 (P2 PCH) April – July breeding season 98.9 % avoidance rate	44.0	1.5	0.6	46.1
3	83% breeding season apportioning Band Model Option 1 (P2 PCH)	35.6	1.5	1.3	38.5

	May – July breeding season 98.9 % avoidance rate				
4	83% breeding season apportioning Band Model Option 1 (P2 PCH) May – July breeding season 99.2% avoidance rate	25.9	1.1	1.0	28.0
5	83% breeding season apportioning Band Model Option 4 (P2 flight height distribution) May – July breeding season 98% avoidance rate	11.2	0.5	0.4	12.1

1.11 Projects considered in combination with Project Two

Overview

1.11.1 The Applicant and Natural England have set out their positions considering projects in combination with Project Two within their submissions at Deadline IIa and III respectively. Under the scenario advocated by the Applicant, 145.8 kittiwake collisions per annum are predicted. Under the scenario advocated by Natural England 503.1 kittiwake collisions per annum are predicted.

1.11.2 The Applicant has broadly followed the advice given by Natural England with respect to the assessment of projects considered in-combination. Notable differences include:

- No inclusion of any project in the breeding season that is outside of Natural England's advised foraging range (156km) including Dogger Bank Teesside A and B.
- Application of Extended Band (2012) Model results where available
- Where only Basic Band (2012) Model results available, avoidance rate of 99.2% is applied based on Cook *et al.,* (2014).

1.11.3 Natural England have provided a full breakdown of their position with regards to that summarised in their Deadline III position. This is included in Appendix 2 of this Note.

1.11.4 The Applicant has reviewed Natural England's submission and considers that the method of determination on whether a project is included in the assessment and the subsequent apportioning values is matter of some debate. The Applicant has agreed with Natural England that it would be of value to present the level of confidence that can be drawn from the projects identified in terms of their potential to affect FFC pSPA.

1.11.5 The assessment in Stage 1 for the Project alone (Section 1.5) considered an alternative (and still highly precautionary) upper celling for breeding season apportioning. A parallel exercise with respect of Hornsea Project One (which is subject to 100% breeding season apportioning within Natural England's submission) is undertaken.

1.11.6 Finally, the application of the Extended Band (2012) Model and the use of supported avoidance rates within the Basic model have been reviewed for the Project alone in Sections 1.8 and 1.9. The implications for projects considered in combination are therefore discussed within this section of the Note.

Review of projects considered in combination

1.11.7 This section presents a tiering system for projects considered in combination indicating decreasing confidence that predicted impacts in the breeding season for kittiwake relate to FFC pSPA.

1.11.8 Tiers are defined based on mean-maximum foraging range as defined in Thaxter et al., (2012) (indicated in Figure 1.4) and the degree of 'connectivity' between a project and the pSPA as shown by tracked kittiwakes through the FAME Project. Tiers are defined as follows:

- Tier 1: Any project falling within Thaxter *et al.* (2012) mean maximum foraging range (60 km);
- Tier 2: Any project with strong connectivity recorded by FAME;
- Tier 3: Any project with weak connectivity recorded by FAME; and
- Tier 4: Projects outside of foraging range and no connectivity noted by FAME.

1.11.9 Table 1.11presents the outcome of the tiering exercise and presents results from the Project without consideration of Stages 1- 5 presented within this Note. Tier 1 projects are those within mean-maximum foraging range of FFC pSPA (Westermost Rough and Humber Gateway) and represent 2.7 collisions in the breeding season calculated using Natural England's advocated Band Model (i.e. Basic Model) and avoidance rate (98.9%).

1.11.10 Tier 2 projects are those with deemed connectivity with FFC pSPA despite being outside of mean-maximum foraging range (Figure 1.4). These projects comprise Hornsea Project One and the Project and represent 175.3 collisions in the breeding season (178.0 combined with Tier 1) under Natural England's advocated Band Model and avoidance rate (assuming a breeding season apportioning value of 93.5%).

1.11.11 Tier 3 projects are those where only weak connectivity with FFC pSPA has been established through FAME tracking data. Natural England has applied 100% apportioning in the breeding season for all of these projects with the exception of 19.3% for Dogger Bank Creyke Beck A and B. These projects represent 83.0 collisions in the breeding season (261.0 combined with Tier 1) under Natural England's advocated Band Model and avoidance rate.

1.11.12 Tier 4 projects are those where no connectivity has been established by FAME data and are also outside of any defined foraging range. Natural England has again applied 100% apportioning in the breeding season for all of these projects with the exception of 19.3% for Dogger Bank Teesside Beck A and B. These projects represent 79.0 collisions in the breeding season (340.0 combined with Tiers 1-3) under Natural England's advocated Band Model and avoidance rate.

1.11.13 Pre- and post-breeding collisions are presented without change from Natural England's breakdown of their Deadline III submission (Appendix 2 of this Note).

.

Table 1.11: Tiering exercise of projects considered in combination with Hornsea Project Two (breeding season under Natural England's advocated Band Model and avoidance rate).

Tier	Project	Collisions	Natural England apportioning %	NE Collisions
1	Westermost Rough	0.176	100	0.18
	Humber Gateway	2.55	100	2.55
Tier 1 Subtotal				**2.73**
2	Hornsea Project One	47.9	100	47.9
	Hornsea Project Two	136	93.5[5]	127.2
Tier 2 Subtotal				**175.30**
Tiers 1 & 2				**178.03**
3	Lincs	0.92	100	0.92
	Race Bank	1.86	100	1.86
	Triton Knoll	24.6	100	24.6
	Dogger Bank Creyke Beck Projects A and B	288	19.3	55.6
Tier 3 Subtotal				**82.96**
Tiers 1, 2 & 3				**260.99**
4	Blyth Demonstration Project	1.8	100	1.8
	Dogger Bank Teesside Projects A and B	136.9	19.3	26.4
	Dudgeon	0	100	0
	Teesside	50.8	100	50.8
Tier 4 Subtotal				**79.02**
Breeding Season TOTAL				**340.01**
Pre- and post-breeding				**161.35**
ANNUAL TOTAL				**501.36**

1.11.14 The Applicant considers that Tier 4 projects should be considered as uncertain as to their relevance to the in combination assessment on FFC pSPA in the breeding season and therefore treated accordingly. The Applicant also considers that there is significant doubt on the role of Tier 3 projects and the apportioning percentage applied to Triton Knoll, Race Bank and Lincs are highly likely to be over stating connectivity with the pSPA

1.11.15 Where apportioning values have been applied within examination of a project, Natural England have directly transferred these values to the in combination

[5] Updated from 94.6 to provide accurate representation of 1st year birds recorded in Natural England's advocated breeding season of May - July

assessment of Project Two. Appendix 2 provides a breakdown relating to Natural England's submission at Deadline III. For Dogger Bank Creyke Beck A and B, Natural England have applied 19.3% breeding adult proportion, however this value was apparently not included in submissions for Dogger Bank Creyke Beck. Forewind (2014a) includes the calculation of the breeding adult proportion calculated as the FFC pSPA population (89,040 breeding adults) divided by the total breeding adult population present in the North Sea (considered to be 640,648 breeding adults for the purposes of the Dogger Bank Creyke Beck assessment) providing a proportion of 13.9%.

1.11.16 It is also apparent that the proportions calculated at Dogger Bank Creyke Beck and Dogger Bank Teesside A & B do not represent breeding adult birds. The apportioning documents for each project (Forewind, 2014a,b) clearly state that:

"…there are not expected to be any breeding adults present on the wind farms during the breeding season. Birds recorded at this time are therefore assumed to be failed or non-breeders (including immature birds)."

1.11.17 The reports then calculate proportions (13.9% for Dogger Bank Creyke Beck and 19.3% for Dogger Bank Teesside A & B) that represent the proportion of non-breeding adult birds associated with the FFC pSPA that are present at the relevant project. This information supports the Applicants assertion that projects included in Tiers 3 and 4 of Table 1.11 should not be seen as contributing materially, to a breeding season collision risk impact on breeding adult kittiwakes from the pSPA.

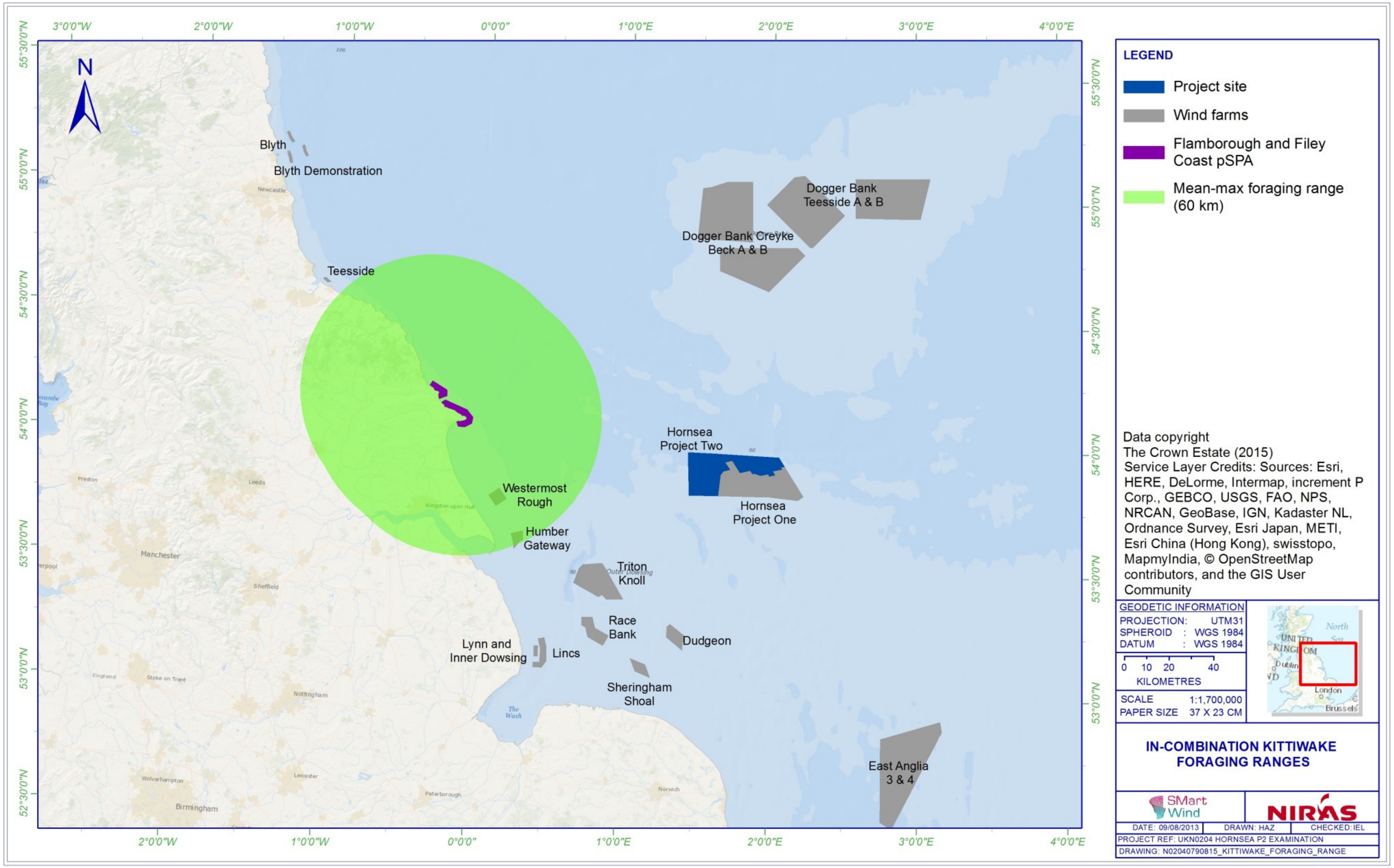

Figure 1.4: Projects considered in combination with Hornsea Project Two and mean-maximum foraging range of kittiwake from FFC pSPA

Review of Hornsea Project One breeding season apportioning

1.11.18 The assessment in Stage 1 for the Project alone (Section 1.5) considered an alternative (and still highly precautionary) upper celling for breeding season apportioning. A parallel exercise with respect of Hornsea Project One (which is subject to 100% breeding season apportioning within Natural England's submission) is reviewed.

1.11.19 Within the Natural England defined breeding season of April – July for kittiwake, 12.9% of birds were specifically identified as being 1st year individuals. Following the same basic calculation undertaken for the Project, a total of 66.59% of birds are therefore likely to be adults (Table 1.12).

Table 1.12: Estimated breeding season contribution of FFC pSPA birds to total predicted to be present on the Hornsea Project One using immature proportions as calculated from survival rates and numbers of one year old birds recorded.

Successive steps of the analysis	Formulas used (using the parameters identified in first and third columns)	Value
(a) Survival rate of juvenile birds		0.79
(b) Survival rate of one year old birds		0.85
(c) Survival rate of two year old birds		0.87
(d) % of kittiwakes at project site assigned to one year old birds		12.90%
% of kittiwakes at project site assigned to other immature age classes: (e) two year old (f) three year old	e = [{(1 x a) x b} / a] x d f = ([{(1 x a) x b} x c] / a) x d	10.97% 9.54%
(g) % of kittiwakes at project site assigned to adults	g = 100% - (d + e + f)	**66.59%**
(h) Revised breeding season apportioned collisions to FFC pSPA	h = 0.666 x 47.9	**31.9**

1.11.20 Applying this to the breeding season estimate of mortality for Hornsea Project One under Natural England's advocated Band Model Option and avoidance rate results in a correction to 31.9 collisions apportioned to FFC pSPA.

Project Two considered in combination with other projects

1.11.21 Table 1.13 presents a matrix of the in combination tiering presented against the individual stages applied to the Project. The table includes the following:

- Breeding season figures presented with annual figures in parentheses;
- Natural England's position updated to reflect a 93.5% breeding season apportioning for the Project;
- In combination tiering includes correction to Project One figures as presented above; and
- No further correction of projects considered in combination with respect to Band Model option and / or avoidance rate.

Table 1.13: Matrix of in combination tiering presented against Stages applied to the Project.

		Stage applied to Project Two					
In combination tier		NE	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
	NE	341.8 (501.1)	325.5 (486.9)	256.0 (414.3)	248.3 (406.6)	238.3 (396.1)	223.3 (380.3)
	Tiers 1-4	324.0 (485.4)	309.8 (471.2)	240.6 (398.5)	232.2 (390.9)	222.5 (380.4)	207.8 (364.5)
	Tiers 1-3	245.0 (406.3)	230.8 (392.1)	161.6 (319.5)	153.2 (311.8)	143.5 (301.4)	128.8 (285.5)
	Tiers 1-2	162.0 (323.4)	147.8 (309.2)	78.6 (236.5)	70.2 (228.9)	60.5 (218.4)	45.8 (202.5)
	Tier 1	2.72 (164.1)	2.72 (164.1)	2.72 (164.1)	2.72 (164.1)	2.72 (164.1)	2.72 (164.1)

Collision risk modelling at projects considered in combination

1.11.22 The matrix Table 1.13 includes tiering of projects considered in combination although notably, does not correct any figures quoted by Natural England in Appendix 2 of this note with the exception of the Project (within Stages 1-5) and Hornsea Project One (undertaking a parallel Stage 1 analysis for this project).

1.11.23 If the equivalent of stages 3, 4 or 5 are investigated for each project, implications are significant. Stage 3 investigates the defined breeding season by Natural England although it is considered that the month of April may or may not be considered as part of the breeding season depending on the location of a given project. The Applicant considers that the projects located considerably offshore and distant from FFC pSPA as with the Project (i.e. Hornsea Project One, Dogger Bank Projects) are likely best described as having a breeding season of May –

July. Indeed, the ‘core- breeding season defined for kittiwake for Dogger Bank Teesside was May – July (Forewind, 2014a).

1.11.24 Table 1.14 presents further analysis on the in combination collision risk numbers estimates detailed in Table 1.13. Prior to updating the breeding season to May-July for all projects, in combination totals are indicated firstly by showing the Project and Hornsea Project One with revised breeding season apportioning percentages (i.e. Stage 1). Secondly, both of these projects are then shown with Option 1 results. The fourth and fifth applications comprising the Basic Band (2012) Model avoidance rates to 99.2% and using Extended Model outputs where available.

Table 1.14: Further analysis stages applied to annual in combination kittiwake results

Updates to In combination CRM	Breeding			Non-breeding	Total
	Tiers 1 & 2	Tiers 1-3	Tiers 1-4	All projects	All projects
(i) Project 2 & Project 1 Stage 1 applied (revised apportioning %)	147.1	230.1	309.1	161.3	470.4
(ii) Project 2 and Project 1 Stage 2 applied (Option 1)	78.6	161.6	240.6	157.9	398.5
(iii) May – July breeding season for all projects	66.8	131.8	190.2	167.7	357.9
(iv) Avoidance rate updated to 99.2%	48.6	95.8	138.2	121.9	260.1
(v) Extended Band Model applied where available	17.6	46.8	92.4	74.1	166.5

1.12 Conclusions

1.12.1 This Clarification Note has investigated the sensitivity of key parameters informing the collision risk assessment of the FFC pSPA kittiwake population from Hornsea Project Two alone and in combination with other projects. It has attempted to provide detailed background surrounding values informing Natural England’s position submitted at Deadline III and provide alternative scenarios where possible.

1.12.2 Five analytical stages have been applied to the outputs from the Project alone, with arguments presented that suggest that the following are appropriate to consider:

- A lower upper ceiling apportioning value in the breeding season than Natural England's submitted value;
- Justification for the use of the extensive Project Two dataset on kittiwake flight height and thus the use of Band Option 1;
- An adjustment to seasonal definitions for kittiwake;
- Usage of avoidance rate for kittiwake as recommended in Cook *et al.*,(2014); and
- Application of the Band Extended Model (Option 4).

1.12.3 Investigation of each of these stages in turn has highlighted the overly precautionary nature of Natural England's position and provided reflection that the most realistic measure of risk is more closely aligned with the Applicants position as submitted at Deadline IIa (See Appendix 1 of this Note).

1.12.4 The presentation of projects considered in combination with the Project in the breeding season in a series of tiers based on the certainty with which the projects are likely to affect the pSPA has provided in sight into the confidence of the assessment. It has been identified that projects included in Tiers 3 and 4, which account of 162 collisions in the breeding season are highlighted as being of uncertain affinity to FFC pSPA or not connected at all.

1.12.5 Further analysis collision estimates from projects considered in combination with the Project through seasonal definitions, avoidance rate and application of the Extended Band (2012) Model has provided further insight into scenarios that lie below that presented by Natural England in their Deadline III submission.

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1.14 Appendices

Appendix 1: Seasonal breakdown of predicted total in-combination collision mortality for kittiwake using results from the Extended Band model, where available (Applicant's position).

Offshore wind farm	Band Model	Option	Avoidance rate (%)	Annual collisions	Breeding	% Apportioning	pSPA breeding collisions	Post-breeding	% Apportioning	pSPA post breeding collisions	Pre-breeding	% Apportioning	pSPA pre breeding collisions
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	2	99.2	13.6				4.3	6.3	0.3	0.8	8.4	0.1
Beatrice	Band (2012)	3	98	17.6				1.3	6.3	0.1	4.8	8.4	0.4
Beatrice Demonstrator	Band (2000)	1	99.2	3.6				1.5	6.3	0.1	1.2	8.4	0.1
Blyth Demonstration Project	Band (2011)	1	99.2	3.9	1.0	100.0	1.0	1.6	6.3	0.1	1.3	8.4	0.1
Dogger Bank Creyke Beck Projects A and B	Band (2012)	3	98	218.0	67.0	19.3	12.9	41.0	6.3	2.6	110.0	8.4	9.2
Dogger Bank Teesside Projects A and B	Band (2012)	3	98	135.0	87.0		0.0	26.7	6.3	1.7	21.3	8.4	1.8
Dudgeon	Band (2000)	1	99.2	0.0	0.0	100.0	0.0	0.0	6.3	0.0	0.0	8.4	0.0
East Anglia One	Band (2012)	3	98	24.4			0.0	16.8	6.3	1.1	5.9	8.4	0.5
Galloper	Band et al. (2007)	1	99.2	47.9			0.0	20.2	6.3	1.3	23.2	8.4	1.9
Greater Gabbard	Band (2000)	1	99.2	20.0			0.0	10.9	6.3	0.7	8.3	8.4	0.7
Hornsea Project One	Band (2012)	4	98	20.7	7.4	100.0	7.4	9.1	6.3	0.6	4.2	8.4	0.4
Hornsea Project Two	Band (2012)	4	98	28.1	13.5	38.0	5.1	8.7	6.3	0.5	5.9	8.4	0.5
Humber Gateway	Not available	1	99.2	5.6	1.4	100.0	1.4	2.3	6.3	0.1	1.9	8.4	0.2
Inch Cape	Band (2012)	1	99.2	219.2			0.0	163.5	6.3	10.3	46.2	8.4	3.9
Kentish Flats	Band (2012)	1	98.9	1.6			0.0	0.7	6.3	0.0	0.5	8.4	0.0

Offshore wind farm	Band Model	Option	Avoidance rate (%)	Annual collisions	Breeding	% Apportioning	pSPA breeding collisions	Post-breeding	% Apportioning	pSPA post breeding collisions	Pre-breeding	% Apportioning	pSPA pre breeding collisions
Lincs	Band (2000)	1	99.2	2.0	0.5	100.0	0.5	0.8	6.3	0.1	0.7	8.4	0.1
London Array	Band (2000)	1	99.2	4.0			0.0	1.7	6.3	0.1	1.3	8.4	0.1
Moray Firth Project One (MORL)	Band (2012)	3	98	43.3			0.0	2.0	6.3	0.1	18.4	8.4	1.5
Neart na Gaoithe	Band (2012)	1	99.2	67.9			0.0	40.8	6.3	2.6	3.2	8.4	0.3
Race Bank	Band (2000)	1	99.2	22.8	1.3	100.0	1.3	17.4	6.3	1.1	4.1	8.4	0.3
Seagreen Alpha	Band (2012)	3	98	172.0			0.0	79.3	6.3	5.0	62.0	8.4	5.2
Seagreen Bravo	Band (2012)	3	98	121.0			0.0	50.2	6.3	3.2	40.2	8.4	3.4
Teesside	Band (2000)	1	99.2	56.1	27.8	100.0	27.8	17.4	6.3	1.1	10.9	8.4	0.9
Thanet	Band (2000)	1	99.2	0.8			0.0	0.3	6.3	0.0	0.3	8.4	0.0
Triton Knoll	Band (2000)	1	99.2	152.0	14.4	100.0	14.4	101.0	6.3	6.4	36.5	8.4	3.1
Westermost Rough	Band et al. (2007)	1	99.2	0.4	0.1	100.0	0.1	0.2	6.3	0.0	0.1	8.4	0.0
TOTAL							**72.1**			**39.0**			**34.7**

Appendix 2. In-combination collision totals for kittiwake population of Flamborough and Filey Coast pSPA used to inform Natural England's Deadline III submission

Offshore wind farm	Band Model	Option	Avoidance rate (%)	Annual collisions	Breeding	% Apportioning	pSPA breeding collisions	Post-breeding	% Apportioning	pSPA post breeding collisions	Pre-breeding	% apportioning	pSPA pre breeding collisions
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	2	98.9	18.70				5.8	5.4	0.31	1.1	7.2	0.08
Beatrice	Band (2012)	1	98.9	57.86				4.3	5.4	0.23	15.9	7.2	1.14
Beatrice Demonstrator	Band (2000)	1	99.2	4.95				2.1	5.4	0.11	1.7	7.2	0.12
Blyth Demonstration Project	Band (2011)	1	98.9	5.39	1.8	100.0	1.8	2.3	5.4	0.12	1.4	7.2	0.10
Dogger Bank Creyke Beck Projects A and B	Band (2012)	2	98.9	718.85	288.0	19.3	55.6	135.0	5.4	7.3	295	7.2	21.2
Dogger Bank Teesside Projects A and B	Band (2012)	2	98.9	444.40	136.9	19.3	26.4	90.7	5.4	4.9	216.9	7.2	15.6
Dudgeon	Band (2000)	1	98.9	0.00	0.0	100.0	0.0	0.0	5.4	0.0	0.0	7.2	0.0
East Anglia One	Band (2012)	1	98.9	429				295	5.4	15.9	104.6	7.2	7.53
Galloper	Band et al. (2007)	1	98.9	65.89				27.8	5.4	1.5	31.8	7.2	2.29
Greater Gabbard	Band (2000)	1	98.9	27.50				15.0	5.4	0.81	11.4	7.2	0.82
Hornsea Project One	Band (2012)	1	98.9	122.00	47.9	100.0	47.9	55.9	5.4	2.9	20.9	7.2	1.50

Hornsea Project Two	Band (2012)	2	98.9	230.00	136.0	95.0	129.2	72.0	5.4	3.9	23	7.2	1.66
Humber Gateway	Not available	1	98.9	7.70	2.55	100.0	2.55	3.19	5.4	0.17	1.9	7.2	0.14
Inch Cape	Band (2012)	1	98.9	301.42				224.8	5.4	12.1	63.5	7.2	4.57
Kentish Flats	Band (2012)	1	98.9	2.20				0.9	5.4	0.05	0.7	7.2	0.05
Lincs	Band (2000)	1	98.9	2.75	0.92	100.0	0.92	1.16	5.4	0.06	0.69	7.2	0.05
London Array	Band (2000)	1	98.9	5.50				2.3	5.4	0.12	1.8	7.2	0.13
Moray Firth Project One (MORL)	Band (2012)	1	98.9	45.4				2.0	5.4	0.11	19.3	7.2	1.39
Neart na Gaoithe	Band (2012)	1	98.9	93.39				56.1	5.4	3.0	4.4	7.2	0.32
Race Bank	Band (2000)	1	98.9	31.35	1.86	100.0	1.86	23.9	5.4	1.3	5.59	7.2	0.40
Seagreen Alpha	Band (2012)	1	98.9	371.25				171.1	5.4	9.2	133.8	7.2	9.63
Seagreen Bravo	Band (2012)	1	98.9	343.20				142.4	5.4	7.7	114.0	7.2	8.21
Teesside	Band (2000)	1	98.9	77.08	50.8	100.0	50.8	24.0	5.4	1.3	2.5	7.2	0.18
Thanet	Band (2000)	1	98.9	1.10				0.5	5.4	0.03	0.4	7.2	0.03
Triton Knoll	Band (2000)	1	98.9	209.00	24.6	100.0	24.6	139.0	5.4	7.5	45.4	7.2	3.27
Westermost Rough	Band et al. (2007)	1	98.9	0.55	0.176	100.0	0.176	0.22	5.4	0.01	0.132	7.2	0.01
TOTAL				**3616.4**			**341.8**			**80.8**			**80.5**