THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN10080

Annex C: Natural England detailed advice on ornithology

7 November 2018

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1. Introduction

1.7. In this appendix Natural England has set out what we consider to be the main issues in relation to the assessment of offshore ornithology for Hornsea Three. These are organised under the following sections:

- Baseline Data Collection and Analysis Methodology;
- Collision Risk Modelling (CRM);
- Assessment of Displacement Impacts;
- Assessment of Cumulative and In-combination Effects;
- Population Modelling Approaches and Population Impacts;
- Phenology, Population Scales and Apportioning to individual SPAs;
- HRA Screening and LSE conclusions;
- Habitats Regulations Assessment (HRA);
- Environmental Impact Assessment (EIA);
- Inaccurate and missing information and data presentation in Application documentation;
- The need to present data and predicted impacts in a way that allows the full range of uncertainty (e.g. around input data, analysis, methodology) to be understood and evaluated;
- Migratory Bird Analysis.

1.8. This response draws on information provided by the Applicant in the following Hornsea Three Offshore Windfarm documents submitted to PINs in May 2018:

- Environmental Statement: Volume 2, Chapter 5 - Offshore Ornithology. PINS Document Reference: A6.2.5 (hereafter referred to as the Environmental Statement Report).
- Environmental Statement: Volume 5, Annex 5.1 - Baseline Characterisation Report. PINS Document Reference: A6.5.5.1.
- Environmental Statement: Volume 5, Annex 5.2 - Analysis of Displacement Impacts on Seabirds. PINS Document Reference: A6.5.5.2
- Environmental Statement: Volume 5, Annex 5.3 - Collision Risk Modelling. PINS Document Reference: A6.5.5.3
- Environmental Statement: Volume 5, Annex 5.4 – Data Hierarchy Report. PINS Document Reference: A6.5.5.4
- Habitats Regulations Assessment. Report to Inform Appropriate Assessment. PINS Document Reference: A5.2 (hereafter referred to as the HRA Report)
- Report to Inform Appropriate Assessment: Annex 1 – HRA Screening Report. PINS Document Reference: A5.2.1
- Report to Inform Appropriate Assessment: Annex 2 - Additional Special Protection Areas Screening Exercise. PINS Document Reference: A5.2.2
- Report to Inform Appropriate Assessment. Annex 3 - Phenology, connectivity and apportioning for features of FFC pSPA. PINS Document Reference: A5.2.3
- Environmental Statement: Chapter 3: Project Description. PINS Document Reference: A6.1.3

1.9. Natural England has significant concerns with a number of aspects of this application in relation to ornithology. Given that our main concerns are fundamental in nature, much of our advice remains at a high level. Consequently we have not been able to identify every element of the application and the ES that we may disagree with within this representation. Therefore, a lack of reference to a specific point or issue should not necessarily be taken to indicate agreement from Natural England.

1.10. Furthermore, it should be noted that our collective understanding of offshore ornithological impacts and associated assessment methods is constantly evolving and at a relatively fast pace. Natural England's advice on any given project is always based on our understanding at that time, and therefore may be subject to change as new scientific evidence becomes available or based on our growing experience of consented and constructed projects. As such, our advice on this project may have evolved from that provided on projects in the past, and may be subject to further refinement in relation to projects in the future.

2. Baseline Data Collection and Analysis Methodology.

2.1. **As a result of the fundamental issues associated with the collection, analysis and use of the survey data outlined in this section, Natural England is unable to form any conclusions about the significance of the impacts presented by the Applicant that are dependent on these data.**

2.2. **The comments in the following sections are therefore caveated on the basis that Natural England consider that there are issues with the derivation of the baseline bird density data that underpin all the analyses that need resolving. However, we have provided comments regarding other methodological aspects of the assessment below where these are not dependent on the baseline survey data.** The aim of the baseline surveys is to produce the most reliable, precise and accurate estimates possible of bird numbers at the Hornsea Three project site. These estimates need to have some measure of the degree of variability around them, which reflects both the degree of natural variation in numbers (e.g. from year to year) as well as uncertainty in the estimates e.g. from sampling or measurement errors. In order to capture the variability and uncertainty in numbers at the site it is necessary to sample across the full range of natural variation in numbers and to ensure that the sample design is such that the sample size and distribution of sampling minimises sampling and measurement errors.

2.3. Achieving all of the above is made difficult by the inherent variability in almost every aspect of seabird ecology and the wide range of temporal and spatial scales over which variability occurs. For example, considering temporal variability, evidence from at sea survey data has shown that the number of birds recorded can vary substantially within years (even within months/seasons), and between years. That raises the problem of capturing real-world variation through sampling that is invariably limited to a degree in terms of the total number of surveys, extent of the area surveyed, time-periods surveyed, etc. All this natural variation needs to be quantified and captured in assessments, while at the same time minimising sampling error.

2.4. If this variability is not adequately quantified the resulting assessment for a species may significantly under or over-estimate the potential impact of a development. If insufficient data are collected it will not be possible to make reliable conclusions regarding the key ornithological questions that the surveys seeks to address. Natural England advises that a **minimum** of two years of survey data are collected to inform the Environmental Statement.

2.5. The Applicant has collected data to characterise the baseline environment for bird abundance and density in the Hornsea Three Study Area using digital aerial surveys conducted monthly over the period April 2016 to November 2017. As a result the baseline survey data to inform the offshore ornithology assessments only comprise 20 months of data. While there are two years of baseline data from the months April to November for key species, there are only one year of data for the December-March period, in other words, the December to March period has not been adequately characterised.

2.6. This has a number of implications for the offshore ornithology impact assessments. At a practical level, the lack of data presents methodological issues, for example, the collision risk modelling requires density estimates for each month of the year which have sampled the range of variability in bird numbers present in the project area across years, and the displacement assessments require data from all months within a season in order to be able to select a peak abundance figure for the season, neither of which are possible if some months are missing. In terms of assessing the significance of predicted impacts, large numbers of birds of the key species were recorded in the months December to March of the 2016/17 survey year – including the peak annual count of guillemot (December 2016) – therefore the December to March period represents a period of significant site usage by the key species.

2.7. Natural England considers that having less than two years of data will substantially increase the scientific uncertainty around the offshore ornithology impact assessment and will limit confidence in any conclusions reached.

2.8. Throughout the Evidence Plan process, Natural England advised the Applicant that two years of baseline survey data (covering two complete “bird seasons” for each species and season) are the minimum requirement in order to characterise the baseline environment and to enable the assessment of potential impacts.

2.9. The Applicant has sought to address the issue of insufficient baseline data, by incorporating information from historical boat-based survey data collected at various spatial and temporal scales across the Hornsea Zone Study Area over the period 2010 to 2013.

2.10. Natural England has provided advice to the Applicant regarding the validity of both the historical datasets used, and the Applicant’s method for incorporating elements of these boat-based datasets into the 2016/17 digital aerial survey baseline for the purposes of the environmental impact assessment. In particular there are issues around the integration of the datasets due to the different survey platforms used (boat based versus digital aerial), the spatial and temporal coverage of the historical datasets (and the effect this has on the sample size of data available), and the age of the boat based data. These issues are compounded further by the method that the Applicant has used to integrate data from the boat and digital aerial surveys to generate densities and abundances of bird species to use in the subsequent impact assessment which are covered in the section below.

Hierarchical Data Selection Method and integration of boat-based and aerial datasets

2.11. The Applicant undertook a review of historical datasets of boat-based data collected across the Hornsea Zone (which included some overlap with Hornsea Three), including survey data from the Hornsea One and Two project sites, to determine if existing data (2010-2013) could be used to inform the baseline for Hornsea Three.

2.12. A particular issue that was not resolved in this meta-analysis was whether the digital aerial data are comparable with boat based data. This was difficult to test because the Applicant was comparing boat-based data collected in different years from the digital aerial data so that any platform differences were confounded by variability in bird abundances between years. The Applicant's comparison between boat-based data and digital aerial data therefore focussed on comparing modelled boat data extrapolated to 2016/17 with 'real' digital aerial from 2016/17. Densities predicted for Hornsea Three for 2016/17 using boat data did not match the 2016/17 aerial data well for many species (and the comparisons based on the predictions from the models using Hornsea Three overlap data only were less robust than the models that use all the Hornsea Zone data). As a result it was not clear how much of the difference between the modelled boat survey estimates for 2016/17 and the digital aerial estimates for 2016/17 was a platform effect, and how much was due to the failure of the boat-based data models to predict densities in Hornsea Three in 2016/17 accurately. As a result, Natural England's view is that it was not possible to conclude that densities and associated confidence intervals generated from the historical boat-based data are comparable with densities and associated confidence intervals (CIs) generated from the digital aerial data.

2.13. Therefore there are problems in trying to compare and integrate data from the boat-based surveys with the data from the digital aerial surveys generally – and in particular Natural England does not agree with the way the Applicant has chosen to incorporate the historical boat-based data into the baseline data for Hornsea Three for their displacement and collision risk assessments.

2.14. The Applicant has not used the modelled data in their impact assessments, however they have used historical density data derived from boat-based surveys (that in some instances cover the whole Hornsea Zone and in others just the Hornsea Three overlap data) in their ES assessments of collision and displacement risk. Their hierarchical method for selecting which data to use for a given month (December - March) is based on the degree of overlap between the confidence intervals around densities and abundances from the 2010-2013 boat-based data and the 2016/17 digital aerial survey (DAS) data. The method used by the Applicant means that, depending on the species, the impact assessments are based in some months on two years of DAS data (April – November), in some months on only one year of DAS data, in some months on a combination of Hornsea Three boat and DAS data and in some months on a combination of Hornsea Zone and DAS data. For example the collision risk modelling for lesser black-backed gull and great black-backed gull is based on just one year of data for the months December to March and the same applies to the displacement assessment for guillemot and puffin. In contrast, for gannet the collision risk figures for December use both DAS and 2010 Hornsea Three boat data, for February they use DAS data and Hornsea Zone boat data from three years 2011-2013 and for January and March the collision figures are derived from just one year of DAS data (2017).

2.15. Natural England does not consider this to be a valid methodology. Firstly, one purpose of having multiple years of survey data is so the ecological variability in bird numbers across years is captured and reflected in both the mean and the CIs of the estimates. If just a single DAS estimate with CIs is taken forward for the impact assessment (as is the case for some months/species combinations) the natural variability between years is not captured at all as the mean DAS density and CIs for a single month has not sampled the inter-annual variation in numbers. Secondly, the densities and CIs for the boat based data have been generated using a different methodology and in the case of the data from just Hornsea Three overlap areas are based on low sample sizes and coverage. The meta-analysis work undertaken by the Applicant does not provide any evidence that the estimates and associated confidence intervals are comparable across survey platforms and in a number of cases the CIs around the boat-based estimates are larger than those associated with the DAS estimates, yet the Applicant's methodology for deciding whether or not to use the historical boat-based data is to compare whether the CIs for estimates from the different platforms overlap. Natural England does not consider that it appropriate to compare these, and in the situation whereby the mean estimates from boat based and DAS surveys are combined for use in the impact assessments, Natural England do not consider that it is not valid to do so. The Applicant has not indicated the reasons why the confidence intervals calculated for the boat based data seem larger than those calculated for the DAS data, but they could be a function of the different data sampling or collection methods, or due to real differences in the variability of the samples. For example, Natural England notes that the coefficient of variation (which is a measure of the variability of a sample, and therefore precision) around the densities of gannet in flight for the DAS data for January 2017 is 90% compared to a coefficient of variation of between 200% and 245% for the Hornsea Three boat-based data and between 114% and 125% for the full Hornsea Zone boat-based data equivalent. From this it is clear that there is considerably more variability around the boat-based density estimates compared to the DAS estimates, and this will have an impact on the Applicant's method which is based on comparing the overlap in the variability between boat-based and DAS estimates.

2.16. Based on the evidence provided by the Applicant, and the meta-analysis undertaken, Natural England does not consider it possible to conclude that the digital aerial survey data collected over one winter season (i.e. one year rather than two) adequately reflects the inter-annual variability in densities across that would be expected at Hornsea Three, or that the densities derived from digital aerial data are comparable to boat based data and therefore can be integrated in the way that the Applicant has done.

2.17. Natural England's position is that:

- The subset of the historical boat survey data that overlaps spatially with Hornsea Three, which the Applicant has selected to use in the environmental impact assessment for Hornsea Three is not robust or appropriate for generating species densities and abundance estimates for Hornsea Three;
- The Applicant's method for integrating densities/numbers of birds derived from digital aerial and boat-based survey data, and deriving confidence limits around these combined estimates is not robust or appropriate;
- Natural England does not agree with the Applicant's hierarchical data selection method to derive densities for use in collision risk modelling, which results in density estimates for April to November being generated from two years of digital aerial data, but estimates for December to March in some instances being based on a single year of digital aerial data, in other instances on one year of digital aerial data combined with multiple years of Hornsea Survey Area boat data, and in other instances on one year of digital aerial data combined with one year of boat based data from Hornsea Three transects surveyed in 2010. The exact datasets used varies for month and species concerned.
- Natural England does not agree with the Applicant's hierarchical data selection method to generate population estimates for the displacement assessment, which results in peak counts for some species/season combinations being based on selecting a peak count for a season from an incomplete set of monthly counts.

2.18. **Therefore Natural England does not agree that the historical boat-based data can be used to inform the impact assessment for Hornsea Three as presented by the Applicant. This includes integration of either the Hornsea Three boat survey data or the wider Hornsea Zone boat survey data with the DAS data collected in 2016/17.**

Adequacy of the Digital Aerial Survey (DAS) data collected in 2016/17

2.19. Natural England considers that the data analysed from the 2016/17 digital aerial surveys are not sufficient to adequately characterise the baseline. Surveys were undertaken using an aircraft equipped with four cameras. Each camera sampled a strip of 125 m width, separated from the next camera by ~25 m, thus providing a combined sampled width of 500 m within a 575 m overall strip. There were 20 transects surveyed across the Hornsea Three array area plus a 4 km buffer. If all data collected had been analysed to generate density and population estimates for species there would have been coverage of approximately 20% of the survey area. However the analyses were conducted utilising data from only two of the four cameras, representing 10% coverage of this area, with "*this level of coverage deemed to be sufficient for baseline characterisation based on the results of previous surveys*" by the Applicant (Annex 5.1: Baseline Characterisation Report).

2.20. Natural England does not agree that this level of coverage can be considered to be sufficient for baseline characterisation "*based on the results of previous surveys*" as it will depend on the nature of the area being surveyed and the abundance and distribution of receptors across the area. Further, if a narrower transect width is used for surveys (e.g. a 250m transect width rather than a 500m width) then it is likely that a larger number of transects will be needed to achieve the same level of precision as would be derived from a sample of wider transects (Buckland et al. 2012, Thaxter and Burton 2009). No information is presented to show that an analysis was undertaken to look at the level of precision that could be achieved by analysing the full dataset collected (from four cameras) versus the reduced coverage selected by the Applicant. However, Natural England note that during the Evidence Working Group process the Applicant indicated that the proposed coverage of 10% would be sufficient for achieving a CV of 16% or better for abundance estimates. Natural England has not seen information on the precision of the estimates for the full digital aerial survey dataset as the Applicant has not presented these data in the Application documents, but the levels of precision achieved for the population estimates that Natural England have seen via Evidence Working Group reports have typically been considerably lower, with CVs greater than 16% (and in many cases much higher). In discussions with the Applicant during the Evidence Working Group process, Natural England queried whether 10% survey coverage was sufficient to achieve the desired level of precision and whether the Applicant could look back at the boat based survey data to check 10% coverage was sufficient. Natural England remains unsure of the reasons why the Applicant did not analyse the full four-camera dataset given that the levels of precision around the estimates did not achieve the expected levels of precision.

Method for calculating confidence intervals around mean density estimates

2.21. A further issue that predominantly affects the Applicant's collision risk modelling assessment concerns the methodology used for generating a density estimate with confidence intervals for each month, to use in the collision risk model. The Applicant has analysed the survey data for each survey year separately to generate a density estimate with confidence intervals for each of the 20 months of the year where survey data were collected. In the months where the Applicant has two years of DAS data (April-Nov) they have therefore generated two density estimates per month (one for year 1 and one for year 2) each with their own associated confidence intervals. In order to derive a single density estimate for a particular month e.g. April, to use in the collision risk model the Applicant has simply calculated the mean of the year 1 and year 2 density values for a given month (e.g. April). Generating confidence intervals around this mean value is more complicated and the Applicant has used a method outlined in Section 2.7 of Annex 5.4 of the ES. Natural England queried the validity of this approach during the Evidence Working Group process and in particular, the method for deriving the pooled confidence intervals around the average mean densities by month, and we do not consider that the confidence intervals that have been generated by this method are adequately capturing the uncertainty and variability in densities of birds present in Hornsea Three across years. This will affect the upper and lower confidence intervals of the collision risk figures calculated from the density data and will potentially underestimate the collision risk.

2.22. **As a result of the fundamental issues associated with the collection, analysis and use of the survey data, as outlined in this section, Natural England is unable to form any conclusions about the significance of the impacts presented by the Applicant that are dependent on these data.**

2.23. **The comments in the following sections are therefore caveated on the basis that Natural England consider that there are issues with the derivation of the baseline bird density data that underpin all the analyses that need resolving. However, we have provided comments regarding other methodological aspects of the assessment below where these are not dependent on the baseline survey data.**

3. Collision Risk Modelling (CRM)

3.1. The Applicant has undertaken collision risk modelling (CRM) for four species of seabird recorded in the Hornsea Three Study Area (gannet, kittiwake, lesser black-backed gull and great black-backed gull). Additionally they have undertaken migratory CRM on five species of seabird that are present in Hornsea Three Study Area predominantly during passage and also twelve migratory waterbird species.

Seabird CRM Model Options – gannet, kittiwake, lesser black-backed gull and great black-backed gull

3.2. The Applicant has used Option 3 of the Extended Band Model (Band 2012) to assess the predicted impacts on gannet, kittiwake, lesser black-backed gull and great black-backed gull from collisions with turbines in the Hornsea Three Study Area. The predicted collisions for Hornsea Three that are used in the cumulative assessment of impacts use Option 3 CRM outputs for all four species.

3.3. Natural England do not agree with the Applicant's use of Option 3 for the assessment of collision impacts at Hornsea Three for the following reasons:

3.3.1. The SNCB position is that 'it is not appropriate to use the Extended Band model in predicting collisions for northern gannet or black-legged kittiwake, at the current time' (JNCC et al., 2014).

3.3.2. While the current SNCB position is that the Extended Band Model (Option 3) can be used for lesser black-backed gull and great black-backed gull with an avoidance rate of 98.9% (+/- 0.002), JNCC et al. (2014) further notes that concerns remain over the use of the Extended Band Model, in particular regarding the Extended Band Model's (Option 3) sensitivity to flight height distribution data and the uncertainty this component introduces to variation in estimates of collision. This is of particular relevance for the Hornsea Three CRM, as the Applicant has used generic flight height information derived by Johnston et al. (2014a,b), which comes predominantly from boat-based surveys (with no data on flight heights from digital aerial surveys included). This means that the Applicant has used flight height distribution data derived from boat based surveys with site-specific bird density data derived from digital aerial surveys. Where the extended Band model is used, flight height distributions derived from boat based data (such as presented in Johnston et al., 2014a,b) may not be transferable to flight height density data derived from digital aerial survey (Johnston and Cook, 2016). This is because while the flight height distributions derived from boat and digital aerial surveys have been shown to result in similar predictions of the proportion of birds flying at collision risk height and so appear to be transferable across platform for the purposes of calculating a PCH value for use in the basic Band Model, the different underlying shapes of the flight height distributions derived from the different platforms, coupled with platform differences in density estimates for birds in flight, may lead to significant differences in the number of collisions predicted when using an extended version of the Band model to carry out CRM (Johnston and Cook, 2016). For this reason, given that the CRM will be using flight height data derived from boat surveys but densities of birds in flight derived from digital aerial surveys, Natural England does not recommend that the extended Band Model Options are used for the lesser black-backed gull or great black-backed gull CRM for Hornsea Three.

3.4. Therefore **Natural England's position is that the Basic Band Model should be used for the CRM for all species at Hornsea Three**.

3.5. There are two options within the Basic Band Model, both of which require calculation of the proportion of birds at risk height. Option 1 uses site-specific flight height data, and Option 2 uses generic flight height data to derive the proportion of birds at risk height.

3.6. The Applicant is unable to utilise the flight height information generated from the Hornsea Three digital aerial surveys (due to a methodological problem that became apparent during the collection of the digital aerial survey data at Hornsea Three), so Option 1 cannot be used with these data.

3.7. The Applicant has, however presented Option 1 outputs, by deriving a Hornsea Three site-specific proportion of birds at risk height (PCH value) from the historical boat based data. Natural England do not consider that the data or methodology used by the Applicant to generate PCH values for use with Option 1 are appropriate for a number of reasons including:

- While there is a considerable amount of flight height data collected from boat surveys across the Hornsea Survey Area for the period 2010-2013, the Applicant has calculated PCH values using only those survey records that occurred within Hornsea Three plus a 4 km buffer. This considerably reduces the amount of data on flight heights available and introduces significant biases into the dataset based on the limited spatial and temporal coverage of Hornsea Three during the Hornsea Survey Area surveys.
- Natural England did not agree with the methodology applied to derive PCH values from the boat based data as presented by Hornsea Two (which is the same method applied by Hornsea Three). A particular concern was the assertion by Hornsea Two, that observers on boats were able to accurately assign birds to five metre height bands defined as 32.5-37.5 m, for example,

but we also raised concerns about the post collection processing of birds in flight data to calculate PCH values coincident with the rotor height.

3.8. Therefore Natural England does not consider it is appropriate to use Option 1 of the Band Model for the Hornsea Three seabird CRM and advises that Option 2 outputs should be used to assess impacts for all species.

Nocturnal Activity Factors in CRM

3.9. The Applicant has used nocturnal activity factors (NAF) of 3 for lesser black-backed gull and great black-backed gull, 2 for kittiwake and 1 for gannet in the CRM. The nocturnal activity factor input parameter used in the Band Model calculation of collision risk is a ranking score from 1 to 5, derived from an assessment of nocturnal activity in different species in Garthe and Hüppop (2004) (where 1 denotes "*hardly any flight activity at night*" and 5 "*much flight activity at night*"), and not a 'nocturnal activity rate' *per se*. The Band model converts these factors to a percentage: 0% (factor 1), 25% (2); 50% (3), 75% (4) and 100% (factor 5) that is applied to the densities of birds in flight collected from surveys during daylight hours to correct for a different pattern of flight behaviour (typically reduced) occurring during the night. Under this broad classification Garthe and Hüppop (2004) assigned a factor of 2 to gannet (i.e. densities of birds in flight at night are assumed be 25% of the densities of birds in flight recorded during day), and kittiwake, Herring gull and lesser black-backed gull a factor of 3 (King et al., 2009, adds great black-backed gull as factor 3) and these are the levels that Band (2012) advises should be used in the absence of night-time survey data or other empirical evidence of nocturnal activity levels for a species.

3.10. The Applicant has used evidence from studies that have deployed loggers on seabirds that provide empirical data on activity levels at different times of the day and night for kittiwake and gannet. The Applicant has used this empirical evidence of nocturnal behaviour and made a set of assumptions about how this might relate to a NAF for use in the Band Model. Natural England's position is that we currently do not have any agreed 'empirically derived' nocturnal activity factors that can be used with the Band model. We recognise from recent evidence presented e.g. by MacArthur Green (2015) and Furness et al. (2018), that nocturnal activity levels relative to daytime levels for some species may be lower than the levels that equate to the nocturnal activity factors currently used in CRM. However we also note that there is uncertainty and variability about the empirical activity levels derived from tracking studies, uncertainty around the models that are used to derive daylight hours and how day-length is defined (Forsythe et al. 1995), and uncertainty about how these might translate into nocturnal factors applicable to the Band model. For example, there will be variability in nocturnal activity levels with time of year, location, dependent on levels of ambient lighting e.g. from offshore structures etc. Further, the Band model calculation defines day-length as the time period between sunrise and sunset, using the US government definition of sunrise and sunset of when the top of the sun is "apparently" even with the horizon (see Forsythe et al.(1995) for other definitions of sunrise and sunset). As a result the Band model calculation of night-time includes periods of twilight (e.g. civil twilight, nautical twilight or astronomical twilight) which include periods when light levels can be relatively high and where there are likely to be higher levels of seabird foraging activity compared to true night-time.

3.11. Additionally, the tagging studies cited by the Applicant calculate flight activity during night relative to daytime flight activity derived from those same tracking studies. However, daytime flight activity in the Hornsea Three area which come from the at sea surveys data may not match the levels of daytime flight activity that are the basis of the calculations in the empirical tagging studies. For example, the percentage of birds recorded as flying in the Hornsea Three surveys ranged from 7% to 76% for gannet and 17% to 90% for kittiwake, depending on the survey year and month. The tagging examples, cited by the Applicant in Table D1 of Annex 5.3 of the ES calculated nocturnal activity relative to daytime activity where daytime activity levels ranged from 10-50% for gannet and 15-42% for kittiwake. It is therefore not clear whether it is appropriate to apply the proportional nocturnal activity data from the tagging studies to the Hornsea Three daytime activity level data in this way since the nocturnal flight activity percentage as a proportion of daytime activity from the tracking studies is assumed to apply to a daytime activity level ranging from 7% in some months and 90% in other months. Therefore, while use of the nocturnal activity factors in Garthe and Hüppop (2004) may overestimate flight activity during hours of total darkness, it is equally not clear what an appropriate empirically based figure should be for use with Hornsea Three flight activity data. The emerging evidence on nocturnal activity levels from analysis of tagging work has itself generated conflicting recommendations. The MacArthur Green (2015) paper which the Applicant cites as the evidence to support the use of a 1 as a nocturnal activity factor for gannet, recommends use of 0% nocturnal activity during the breeding season and 2% nocturnal activity for gannet in the non-breeding season. However, in a subsequent analysis Furness et al. (2018) calculated average activity rates for gannet from several studies and recommended use of a "precautionary" 8% of daylight activity in the breeding season and 3% in the non-breeding season applied to the period sunset to sunrise. A submission as part of the Norfolk Vanguard project application (MacArthur Green 2018) recommends use of 4.3% in the breeding season and 2.3% in the non-breeding season. While these analyses differ in terms of suggested levels of nocturnal activity, none of these papers provide evidence to support the use of a nocturnal activity factor of 1 (no activity) during the nocturnal period, as used by the Applicant in their CRM for gannet.

3.12. Likewise, for kittiwake, the Applicant uses MacArthur Green (2015) figures of 0% nocturnal activity in the breeding season and 12% in the non-breeding season as evidence to support use of a NAF of 2 in the Band model. However, MacArthur Green (2018) reports evidence to suggest use of a nocturnal activity rate of 20% of daytime activity in the breeding season and 17% in the non-breeding season, with variability around these mean levels.

3.13. Given the uncertainty as well as variability in the data on activity levels (both during the daytime and during night), Natural England advises that collision risk outputs covering a range of nocturnal activity factors are considered to account for the uncertainty/variability (in the same way as has been recommended for bird densities, avoidance rates and flight heights). The suggested range of nocturnal flight activities to be considered within the Band model CRM are:

- Gannet: 1-2 (equating to 0-25% nocturnal activity)
- Kittiwake: 2-3 (equating to 25-50% nocturnal activity)
- Large gulls: 2-3 (equating to 25-50% nocturnal activity)

Bird Densities used in Collision Risk Modelling (CRM)

3.14. As set out in section 1 above, Natural England does not agree with the methodology the Applicant has used to generate monthly estimates of density and associated confidence intervals for use in the CRM.

3.15. Given these issues, Natural England advises that monthly density estimates and confidence intervals for the CRM assessments should:

- Be derived using only data collected from the digital aerial surveys of Hornsea Three;
- Improve the precision of the population by analysing the data collected from all four cameras, rather than the data from just two cameras;

3.16. Applying this approach will result in density estimates for December, January, February and March being based on a single year of survey data. These density estimates will not capture any of the inter-annual variability in bird numbers at Hornsea Three and therefore there will be additional uncertainty associated with these estimates that cannot be quantified. While it is not possible to fully address this additional uncertainty (see paragraphs 3.17-3.25 below), Natural England advises that it would be precautionary to place greater weight on using the upper confidence intervals of the density estimates for these months, in order to try and reduce the likelihood that impacts are underestimated.

Presenting Uncertainty in Collision Risk Predictions

3.17. The assessment of collision risk needs to take account of the effect that uncertainty and variability in input parameters have on the predictions of collisions. Some of the uncertainty comes from natural variability in the input data (e.g. monthly densities of birds, flight heights etc), some due to uncertainty in the data (e.g. sampling error, uncertainty in windfarm design parameters), and some of which is due to imperfect understanding of how systems work (e.g. avoidance rates and collision models). It is well documented that there is considerable uncertainty in the input parameters used in the Band Model and in the model itself and in order to be able to make a robust assessment of potential collision impacts on populations it is necessary to understand and, where possible, take account of the uncertainty (Band 2012, Masden 2015, Natural England 2015, SMartWind (2015), McGregor et al. 2018).

3.18. The Band (2012) collision risk model is a deterministic model. It is not possible to incorporate variability and uncertainty in the various input parameters of the model and to incorporate these into calculations of variability and uncertainty in the outputs of collision prediction from the model. However, Band (2012) did emphasise the need to be explicit about the uncertainty in the collision risk estimate outputs, "*by indicating, in addition to a 'best estimate', a range of confidence around that estimate*".

3.19. Therefore, Natural England advises that assessments of collision risk undertaken with the Band Model need to consider the effect that variability in key input parameters to the model have on the predicted number of collisions. Key parameters where variability and uncertainty needs to be considered are the monthly densities of birds in the project area, the flight heights of birds and avoidance rates. Nocturnal activity factors are another parameter where variability could be considered as outlined in sections 3.9-3.13 above.

3.20. However, there is no way of combining uncertainty across the different parameters in the Band (2012), so the effect of the uncertainty can only be considered on an individual parameter basis. This does give some indication of which parameters might have most influence on the prediction of collision risk, but individually these will not reflect the effect of uncertainty across all parameters.

3.21. Natural England advises that the Applicant presents collision outputs for each species that reflect the variability and uncertainty around densities, flight heights and avoidance rates as a minimum.

3.22. This includes presentation of collisions calculated using the relevant mean avoidance rate and ± 2SD of the mean avoidance rate as given in JNCC et al (2014); presentation of collisions using mean, upper and lower 95% confidence intervals around the mean flight density data by month (noting Natural England's comments above regarding methods for generating density estimates and associated confidence intervals); presentation of collisions using mean, upper and lower flight height distribution data from Johnston et al., 2014b, and presentation of collisions that reflect variability in NAFs for species where relevant.

3.23. The Applicant has provided a range of collision outputs in Annex 5.3 of the ES that consider variability in bird densities, avoidance rates and flight heights. However, as outlined in Section 2 above Natural England does not agree with methods used to derive bird density data and associated confidence intervals, in particular the densities for December, January, February and March where only one year of digital aerial survey data are available.

3.24. Additionally all the collision estimates presented for kittiwake and gannet have been generated using nocturnal activity factors applied to the Band (2012) model that Natural England do not agree with.

3.25. Further the Applicant's assessment of impacts in the ES (and RIAA) is based on a single central value for the density, flight height and avoidance rate inputs and the variability around these estimates is only considered in a general, qualitative way for each species with the conclusion for all species that "*The degree of variability associated with the density data, flight height data and avoidance rates used in collision risk modelling…is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional … population*". Natural England do not agree with these conclusions as consideration of the variability in the collision risk outputs using the Applicant's figures results in changes in the levels of predicted mortality that result in 1% of baseline mortality being exceeded for some species and populations in the assessments, which Natural England do not consider to be a negligible change. Natural England advises that consideration of the effects of variability in input parameters on predicted impacts should be a quantitative assessment using the collision predictions calculated using the range of variability used in the CRM (e.g. as presented in Volume 5, Annex 5.3 of the ES (Collision Risk Modelling).

Avoidance Rates

3.26. The Applicant has presented collision risk predictions using a range of avoidance rates for each species in Annex 5.3 of their ES. However, in the main ES chapter, collision impacts are presented for species based on a single avoidance rate value for each species and Band model option. For kittiwake the Applicant has used an avoidance rate of 99.2% for the Basic Band model options. Natural England do not agree with the use of this avoidance rate and advise that an avoidance rate of 98.9% should be used for kittiwake with the Basic Band model options as set out in JNCC et al. (2014).

4. Assessment of Displacement Impacts

Population estimates

4.1. As a result of the issues Natural England has highlighted, associated with the collection and analysis of the survey data (see Section 2) , Natural England is unable to form any conclusions about the significance of the displacement impacts presented by the Applicant that are dependent on these data.

4.2. As set out in Section 2 above, Natural England does not agree with the methodology the Applicant has used to generate monthly estimates of abundance and associated confidence intervals for use in the displacement assessment

4.3. Natural England advises that monthly abundance estimates and confidence intervals for use in the displacement assessments should:

- be derived using only data collected from the digital aerial surveys of Hornsea Three;
- be presented as population estimates of the Hornsea Three footprint and a 2km buffer (total birds in flight and on the water, after correcting for survey effort and availability bias) on a month by month basis for all 20 months individually with associated upper and lower confidence intervals
- improve the precision of the population estimates by analysing the data collected from all four cameras, rather than the data from just two cameras.

4.4. This approach will result in population estimates for December, January, February and March being presented for a single survey year alone. Displacement effects require the calculation of seasonal mean of peaks – the peak abundance is selected from the monthly population estimates within a season (per year). In the case of Hornsea three, there are four missing months, which will lead to some seasons having a number of missing months (this will vary depending on the season/species). As such, the calculation of mean of peaks will not fully capture the inter-annual variability in bird numbers at Hornsea Three and therefore there will be additional uncertainty associated with these estimates that cannot be quantified. While it is not possible to fully address this additional uncertainty, Natural England advises that it would be precautionary to place greater weight on using the upper confidence intervals of the density estimates for these months, in order to try and reduce the likelihood that impacts are underestimated.

Seasonal definitions

4.5. Furthermore, Natural England disagrees with Hornsea Three in regards the seasonal definitions for several species, in particular those for gannet and puffin are relevant to the displacement assessment (see Section 7).The SNCB recommended (MIG-Birds 2017) approach to displacement assessment is to use the mean seasonal peak, therefore for gannet and puffin (where Natural England recommend different seasons) we do not agree with the mean seasonal peaks used to calculate displacement.

Apportioning

4.6. In regard HRA for Flamborough and Filey Coast potential SPA (FFC pSPA), as previously advised Natural England have a number of concerns regarding the approach Hornsea Three have taken to apportioning (see Section 7), and do not agree with the apportioning of breeding adults presented for gannet, kittiwake and puffin, furthermore we have concerns regarding the lack of apportioning of immature/non-breeding guillemot and razorbill in the breeding season to FFC pSPA.

Combination of seasonal impacts - RIAA

4.7. Furthermore as advised previously (NE PEIr response dated 20.09.17) joint SNCB guidance on assessing displacement (MIG-Birds, 2017) advises that displacement impacts calculated for individual seasons should be summed across seasons to allow assessment of the annual impact on the population. Throughout the HRA Report displacement sections (both alone and in-combination) the impacts per season have been presented separately. The aim of an assessment of impacts to an SPA population is to consider all impacts the population may experience throughout year (from all projects in the case of an in-combination assessment). A key reason for developing the BDMPS (Furness 2015) was to inform apportioning of impacts in the non-breeding season to facilitate the combining of both breeding and non-breeding season impacts. The assessment should therefore be presented as total annual impact to the population under consideration. Again we advise that (as per SNCB guidance, MIG-Birds, 2017) mortality and displacement rates should remain constant across the year. Therefore matrices should be presented of the combined breeding and non-breeding seasons.

Combination of seasonal impacts - EIA

4.8. The same requirement to sum seasonal impacts to present an annual impact applies to EIA assessments. However, in the context of EIA, the annual impact needs to be assessed at an appropriate population scale. NE advises that the appropriate population scale to assess a predicted annual impact should be the largest population under consideration at any point in the annual cycle. This does not preclude consideration of impacts for each season being assessed against a smaller population size to provide contextual information about the relative impacts across seasons and colonies.

Lack of confidence intervals

4.9. Natural England require that the variability and uncertainty in the underlying population estimates is presented (in the form of appropriately calculated upper and lower confidence intervals), so that the full range of potential scenarios can be explored. For the purposes of displacement assessment, confidence intervals should be presented around monthly total abundance estimates for all birds (in flight and on the water), after correcting for availability bias for the site and a 2km buffer. These have not been presented within the application and Natural England's requests that they are provided by the Applicant.

Mortality/Displacement levels

4.10. As previously advised, while it may be the case that displacement levels and mortality do vary at different times of the year for different species, there is no empirical evidence to suggest what these levels might be for different seasons, or even what the relative differences might be. For this reason SNCB advice (MIG-Birds, 2017) is that given there is currently no empirical evidence on the seasonal variation of displacement in seabirds, the SNCBs do not view it as appropriate at this time to apply varying mortality and displacement levels per season, however we do recommend the presentation of a range of displacement and mortality rates for the annual and seasonal assessments to reflect the uncertainty.

Inclusion of immature impacts

4.11. In relation to the HRA Report, we note that in the case of puffin, guillemot and razorbill apportioning figures are presented for adult birds, however Annex 3 (Phenology, Connectivity and Apportioning for features of the FFC pSPA) presents apportioning figures for immatures in the non-breeding seasons as well. Natural England query why this impact to immatures associated with FFC pSPA has not been presented within the assessment and why no attempt to quantitatively apportion immatures in the breeding season has been made. As noted above, a matrix should be presented that combines all displacement impacts to the FFC pSPA population across the year (including immatures). Please see paragraphs 4.7-4.8 for further comments on this.

The exclusion or qualitative assessment of species for in-combination assessments

4.12. Natural England note that the in-combination displacement impact for a number of species (e.g. for FFC pSPA: fulmar, puffin and razorbill) has been qualitatively, rather than quantitatively assessed. The developer has presented several reasons for this approach.

4.13. Firstly, if a 'negligible impact' for the project alone has been concluded by the Applicant. Natural England advises that as a result of the issues Natural England has highlighted, associated with the collection and analysis of the survey data, seasonal definitions, apportioning and displacement assessments, we are unable to form any conclusions about the significance of the displacement impacts presented by the Applicant and therefore cannot agree with the conclusion that the impacts are 'negligible' for the project alone at this stage.

4.14. Secondly, a lack of quantitative data from other wind farm projects has been presented as a barrier to conducting quantitative in-combination assessments. However, the calculation of a displacement effect requires only a population estimate for the wind farm in question at a suitable temporal scale (i.e. seasons). Indeed the Applicant notes they can use two data sources to determine the potential levels of displacement and mortality from wind farms included in the in-combination assessment: population data held in individual wind farm project Environmental Statements and Habitats Regulations Assessments consisting of population estimates for individual project areas rather than raw survey data; and density data provided in the Natural England seabird Sensitivity Mapping for English Territorial Waters (Bradbury et. al., 2014) (see HRA Report 7.6.2.8).

Data for Cumulative and in-combination assessments from other projects for auk species

4.15. The applicant presents tables showing mortality as a result of displacement for auk species for cumulative (guillemot and razorbill) and in-combination (guillemot) assessments which include "0" mortality against several projects in the non-breeding season (e.g. Table 7.40 RIAA. Table 5.41 & Table 5.42 Ch 5, Kincardine, Seagreen A&B projects). This implies there were no birds present in these project areas during the non-breeding season, but Natural England's understanding is that there were large numbers of birds present in these particular project areas and therefore the "0" values in the table may indicate that the Applicant has not obtained the data, rather than that there were no birds/impacts present.

4.16. If this is the case there is a high likelihood that the cumulative and in-combination assessments are underestimated for guillemot and razorbill. The applicant should seek to populate the cumulative/in combination assessment with appropriate data for these wind farms. As noted above (see points 4.12-4.14) the calculation of a displacement effect requires only a population estimate for the wind farm in question at a suitable temporal scale (i.e. seasons).

Combining effects to assess the overall impact to a population

4.17. Natural England advises that in cases where a population may be exposed to multiple effects (for example gannet is assessed for both collision risk and displacement effects) the combined impact to the relevant population should be assessed. This applies to both HRA and EIA assessments alone and in-combination/cumulatively.

5. Assessment of Cumulative and In-combination Effects

5.1. Cumulative and in-combination impacts are a key area of concern in relation to predicted impact levels for Natural England. They are also an area where Natural England has significant concerns about the assessment approach presented by the Applicant.

5.2. The key concerns are summarised below:

- use of Extended Band Model collision figures for gannet and kittiwake for some individual project figures including those of Hornsea Three;
- application of Extended Band Model options that Natural England do not consider appropriate to certain projects in the cumulative assessment for lesser black-backed gull and great black-backed gull (e.g. Option 4 applied to Hornsea One and Hornsea Two; Option 3 for Hornsea Three);
- retrospective application of correction factors to existing collision figures for projects as a proxy for lower nocturnal activity levels than used in the original CRM for a project;
- retrospective "proportional" changes to collision figures for projects based on assumptions that consented turbine configurations represent a lower collision risk than the Rochdale Envelope defined during the consenting process for a project and that the reduction is a simple function of the change in turbine number;
- use of MacArthur Green (2017) ratio correction factors to adjust collision figures for projects based on "as built" versus consented turbine layouts;
- exclusion of impacts from Tier 3 and some Tier 2 projects in the CEA (including Norfolk Vanguard, Thanet Extension, Moray West and Norfolk Boreas);
- conducting qualitative rather than quantitative in-combination displacement assessments for certain species (see detailed comments in points 4.12-4.14).
- the proportions of birds that have been apportioned to FFC pSPA during the breeding season from the different North Sea projects;

- cumulative assessment of impacts under EIA that does not incorporate impacts across the whole annual cycle for a species at an appropriate scale.
- the assessment of EIA impacts on a season-by-season basis, at varying population scales, and therefore with varying project impacts included. Natural England advises that assessment of impacts should be undertaken at an appropriate scale (e.g. North Sea) across the whole year for each relevant species. For example, if the population scale for the cumulative EIA is a North Sea scale, then breeding season impacts on all birds within this scale, from all projects within this scale in the breeding season need to be accounted for and considered together with predicted impacts at a North Sea scale for birds in the non-breeding seasons.

6. Population Modelling Approaches and Population Impacts

6.1. The Applicant has considered the significance of the predicted in-combination mortality impacts on the Flamborough and Filey Coast pSPA (FFC pSPA) by reference to population modelling work undertaken by MacArthur Green (2015b) for Hornsea Two. The Applicant has used outputs from these population viability analysis (PVA) models for gannet, kittiwake and guillemot populations at FFC pSPA.

6.2. Natural England discussed the MacArthur Green (2015b) PVA models with the Applicant during the Evidence Working Group process and indicated that Natural England does not consider the PVA models produced for Hornsea Project Two are adequate to inform the assessments for Hornsea Three for the following reasons:

- The PVA models for Hornsea Two were run over a period of 25 years and not the 35 years that represent the operational phase of Hornsea Three. The counterfactual of population size and counterfactual of growth rate metrics should be calculated at the end of the impact period – which for Hornsea Three should be 35 years – however as the Hornsea Two PVA models were only run for a 25 year period the model metrics are only available for impacts projected over 25 years of windfarm operation and not 35 years. The Applicant has made assumptions about what effect these ten additional years would have on the metrics, but does not have the actual metric value which would vary depending on various model assumptions and parameters;
- The Applicant has considered two PVA model output metrics in order to assess the significance of the predicted impact level on the population - change in median population growth rate and counterfactual of population size. Natural England agree with the use of the counterfactual of population size, but we also recommend using the counterfactual of population growth rate to quantify the relative changes in a population in response to anthropogenic impacts. The change in median growth rate metric that the Applicant has used is not the same as the counterfactual of growth rate that Natural England advises, as it has not been calculated from the growth rate at the end of the duration of the projection, e.g. at 35 years if the model is projected across a 35 year licence period. The Applicant has calculated the growth rate averaged across years five to 25 of the model simulations and compared the median value of the average growth rate between impacted and unimpacted scenarios;
- The stochastic simulations for the Hornsea Project Two models were not run as matched pairs. Where stochastic PVA models are used, it is important to use a ‘matched-runs’ approach where a metric is derived for each matched pair of baseline and impacted simulations. Stochasticity is included in the population model, but the survival and productivity rates used for a ‘pair’ of

impacted and un-impacted populations at each time step are kept the same. This means that the effect that is measured with the metric can be more clearly attributed to the impact, than to model uncertainties such as the variability in the demographic parameters that have been sampled or to observation errors. Cook and Robinson (2017) tested the effect of using unmatched compared to matched runs in PVA models and demonstrated that the median values of several evaluation metrics (e.g. counterfactual of population size) were greater when a matched runs approach was used compared to when the simulations were unmatched and the uncertainty around the metrics was much greater in the unmatched scenario. Models were run with 1000 iterations. It may be the case that the median values of the matched versus unmatched runs approach will converge if a larger number of simulations (e.g. 5000) are used, however the confidence limits are still expected to vary between the two approaches. Natural England therefore advises that one amendment required to the Hornsea Project Two PVA models is to run the simulations using matched-pairs as recommended in Cook and Robinson (2017) and Jital et al. (2017).

- Natural England has also had discussions with the Applicant regarding the way that the additional windfarm mortality is incorporated into the PVA. The PVA models for Hornsea Two required additional windfarm mortality to be added to the models as adult mortality, with the assumption that mortality of the other age classes present in the project area would occur at a level proportional to the model stable age structure. Although there are a number of assumptions inherent in this approach, it can be applied where project impacts are presented in terms of an "adult currency" as they were for Hornsea Two. However, in situations where for example zero mortality is predicted for the adult age class, but where there is predicted mortality for other classes of birds in the population, as is the case for some species at Hornsea Three, it is not possible to derive a metric of population impact from the existing models. The Applicant acknowledges this point (e.g. in section 1.4.1.2 of Annex 3 of the HRA Report), but does not present a method for accounting for this issue. Natural England advise that if mortality is predicted for birds from a particular population that does not include any predicted adult mortality, or where predicted mortality is not distributed across age classes in a manner that reflects the stable age structure within the population model, then an alternative method (to only applying adult mortality impacts to the model) for including the predicted mortality into the population models needs to be used. Natural England considers that the proportions of birds recorded in different age classes present in the Hornsea Three project site from the offshore surveys is the best evidence available for adding mortality to different age classes in the model. In the non-breeding season months, if information on the age classes of birds in offshore projects areas is not available, the proportion of adult and immature birds present in offshore areas that are expected to originate from different colonies can be derived from Furness (2015) and applied to the population models.
- A further issue with deriving the metrics from the Hornsea Two population model is that the Applicant has had to select impact levels from those published for Hornsea Two. This means that the Applicant can only derive metric values from a pre-populated set of impact levels and cannot calculate a metric that is specific to the impact level that they have calculated for Hornsea Three.

6.3. Natural England understands that the Applicant has subsequently produced updated PVA models for some FFC pSPA species that use matched-runs and a 35 year projection and that these will be submitted at Deadline I. Natural England requests that the Applicant provides tables that show the population size at year 35 of the projection based on a full range of additional mortality added to the model, that spans the full range of predicted impacts (and not just the impact value selected by the Applicant), including zero impact. For the stochastic versions of the model the final population sizes at year 35 should include the median value and upper and lower 95% CIs. Additionally, Natural England requests that the Applicant provides the same outputs as above but for the population growth rate in the final year of the simulation.

6.4. Natural England also requests that PVA outputs are provided for the following species that are either qualifying features or are part of the assemblage at FFC pSPA: kittiwake, gannet, guillemot, razorbill and puffin.

6.5. For HRA, Natural England recommends interpreting the metrics from population modelling against a framework of considerations including the Conservation Objectives for the SPA population, SPA and wider population status, threats and pressures acting on the population and policies which may change the wider population status. Natural England notes that, based on the level of kittiwake mortality predicted to arise from Hornsea Three in-combination with other projects, the Applicant has concluded that there is no indication that, the population is likely to decline, over a period of 35 years, to an extent that would mean that the breeding kittiwake population of the FFC pSPA would no longer be considered to be in favourable condition. The Applicant's conclusion is based on a prediction that additional mortality from Hornsea Three in-combination with other plans or projects would not result in the population declining below the cited population of 44,520 pairs.

6.6. The population size on the citation for Flamborough Head and Bempton Cliffs SPA is 83,700 pairs of kittiwake. The citation for the Flamborough and Filey Coast pSPA (which includes the original SPA) is 44,520 pairs based on counts from the period 2008 to 2011. The latest colony census counted 51,535 pairs across the FFC pSPA in 2017 (JNCC 2018). The current population is therefore below the level in the original citation for the SPA and the kittiwake feature of the site is, therefore, in unfavourable condition.

6.7. Therefore any assessment of the significance of a predicted impact or whether it would affect the status of the species at the site or result in an Adverse Effect on Site Integrity needs to be considered against the Conservation Objectives for the site and not necessarily against the current or citation population for a site.

7. Phenology, Population Scales and Apportioning to individual SPAs

Data used to inform definition of the breeding season

7.1. Natural England have consistently advised that for species where breeding birds are predicted to be present in the Hornsea project area, the breeding season months follow those presented in Furness (2015) under "breeding season" and not the "migration-free breeding season", except in cases where relevant colony or site specific information suggests that a different set of months is appropriate for defining colony attendance.

7.2. Natural England have noted throughout the Evidence Working Group process that the interpretation of at sea, project specific abundance data can be extremely challenging. Natural England place considerably higher confidence and emphasis on the use of colony specific data to inform colony specific breeding seasons, while Hornsea Three have focussed substantially on the use of at sea abundance data (from a variety of offshore wind farms in the area) to define seasons. As such, and as previously advised, Natural England do not agree with the seasonal definitions for gannet, kittiwake and puffin.

7.3. Natural England advise that when undertaking an assessment in relation to a specific colony (e.g. for HRA) it is important, where possible, to use colony specific breeding seasons for the assessment (i.e. to apportion birds at the project site to the colony at an appropriate rate during those months associated with breeding at the colony in question).

7.4. Of the evidence sources available to establish colony specific breeding seasons, Natural England place higher confidence in observations made at the colony, as opposed to at sea observations. Colony specific observations (e.g. colony attendance, egg laying, chick fledging, colony desertion dates) give a clear indication of when birds are present at the colony and the assumption that birds observed are part of the colony in question is a reasonable one. Indeed, Busch and Garthe (2018) in their paper on the need to consider annual cycles within cumulative assessments, use kittiwake as an example and recommend the use of a 'colony attendance' season based on colony specific data.

7.5. The alternative option of interpreting at-sea data gathered as part of the baseline characterisation surveys of the wind farm site (e.g. abundance peaks) is challenging and introduces considerably uncertainty. In the case of Hornsea Three and the FFC pSPA, for the species where connectivity in the breeding season has been established at FFC pSPA (kittiwake, gannet and puffin) a peak in bird numbers can variously be interpreted as birds on passage passing through the project site to colonies further afield, breeding birds from FFC pSPA using the project site in higher numbers during a period in the breeding season when central place foraging constraints are relaxed and/or when both birds of a pair can forage (e.g. Robertson et al 2014), immature birds returning to the colony they intend to recruit into (e.g. Votier 2010), or failed/non-breeders associated with FFC pSPA. In reality the birds observed at Hornsea Three are likely to be a combination of all these categories, and it is important to note that the last three categories (breeding birds, immatures, non-breeders) are all components of the FFC pSPA population to some extent. Natural England accepts that during the FFC pSPA breeding season, a proportion of the birds present at the project site will be 'non-FFC' birds, but that this should be addressed in the approach to apportioning and not in the definition of the FFC pSPA breeding season.

7.6. In terms of defining the length of the breeding season at a colony, using observations from the colony in question is more defensible and provides greater certainty that attempting to interpret at-sea data. At-sea data (e.g. abundance peaks, flight direction, fish carrying behaviour) combined with other evidence sources (e.g. tracking data, ringing recoveries) can however help build a picture of how birds are using the project site throughout the breeding season.

7.7. Natural England have referred to a number of evidence sources to determine the appropriate breeding length definitions for FFC pSPA (summarised below in Table 1). It should be noted that data on colony attendance and breeding observations are found predominantly in the grey literature (in monitoring reports and observer records) and are not commonly peer-reviewed. In the case of FFC pSPA it is closely managed and monitored by the RSPB, and as such, the RSPB reserve managers are best placed to advise on breeding colony attendance periods (these are included as *pers comms* and by reference to monitoring reports (e.g. Aitken et al 2017, Babcock et al 2016) in the table).

7.8. The use of colony observations to define the length of the breeding season for kittiwake, gannet and puffin results in breeding seasons at FFC pSPA that are closely aligned to the breeding seasons described in Furness (2015) for the UK.

The interpretation provided by the applicant of at-sea data to define the breeding seasons for these species results in reduced breeding seasons (see Table 1).

Table 7.1 – Summary of evidence sources to inform breeding season definition at FFC pSPA for the purpose of HRA for gannet, kittiwake and puffin, and seasons advised by Natural England and proposed by the applicant.

Species	FFC pSPA specific evidence sources	NE proposed breeding season for FFC pSPA	Applicant's proposed breeding season
Gannet	RSPB reserve managers advise that numbers of gannet inshore start to increase from mid-January, with birds prospecting on the cliffs from February onwards, with the majority returning by late March. A high proportion of birds have departed the colony by the end of September, though some presence on the cliffs is expected throughout October and into November. The last juveniles on the cliffs are usually in early November. (K Clarkson, A Barratt, M Babcock *pers comm*) Langston et al (2013) conducted tracking studies at FFC pSPA between 2010 and 2012. They noted that in 2012 gannets started to return in mid-January, with most birds back at their nest during March. In 2010 peak fledging occurred late August/early Sept, in 2011 it was the first 3 weeks of August (with most fledged by the end of Sept) and in 2012 it was late August (with the last few fledging by the end of Sept). They further noted that: 'Many adults remain at Bempton Cliffs for a while after their chicks have fledged. Tracking studies indicated that most adults departed Bempton Cliffs during the second half of September in 2011 and all adults had left by early October. Productivity monitoring at Bempton Cliffs takes place between late April and October (Aitken et al, 2017)	March – Sept	April - August
Kittiwake	RSPB reserve managers advise that: Birds usually start to return to the colony from mid-February, but irregularly, with significant numbers not expected until late March and egg-laying not generally occurring until May. Early August finds the colony still well occupied, but numbers decline during the month and the colony is usually deserted come September. (K Clarkson, A Barratt, M Babcock *pers comm*) RSPB analysed data from twenty-two kittiwake plots across the colony in 2016 and 2017, comprising of 713 apparently occupied nests (AON) in 2016, and 749 AON in 2017 to calculate estimated laying and hatching dates. The plots were visited at 7 day intervals, and so the resulting	March - August	April - July

	dates could be up to 7 days earlier (but not later). The modal lay dates were 24th May & 9th May and hatch dates were 28th June and 13th June (2016 and 2017 respectively). In regards defining the end of the breeding season, the latest hatch dates were at the end of July in both years (30th and 25th July respectively for 2016 and 2017). (RSPB, unpublished data) RSPB productivity monitoring takes place between May and August (Aitken et al, 2017).		
Puffin	RSPB managers advise that: Productivity monitoring at Bempton Cliffs is not possible, due to puffin nesting in inaccessible clefts in the cliffs. (K Clarkson, A Barratt, M Babcock *pers comm*). From 2016 onwards a snapshot of colony numbers was estimated by recording numbers of birds aggregating on the sea below the colony prior to breeding. The first reports of large numbers of puffin on the sea were in the morning of 22nd March in 2016 (Babcock et al, 2016). In 2017, the equivalent date was 24th March (Aitken et al, 2017). In 2018, this assembly did not occur until early April, reflecting the lateness of the breeding season (Mike Babcock *pers comm*). The breeding season ends later than the other auks, although the majority have departed by mid-August. (K Clarkson, A Barratt, M Babcock *pers comm*). Mather (1986) notes that puffin arrives on the breeding cliffs of the Yorkshire coast in April, though no specific information is given to support this.	April – July (NB wider evidence presented in Furness (2015) suggests early August however in the colony specific case of FFC pSPA NE consider inclusion of July to be sufficient.	May-July

Breeding season definitions and apportioning

7.9. As the previous section outlines, there continues to be a lack of agreement between the Applicant and Natural England in regards the appropriate definition of the breeding season for certain key species both at FFC pSPA and at wider population scales. Natural England consider that controversies arise because there is a conflation between the definition of the breeding season and the approach to apportioning.

7.10. In Natural England’s view breeding seasons should be defined by the breeding population under consideration, and largely informed by colony-specific data (e.g. if the population of interest is the UK breeding population then the appropriate breeding season should encompass the full extent of time that breeding activities are underway within the UK for that species). In the case of FFC pSPA, the appropriate breeding season should be defined by when birds are present at the FFC pSPA breeding site engaged in breeding behaviours (see comments above).

7.11. Developers and SNCBs regularly refer to the Natural England commissioned report on ‘Non-breeding season populations of seabirds in UK waters’ (Furness 2015).

The aim of this project was to review and define species-specific non-breeding season seabird populations at biologically defined minimum population scales (BDMPS) to enable the apportioning of potential impacts of marine renewable developments during the non-breeding season. The apportioning rates derived using BDMPS in the non-breeding seasons assume a totally homogenous mixing of birds within the spatial region defined (e.g. North Sea), and therefore reflect an average probability of encountering a bird from a specific colony across the BDMPS region. In reality the probability of encountering a bird from a particular colony will vary both temporally and spatially within the season and within the BDMPS region under consideration. For example, it would be expected that there is a higher chance of encountering a kittiwake from the Flamborough and Filey Coast SPA colony at the Hornsea Three site in the first few weeks after the breeding season, than encountering a kittiwake originating from the Flamborough and Filey Coast SPA colony in waters around Shetland at this time. Similarly while the BDMPS assumes that 25% of kittiwake in the North Sea BDMPS in spring are from Norwegian colonies, it might be expected that the proportion of Norwegian birds in northern Scottish waters might be higher than this and the in southern North Sea waters lower – particularly during the tails of the season.

7.12. Hornsea Three argue that in some months (early or late in the breeding season) there may be adult birds from colonies further afield present at the project site (i.e. in transit to or from their breeding grounds), and use this to support excluding these months from the breeding season (as they do not consider apportioning the majority of birds to FFC pSPA is appropriate), and instead apportion them at a non-breeding season rate.

7.13. Natural England agree that the probability of an adult bird observed at a project site being part of the FFC pSPA breeding population will vary over the full breeding season (although finding suitable evidence sources to quantify this is challenging). However excluding these months, and using the non-breeding apportioning figures (derived from Furness 2015) is likely to considerably under-estimate the number of adults apportioned to the colony[1]. During these early/late breeding season months the likelihood of encountering a bird from the Flamborough colony is higher, than encountering a bird from a breeding colony much further afield (e.g. Norway).

7.14. The current approach to apportioning is to keep the percentage of adults apportioned to a colony constant across the season, however this should reflect the average probability across that period of time (i.e. the apportioning rate used for the full breeding season should reflect our understanding where possible of the variability in proportions of birds connected to the colony in different months of the breeding season).

7.15. As such, Natural England continue to advise that breeding seasons should be defined by the colony in question (e.g. FFC pSPA), and that any debate should focus on agreeing an appropriate apportioning rate to use that encompasses the

[1] To use Gannet as an example, Natural England advise that a breeding season of March – Sept is defined for FFC pSPA while Hornsea Three have selected April – August (see below). The apportioning rates defined by Hornsea Three for gannet are: 40.4% in breeding season, 4.8% in post breeding and 6.2% pre-breeding. This would mean that in March (when breeding gannets are in attendance at FFC pSPA) only 6.2% of birds observed at the project site are considered likely to be part of the nearest breeding colony. Likewise in September (when gannets are still breeding at FFC pSPA) only 4.8% of birds recorded at the project site would be apportioned to FFC pSPA.

variability in the proportions of FFC pSPA birds present at the project site during the breeding season.

Age Class data

7.16. Hornsea Three have presented an apportioning approach for gannet, kittiwake and puffin based on at-sea age class data. As previously requested (EWG meeting, 23.11.17) a detailed breakdown of age class data from boat and digital aerial data sets should be provided in order for Natural England to assess suitability of the two data sets and help to establish suitable apportioning figures.

7.17. Natural England understands that the applicant intends to submit these data at Deadline 1. We would like to take the opportunity to re-iterate the data requirements for this, and note that as per Section 11 below we also request these data for guillemot and razorbill.

- Species list: Puffin, Gannet, Kittiwake, Guillemot, Razorbill
- Digital aerial data:

  All species. All age class data should be provided (including the un-aged class) for every survey month (2016 and 2017 should be presented separately), and at all survey scales (site footprint, 2km buffer, 4km buffer);

- Boat based data:

  All species. All age class data should be provided (including the un-aged class) for every survey month (years presented separately) of the sub-set of data that applies to Hornsea Three. Or in the cases where there is insufficient data at the HOW3 level, (e.g. puffin) then from the entire Hornsea zone.

Survey platform and coverage issues to inform age class

7.18. Hornsea Three present age class data derived from both boat based survey data and digital aerial survey data. As a general comment on the suitability of the two data sets it is of note that the boat based data is now several years old (2010-2013), and the transects covering the Hornsea Three project site were spaced at 6km and resulted in a maximum coverage of 5%. This compares to the digital aerial data that were from surveys designed specifically for the Hornsea Three project site, cover the 2016 and 2017 breeding seasons, and results in a consistent coverage of 10% of the project site. Furthermore, Natural England note that the digital aerial data collected to inform the Hornsea Three application was collected using four cameras, yet only two cameras have been analysed, and presented within the application, resulting in half the data collected not being presented within the application. Natural England would recommend that that these survey data are analysed and presented, this would increase the sample size (and hence decrease uncertainty) for age class data derived from these surveys, and result in 20% coverage of the project site.

Approach to apportioning for kittiwake and puffin

7.19. Hornsea Three present an approach to apportioning for kittiwake and puffin that utilises age class data (for first year birds alone) and immature survival rates. As previously advised through the Evidence Plan process (NE DAS letters to Ørsted, dated 24.03.17 and 15.12.17), Natural England does not consider this approach is warranted given that it is entirely dependent on the accuracy of the numbers of first year birds recorded on survey and survival rates estimated for immature age classes, both of which are subject to considerable uncertainty (and variability in the case of age class proportions). Furthermore, it assumes that sub-adult age classes are present at the project site in proportions related to the numbers of first year birds, which, as various sections within Annex 3 of the HRA Report argue (see 1.4.3.11 and 1.4.3.12 kittiwake and 1.4.4.9 and 1.4.3.11 puffin) is not likely to be the case. Natural England's preference is to use the age class data from the offshore surveys to estimate the proportions of 'adult type' birds that are present at the project site and to use this to inform a range of adult apportioning values.

Apportioning immature impacts within the breeding season - RIAA

7.20. The applicant states that in relation to razorbill and guillemot at Hornsea Three it is likely that a large proportion of the immature population present at Hornsea Three in the breeding season will originate from those breeding colonies that are closest to it (Annex 3 of HRA Report). The applicant identifies the colonies listed below and notes that as a result, only a proportion of the mortality of immature birds predicted will be attributable to the Flamborough and Filey Coast SPA.

7.21. In the case of razorbill, the Applicant identifies: 'FFC pSPA (10,570 pairs), the Farne islands (491 occupied sites in 2016), St Abb's to Fast Castle SPA (1,385 pairs in 2016) and the Firth of Forth (3,597 equivalent pairs in 2015)'. In the case of guillemot: 'FFC pSPA (the Farne Islands (32,855 pairs in 2016), St Abb's to Fast Castle SPA (24,258 pairs in 2016) and the Firth of Forth (21,181 pairs in 2015).'

7.22. Natural England welcomes the acknowledgement that a proportion of the birds present at Hornsea Three will exhibit connectivity with FFC pSPA but query how the 'nearest colonies' presented in this annex have been determined and why these can't be used to inform a likely apportioning figure. Furthermore we request age class data (including observations of juveniles with attendant adults) are provided for guillemot and razorbill from both digital aerial and boat based data sets (see points 7.16-7.17 above).

8. HRA Screening and LSE Conclusions

8.1. Natural England commented on the Applicant's LSE methodology in our response to the Hornsea Three Habitat Regulations Assessment Screening Report (NE DAS letter to Ørsted dated 03.02.17, and NE PEIr response dated 20.09.17). The LSE test is a 'coarse filter', identifying potential effect pathways that warrant further consideration through Appropriate Assessment. The LSE test requires competent authorities to consider whether there is an LSE alone or in-combination with other plans and projects. Generally, a feature should not be screened out unless it can be clearly demonstrated that there is no impact alone or in-combination. The structure of the HRA screening document means that those plans or projects that could contribute to in-combination effects are only considered after the test of LSE has been applied. This potentially misses interactions, that whilst not LSE on their own, might be an LSE in-combination when considered in conjunction with other developments.

8.2. Additionally, given that Natural England has queries regarding the sufficiency of the baseline survey data for Hornsea Three, the way that the data have been analysed and insufficient consideration of variability and uncertainty in the data and assumptions underpinning the assessments, it is Natural England's view that it is not possible to conclude no LSE for a number of sites and associated features, which will therefore need to be captured within the appropriate assessment.

8.3. In particular, Natural England do not agree with the methodology used by the Applicant whereby they have assumed there is a potential for LSE only where a predicted impact amounts to 1% or more of the baseline mortality level for a feature of an SPA. This is firstly, because calculating the predicted level of mortality for a feature depends on analysis and interpretation of a considerable amount of information, with assumptions and uncertainties in the process, and so determining with certainty that a predicted impact is above or below 1% of baseline mortality is not clear-cut. Secondly, while a predicted impact from an individual development may not exceed 1% of baseline mortality for a given population, when considered in-combination with other plans or projects there may be a significant impact.

9. Habitats Regulations Assessment (HRA)

9.1. The issues and uncertainties raised in the preceding sections of this report mean that, on the basis of the information presented by the Applicant, Natural England cannot conclude beyond reasonable scientific doubt the absence of an adverse effect on the integrity on the SPAs and pSPAs assessed by the Applicant. Further, Natural England consider there are additional SPAs and associated features that are missing from the HRA.

9.2. Once these concerns are addressed, and the assessment of impacts is updated, we will need to consider the scale and significance of the predicted impacts from the project alone, and in combination with other plans and projects, in terms of the conservation objectives relevant to the feature populations for the SPAs concerned.

10. Environmental Impact Assessment (EIA)

10.1. The Applicant has used a set of criteria for identifying which species are "Valued Ornithological Receptors" (VORs). Those species not identified as VORs are not included in the EIA assessment process. One of the criteria used to define a VOR is that the population estimate for the species in Hornsea Three plus a 4 km buffer needs to reach 1% of the regional population for a species in a given season. The Applicant further considers "*that any impacts on species occurring in numbers of less than 1% of the relevant regional population will not be significant*".

10.2. Natural England does not agree with this criterion for identifying VORs. Seabirds distributed across an offshore marine area at a scale defined by a windfarm agreement for lease area, such as Hornsea Three, are not expected to reach 1% of a wider population level, when that regional population may be several hundred thousand birds. However, this does not mean that impacts on birds within that area could not be significant when considered cumulatively with other plans or projects, or at different population scales.

10.3. Of particular concern for Natural England is the exclusion of Herring gull as a VOR and therefore from any consideration of cumulative impacts under EIA.

10.4. Natural England also require further clarification regarding the regional, national and international population scales and "importance levels" for species included in the assessment (as presented in Table 1.5 of the Applicant's Annex 5.1: Baseline Characterisation Report).

10.5. The Applicant's approach to determining the significance of impacts based on combining receptor sensitivity and magnitude of impact is confusing and difficult to follow. To determine the significance of an impact, a sequence of criteria are evaluated against each species, each season and each impact. The criteria include receptor sensitivity; magnitude of impact; and significance. Within these criteria there are a number of sub-criteria, for example, receptor sensitivity is made up of conservation value, vulnerability, recoverability.

10.6. This matrix approach involves multiple layers of categorisation for each species and in a number of cases the assessment against a particular criterion has not been done consistently across species and subjective decisions are then multiplied across a number of different criteria. Further, the assessment of EIA significance has been undertaken separately for each potential impact that could affect a species, for each phase of the windfarm, and also separately for each season (Table 5.56 of Environmental Statement Report) which makes it difficult to determine whether there could be an overall significant effect on a particular species.

10.7. The assessment of magnitude of impacts (as set out in Table 5.14 of Environmental Statement Report) is based on factors such as spatial extent, duration, frequency and reversibility of the impact. On the other hand, for some impacts, such as collisions and displacement, a quantitative assessment of impact is made and the Applicant has assessed whether this predicted additional mortality exceeds 1% relative to baseline mortality. However it is not clear how this threshold has been factored into the assessment of magnitude or significance of the impact. Natural England advises that predicted mortalities that exceed 1% of baseline mortality for a population require further investigation as to the likelihood of significant impact.

10.8. Additionally, the Applicant has assessed the significance of the impact mortality separately for each season with no attempt to consider the significance of the mortality across the whole annual cycle at an appropriate scale for each species. As a result, while predicted mortality may not exceed 1% of baseline mortality for an individual season, when considered across the whole annual cycle and an appropriate population scale, the predicted impact could exceed 1% of baseline mortality and potentially be significant.

10.9. In assessing the significance of EIA impacts, the Applicant has determined that anything categorised below 'moderate' in the matrix (Table 5.15 in Environmental Statement Report) is not significant. However Natural England considers that excluding any impacts categorised as below moderate could lead to errors in assessing cumulative effects properly as limited impacts when taken cumulatively can become significant.

10.10. Natural England requests that the Applicant sets out a transparent methodology which explains the EIA assessment approach, and that they then demonstrably apply that methodology to the assessment.

10.11. Given the uncertainty surrounding a number of crucial elements to the Hornsea Three Environmental Impact Assessment (EIA), Natural England is unable to conclude at this stage that the project, either alone or cumulatively with other plans or projects, would not have a significant effect on a number of seabird species.

11. Data Presentation Issues: Inaccurate and missing information in the Application documentation

11.1. It is important that the information provided by the Applicant is accurate and clearly presented in a way that can be easily understood, and that all the information to support each aspect of the assessment is provided. This is not always the case in the documentation provided by the Applicant. In some instances there are discrepancies and errors in the information and data presented across the documentation.

11.2. For example, in the Project Description and Collision Risk Annex a 300 turbine scenario is described where the turbine diameter is given as 195m. However, in the Offshore Ornithology chapter the turbine diameter is cited as 185m.

11.3. Another example of inconsistency across the documentation is the list of SPAs and features that have been screened into the HRA. Table 3.7 of the HRA Report lists *European Sites designated for ornithological features for which LSE has been identified or could not be discounted during HRA screening* but does not list fulmar under FFC pSPA. Likewise fulmar does not feature in Table 7.1 *European sites and features for which LSE have been identified – offshore birds,* although it is identified in Table 7.8: *Results of the screening process with respect to the FFC pSPA.*

11.4. Another example where the presentation is unclear and misleading is in the cumulative and in-combination collision mortality tables. For example, Table 5.47 in the Environmental Statement Report presents a column of data headed "*Uncorrected collision risk estimate*", however the totals do appear to include some corrections to collision totals for certain projects on the basis of assumptions about changes to a projects' collision figures based on differences between the assessed project layout and the consented one (as documented in Table 5.48).

11.5. There are also a number of instances where data is either not presented at all or where incomplete data is presented that prevents Natural England from being able to understand or comment on the assessment that the Applicant has undertaken. For example, the Applicant presents tables showing cumulative mortality as a result of displacement for auk species which includes "0" mortality against several projects in the non-breeding season. This implies that there were no birds present in these project areas during the non-breeding season, but Natural England's understanding is that there were large numbers of birds present in these particular project areas and therefore the "0" values in the table may indicate that the Applicant has not been able to obtain the data, rather than that there were no birds/impacts present. If this is the case, the Applicant should indicate this clearly in the information provided, rather than substitute "no information" for a zero value. Furthermore the applicant should seek to populate the cumulative/in combination assessment for these wind farms with appropriate data. As noted above (see paragraphs 4.12-4.16) the calculation of a displacement effect requires only a population estimate for the wind farm in question at a suitable temporal scale (i.e. seasons). Indeed the Applicant notes they can use two data sources to determine the potential levels of displacement mortality from wind farms included in the in-combination assessment: population data held in individual wind farm project Environmental Statements and Habitats Regulations Assessments consisting of population estimates for individual project areas rather than raw survey data; and density data provided in the Natural England seabird Sensitivity Mapping for English Territorial Waters (Bradbury et. al., 2014) (see HRA Report section 7.6.2.8).

11.6. In order to provide transparency and a clear audit trail for the competent authority to undertake a full assessment of the proposed project, Natural England requests that the Applicant provides the following information relevant to the assessment for the relevant species:

- Band Model spread-sheets populated with all the project, turbine and bird parameters and data used for CRM for each species (gannet, kittiwake, lesser black-backed gull, great black-backed gull and Herring gull);

- Raw digital aerial survey data giving the number of birds of each species recorded on each survey day and each transect, with birds in flight and birds on the water presented separately.
- Tables of raw numbers of birds recorded in each year and month of the baseline surveys – presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. With numbers presented separately for birds in flight and birds on the water.
- Tables of population estimates for birds in each year and month of the baseline surveys – presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. With numbers presented separately for birds in flight and birds on the water (availability bias corrected) and upper and lower 95% confidence intervals around each population estimate provided.
- Tables of population estimates with 95% confidence intervals, generated by bootstrapping all the transect data for a given month and year (ie 2 separate monthly estimates where there are data from 2 years) calculated for birds on the water (with availability bias correction) and birds in flight combined. Presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. Standard deviations and coefficients of variation should also be presented for each population estimate.
- Tables of density estimates for birds in flight for each year and month of the baseline surveys - presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. With upper and lower 95% confidence intervals around each density estimate provided. Standard deviations and coefficients of variation should also be presented for each population estimate.
- Age class data provided month by month, and include the 'unaged' proportions (per month) for each data set of both digital and boat based data (see points 7.16-7.17).
- All of the above data presented from analysis of the full 4 camera survey strips within each transect;
- PVA Tables with median, L95% CI and U95%CL of un-impacted population size in each year of the simulation n=0…35
- PVA Tables with median, L95% CI and U95%CL of impacted population size for each year of the simulation n=0…35, and the equivalent for impact levels equating to adult mortality at 5 bird increments e.g. 5, 10, 15, 20 …
- PVA Tables with median, L95% CI and U95%CL of un-impacted population growth rate in each year of the simulation n=0…35
- PVA Tables with median, L95% CI and U95%CL of impacted population growth rate for each year of the simulation n=0…35, and for impact levels equating to adult mortality at 5 bird increments e.g. 5, 10, 15, 20 …
- PVA outputs for 10-13 above provided for gannet, kittiwake, guillemot, razorbill and puffin for FFC pSPA.
- Information on demographic parameters used in PVA models for each species;
- Information on the stable age structure of the PVA models for each species;
- Cumulative and in-combination project tables for the relevant species that contain all available data by month (ideally) or season with no changes applied to the figures derived from the relevant project Environmental Statement (or

whatever source the data were derived from). The precise source of the data presented should also be clearly referenced.

12. Treatment of uncertainty in the impact assessments.

12.7. There is uncertainty around the predicted impacts in the assessments presented in the Applicant's Environmental Statement Report and HRA Report. Some of this comes from natural variability and uncertainty in the input data (e.g. densities of birds at Hornsea Three, flight heights, sampling and measurement errors etc.) and some of which is due to imperfect understanding of how systems work (e.g. avoidance rates and collision models, effects of displacement on mortality of birds etc.). In order to be able to make an assessment of the significance of potential impacts on populations it is necessary to understand and, where possible, take account of this uncertainty.

12.8. The Applicant has presented predicted impacts that take account of some of the uncertainties in flight heights, avoidance rates and densities (noting that Natural England does not agree with the method used to derive some of these parameters) in the Collision Risk Modelling Annex, but this range of collision predictions have not been used by the Applicant to inform the Appropriate Assessment or EIA. Further, the Applicant has not considered uncertainty around the population estimates in the assessment of displacement impacts.

12.9. Natural England advises that the assessments of displacement and collision mortality should both use the information on uncertainty and variability in the input parameters (e.g. bird densities, flight heights, avoidance rates) to allow consideration of the range of values predicted impacts may fall within, and to allow an assessment of confidence in the conclusions made regarding adverse effects on site integrity and significance of impacts for populations.

13. Migratory Bird Analysis.

13.1. Natural England has made several comments in relation to the approach to migratory bird collision risk analysis which we have detailed in paragraphs 13.3-13.7below. Whilst Natural England does not agree with all aspects of the Applicant's methodology or approach, we do not believe that the methodology and approach adopted has resulted in fundamentally different conclusions to the assessment in the specific cases assessed. However, there remains a lack of clarity regarding: the criteria on which migratory waterbird species were selected for this analysis; the suite of SPAs with which those species may be associated; those species/SPAs close to the Hornsea Zone but not considered in this analysis, and the magnitude of potential cumulative and in-combination impacts for migratory species. While we do not consider it very likely that this additional information will identify further species/sites for which a significant effect might arise from collision mortality during migration for Hornsea Three alone or in combination with other plans or projects, the information requested will confirm whether these assumptions are correct, and will provide greater certainty to all parties that this is not the case.

13.2. It is worth bearing in mind that when considering the impact pathway for migratory birds, the likelihood of a significant effect arising on a given population is most likely to arise from cumulative and in-combination effects across multiple developments, even if the effects from each individual development appear insignificant. Thus, there is benefit in the environmental impact assessment of every development considering a wider suite of species than might otherwise be considered most important in each case. This additional information can inform future cumulative and in-combination impact assessments such as might for example be conducted in forthcoming plan-level impact assessments.

Seabirds – skuas, terns, little gull

13.3. Natural England notes that the Applicant has used a migratory front approach for the migratory seabird CRM given that the offshore digital aerial baseline surveys will not be appropriate for characterisation of the interaction of these migratory species with the Hornsea Three project area. Natural England agrees that this is an appropriate approach in these cases.

13.4. The migratory seabird CRM approach requires definition of an interacting population size, and for the skua and tern species the Applicant has defined an interacting population size based on information in Furness (2015).

13.5. Natural England notes that the Furness (2015) population numbers may not be the most biologically appropriate numbers to use as an 'interacting' population size for a migration collision analysis as they were derived to provide an estimate of the number (and origins) of birds in a geographically defined area (generally smaller than a flyway or biogeographic population scale) during the non-breeding season. Natural England has not reviewed the use of the population estimates from Furness (2015) in the context of a migration front CRM assessment or compared the results derived using the numbers in Furness (2015) with those using other interacting population sizes so cannot say whether they would produce comparable results.

Waterbirds

13.6. Natural England is unsure about the rationale for selecting the 12 species that have been included in the migratory waterbird collision risk modelling. The text states that selection was '*consistent with the suite of species incorporated into similar modelling undertaken for other offshore wind farms in the vicinity of Hornsea Three (i.e. Hornsea Project One and Hornsea Project Two)*. *This list represents those species recorded during boat-based surveys at Hornsea Project One in addition to migrant species that may potentially cross the former Hornsea Zone with species ultimately selected through consultation with Natural England and JNCC based on a relatively high proportion of birds occurring within the SPAs close to the former Hornsea Zone*.'

13.7. However, Natural England considers that there are other species with a relatively high proportion of UK SPA birds occurring in SPAs close to the Hornsea zone and where a large proportion of the population is predicted to migrate through UK waters including areas that would overlap with the Hornsea Zone. These include redshank, gadwall, teal, pintail, shoveler and turnstone. Further, the Applicant has not set out how the predicted collisions have been assigned to the relevant SPAs, and has made no attempt to consider in-combination impacts across all plans and projects. Therefore, Natural England requests that the Applicant presents 1) the criteria for identifying the selection of waterbird species to include in the migratory collision risk modelling; 2) information about the SPA sites that the species included are connected to and how predicted collisions have been assigned to these SPAs; 3) the list of SPA qualifying feature species for SPAs close to the Hornsea Zone that have so far been omitted from the analysis; 4) include in-combination assessment totals for the species and SPAs that are in scope.

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