Hornsea Project Four

Ornithology EIA & HRA Annex

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Revision Summary

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Revision Change Log

Rev	*Page*	*Section*	*Description*
02			Additional Gannet Collision Risk Modelling included at the Request of Natural England
03	Throughout document	N/A	Amendment to gannet, kittiwake and great black-backed gull minimum and maximum collision risk estimates. Amendments to BDMPS population sizes for great black-backed gull and razorbill

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Glossary

Term	Definition
Bio-season	Bird behaviour and abundance is recognised to differ across a calendar year, with particular months recognised as being part of different seasons. The biologically defined minimum population scales (BDMPS) bio-seasons used in this report are based on those in Furness (2015), hereafter referred to as bio-seasons.
Bootstrapping	Tests that use random sampling with replacement to assign measures of accuracy to sample estimates.
Confidence intervals	Range of values that with a specified certainty contains the true mean of the population that a sample was taken from. For example, 95% confidence intervals states a range of values with a 95% certainty those values contain the population mean.
Design-based Abundance Estimates	An estimated total abundance of identified targets (in the case of this report gannets) within a given area ("design- based" because the approach relies on the survey design providing representative sampling and assuming transects can be considered independent samples from a uniform distribution) based on the raw observations recorded within a survey.
Displacement	The potential for birds and other animals to avoid an area due to the presence of the wind turbines or from vessel activity.
Hornsea Project Four Offshore Wind Farm	The term covers all elements of the project (i.e. both the offshore and onshore). Hornsea Four infrastructure will include offshore generating stations (wind turbines), electrical export cables to landfall, and connection to the electricity transmission network. Hereafter referred to as Hornsea Four.
Macro Avoidance	Avoidance response prior to entry of the OWF array area.
Meso Avoidance	Avoidance response within the OWF array area.
Micro Avoidance	avoidance response within 10 m of the rotor swept zone of individual wind turbine generators.
MRSea	Statistical package to model spatial count data and predict spatial abundances; developed by the Centre for Research into Ecological and Environmental Modelling (CREEM) specifically for dealing with data collected for offshore wind farm projects.
Orsted Hornsea Project Four Ltd	The Applicant for the proposed Hornsea Project Four Offshore Wind Farm Development Consent Order (DCO).
Raw Observations	The georeferenced locations of identified targets (in the case of this report gannets) that were recorded within the flown transects for the site specific digital aerial surveys.

Acronyms

Term	Definition
BDMPS	Biologically Defined Minimum Population Scale
CI	Confidence Interval
CRM	Collison Risk Model
CV	Coefficient of Variation
EIA	Environmental Impact Assessment
EP	Evidence Plan
ExA	Examining Authority
FFC	Flamborough and Filey Coast
HRA	Habitats Regulations Assessment
OWF	Offshore Wind Farm
sCRM	Stochastic Collision Risk Modelling
SD	Standard Deviation
SNCB	Statutory Nature Conservation Bodie
SofS	Secretary of State
SPA	Special Protection Area

1 Introduction

1.1 Background

1.1.1.1 Within Natural England's Relevant Representations (RR-029) a number of queries were raised in relation to the MRSea_V1 modelling methods used to characterise the offshore ornithology baseline. Following review of the queries raised through the Relevant Representations, the Applicant further consulted with Natural England on this matter and agreed to rerun MRSea initially for gannet following additional guidance from Centre for Research into Ecological and Environmental Modelling (CREEM), the developers of the model who undertook a review of the original MRSea_V1 analysis on behalf of Natural England. An initial rerun of MRSea for gannet was agreed in order to understand whether there would be a material difference between the results produced by the original MRSea_V1 and the remodeled MRSea_V2.

1.1.1.2 As presented within G2.10 MRSea Baseline Sensitivity Report (Gannet) (REP3-029) and G4.13 Comparative Gannet Assessment (REP4-047) the results of the MRSea_V2 were found to provide a better model fit and have improved spatial distribution comparatively to the MRSea_V1, though it was noted that the differences between the resultant impact values when applying the MRSea_V2 data through assessments was found to be insignificant.

1.1.1.3 An unexpected result of the MRSea_V2 remodeling, when following the guidance of CREEM, was the 'best fit' model resulted in 12 months of smoothed data outputs instead of the typical 24 months of data outputs used for baseline characterisation and impact assessments. As detailed within Natural England's response note to the MRSea Baseline Sensitivity report (REP4-055), Natural England expressed concerns in relation to the use of smoothed 12 months of data for displacement analysis, whilst also requesting that other key species (kittiwake, guillemot and razorbill) should be remodeled where possible or revert back to design-based abundance estimates.

1.1.1.4 In order to fully align with Natural England's request, the Applicant undertook revised MRSea_V2 modeling for kittiwake, guillemot and razorbill, the results of which are presented in G5.9 Revised Ornithology Baseline. A separate request from Natural England was to present design-based abundance estimates for all seven species previously assessed using MRSea_V1, which are also as presented within G5.9 Revised Ornithology Baseline. The outcome of the remodeled MRSea_v2 resulted in the 'best fit' model for each species producing the following datasets:

- Gannet – 12 months of data;
- Kittiwake – 12 months of data;
- Guillemot – 24 months of data; and
- Razorbill – 12 months of data.

1.1.1.5 For fulmar, great black-backed gull and puffin the Applicant agreed with Natural England that these species would not be required to be remodeled using MRSea. Therefore, for these three species design-based abundances define the baseline characterisation with the

results presented in **G5.9 Revised Ornithology Baseline**, which are then relied upon for the purpose of updating impact assessments within this report.

1.2 Agreed way forward for Hornsea Four

1.2.1.1 The Applicant presented these results to Natural England, at an Ornithology Technical Panel meeting held on the 25th May 2022, in order to agree the final datasets for informing predicted impacts from Hornsea Four based on the MRSea_V2 results. Both parties agreed during the meeting on the following final approach for the use of different data sets (MRSea_V2 or design-based abundance estimates and density estimates) to be used for different species to be used to inform the impact assessments for each of the key species as set out in the **Table 1** below (see **Ornithology Technical Panel Meeting #16 MRSea Baseline Minutes** (**G5.28**)).

Table 1: Summary of the agreed approach forward with Natural England on final EIA and HRA baseline characterisation datasets for Hornsea Four.

Species	Collision Risk Modelling (CRM)	Displacement analysis	Design-based abundances provided
Gannet	MRSea_V2	Design-based abundances	Yes*
Kittiwake	MRSea_V2		Yes*
Guillemot		MRSea_V2	Yes*
Razorbill		Design-based abundances	Yes*
Fulmar			Yes*
Great black-backed gull	Design-based abundances		Yes*
Puffin		Design-based abundances	Yes*

Table Note: * design-based abundances presented in the **G5.9 Revised Ornithology Baseline**.

1.2.1.2 Following agreement on the final datasets the Applicant has undertaken updates to all impact assessments at both an EIA level and for impacts apportioned to the FFC SPA following both the Applicant's and Natural England's preferred approach to assessment, the results of which are presented in this report.

2 Methodology

2.1 Abundance Estimation

2.1.1.1 Revised abundance estimates have been calculated using either the MRSea (Scott-Hayward et al. 2017) statistical package, following the 'Best Fit' model guidance provided by the Centre for Research into Ecological and Environmental Modelling (CREEM) or using design-based abundance methods as presented in **G5.9 Revised Ornithology Baseline**.

2.2 Collision Risk Modelling

2.2.1.1 Revised collision risk modelling was carried out for gannet, great black-backed gull and kittiwake using the Stochastic Collision Risk Model (sCRM), developed by Marine Scotland (Donovan, 2018) and run deterministically following the details provided in **A5.5.3 ES Volume A5 Annex 5.3 Offshore Ornithology Collision Risk Modelling (APP-076)**. Due to disagreement between the Applicant and Natural England on the most appropriate sCRM input values for assessment in a small number of instances, separate collision risk modelling and assessments have been undertaken following the preferred approach from each party. A summary of the sCRM input parameters used following both parties preferred approach is detailed in **Appendix A**. Natural England's sCRM input parameters are based on the values provided in **Natural England review of G2.10 MRSea Baseline Sensitivity Report (Gannet) (REP4-055)**, The Applicant's justification for divergence from the Natural England's preferred parameters is provided in **G4.7 Ornithological Assessment Sensitivity Report (REP4-041)**.

2.2.1.2 A summary of the predicted monthly collision risk values for all differing scenario runs are presented in **Appendix C** and **Appendix D**.

2.2.1.3 In order to account for pending additional guidance on revised macro avoidance rates to be applied for gannet collision risk modelling the Applicant consulted on a revised approach during the Ornithology Technical Panel meeting held on the 25th May 2022. During this consultation meeting the Applicant presented a revised assessment approach for gannet collision risk modelling to account for a macro avoidance of 70% to be applied to the monthly seabird density estimates (the central value of Natural England's displacement range for this species). The inclusion of this updated macro avoidance for gannet has been incorporated into the sCRM and subsequent assessments for both the Applicant's and Natural England's preferred approach to collision risk modelling (see **Ornithology Technical Panel Meeting 16 MRSea Baseline Minutes** (**G5.28**). Further to this Natural England requested, via an email entitled "Hornsea 4 baseline clarifications" sent on the 24th June 2022, that a reduction of 60%, 65%, 75% and 80% to the monthly seabird density estimates also be considered in relation to inclusion of macro avoidance in collision risk assessments.

2.2.2 Calculation of seabird density variability

2.2.2.1 For design-based abundance estimates, non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. A measure of precision was calculated using a

Poisson estimator, suitable for a pseudo-Poisson over-dispersed distribution. This produced a CV based on the relationship of the standard error to the mean.

2.2.2.2 For MRSea abundance estimates, 1,000 bootstraps were carried out using a robust parametric bootstrap using the function provided within the MRSea package. As each bootstrap produces predicted counts for each cell of the prediction grid, the total abundance can be estimated for a defined area of interest (e.g. the array area only) by summing the predicted count for all cells within that area of interest. The standard deviation (SD) in the total abundance was then calculated from the 1,000 bootstrapped estimates of the total abundance, and the CV was calculated as the SD divided by the mean of the 1,000 bootstrapped estimates of the total abundance.

2.3 Displacement analysis

2.3.1.1 Revised displacement analysis has been carried out for gannet, guillemot, razorbill and puffin using the abundances for both flying and sitting behaviours combined within the array area plus 2 km buffer, as recommended in the SNCBs (2022) updated interim guidance note on displacement. Due to disagreement between the Applicant and Natural England on several different elements of displacement analysis, separate displacement assessments have been undertaken following the preferred approach from each party.

2.3.1.2 For gannet, the Applicant has used the migration-free breeding bio-season defined by Furness (2015) as the months of April to August. The rationale for selection of the migration-free breeding bio-season is based on site-specific evidence in a similar manner to that agreed by the SofS HRA for Hornsea Three, where the ExA and the SofS accepted the Applicant's breeding seasons definitions for gannet, based on their evidence, plus Langston (2013) and Cleasby (2018) tracking studies. SofS HRA section 5.3.1 concluded:

2.3.1.3 *"Given the above, the Secretary of State agrees with the conclusions of the ExA that the use of the longer breeding season to apportion impacts to the gannet and kittiwake populations at Flamborough and Filey Coast SPA is not justified and therefore, in this case, favours the Applicant's preferred shorter breeding season."*

2.3.1.4 Hornsea Four sits in a similar area of the southern North Sea that is also subject to migratory pulses of seabirds throughout the spring and autumn when birds move to and from their breeding colonies further north (both to UK and continental locations). The migratory patterns and timing of gannets through the southern North Sea are similar when considering their routes and interaction with other projects within the Hornsea Zone, this is demonstrated through the provision of supporting evidence from the site-specific survey data (advocated to take preference for inclusion in assessment where feasible by Natural England) collected for Hornsea Four in **A5.5.1 ES Volume A5 Annex 5.1 Offshore and Intertidal Ornithology Baseline Characterisation Report (APP-074)**. Flight direction rose diagrams in Appendix D show gannets are more aligned to north-south flight directions outside of the migration free breeding bio-season and with more east-west flight directions within the migration-free breeding bio-seasons. These flight directions provide supporting evidence to the Applicant's assumption that those birds flying in a north-south orientation

are migratory birds, whilst those orientated east-west are more likely connected to local breeding colonies.

2.3.1.5 Natural England's preferred approach for gannet is to use the months of March to September defined by Furness (2015) as the breeding bio-season.

2.3.1.6 For guillemot, as detailed within **A.5.5.2 Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis (APP-075)**, the Applicant has considered a 'weighted-mean' peak abundance for the non-breeding season to account for the inherent bias caused by a pulse of higher density for a single month in the post-breeding dispersal period (August – September), which form the wider non-breeding season (August – February). For the Natural England approach, standard mean peak abundance has been used to calculate the non-breeding bio-season abundance.

2.3.1.7 For razorbill and puffin, the approach taken for defining seasonality and bio-season abundance is the same for both the Applicant's and Natural England's approach.

2.3.2 Displacement rates

2.3.2.1 The SNCBs (2022) updated interim guidance recommends the following in relation to defining appropriate levels of displacement and mortality:

2.3.2.2 *"developers are encouraged to seek and present emerging sources of empirical evidence to provide support for their displacement assessment"*

2.3.2.3 Following this recommendation, the Applicant has undertaken the most extensive literature review to date in relation to both gannet and auk displacement and mortality rates the details of which are presented in **G2.9 Gannet Displacement and Mortality Evidence Review (REP2-045)** and **G1.47 Auk Displacement and Mortality Evidence Review (REP1-069)**.

2.3.2.4 The gannet displacement and mortality review critically appraised studies from 25 OWFs encompassing 34 years of combined data from 30 reports and publications. The recommended rates from this literature review concluded the most appropriate displacement rates to be a range of 40-60% displacement in the breeding season and 60-75% in the non-breeding season with a mortality rate of up to 1% being suitably precautionary, regardless of the bio-season.

2.3.2.5 The auk displacement and mortality review critically appraised studies from a total of 21 OWFs which included up to six years of post-consent monitoring for some OWFs. The recommended rates from this literature review concluded the most appropriate displacement rates to be up to 50% and a mortality rate of up to 1% being suitably precautionary, regardless of the bio-season.

2.3.2.6 When conducting both critical appraisals it became clear that for both gannet and auks the current advocated ranges of displacement (60-80% displacement for gannet and 30-70% displacement for auks) were compiled regardless of the quality of study, confidence in the derived rate and do not account for studies that have shown no significant displacement effect or even attraction. When considering applicable mortality rates, although empirical

evidence was not as numerous, the empirical evidence was clear that a mortality rate of up to 1% is realistic, whilst still including a suitable level of precaution.

2.3.2.7 Assessments using Natural England's preferred range of 60-80% displacement rate with 1-10% mortality rate for gannet and 30-70% displacement and 1-10% mortality rate for auk species are also presented.

2.4 Apportionment of Impacts to the FFC SPA

2.4.1.1 Revised assessments of impacts apportioned to the FFC SPA have been undertaken for the qualifying features and named components of the site in relation to the following conservation objective:

- Maintain or restore the population of each of the qualifying features.

2.4.1.2 Due to disagreement between the Applicant and Natural England on the method for apportioning impacts to the FFC SPA, predicted impacts following both parties preferred apportionment approaches are presented within this report.

2.4.2 Applicant's Apportionment Approach

2.4.2.1 The Applicants apportioning approach for breeding season impacts is based on the Scottish Natural Heritage (SNH) apportionment tool (SNH, 2018), as detailed in **B2.2 Report to Inform Appropriate Assessment Part 11: Appendix H: Offshore Ornithology Flamborough and Filey Coast (FFC) Special Protection Area (SPA) Population Viability Analysis (APP-177)**. The SNH apportionment tool methodology is based on considering a species' foraging range in addition to three colony-specific weighting factors; colony size (in individuals); distance to colony from the development sites; and sea area (the real extent of the open sea within foraging range of the relevant species), In order to attribute the correct proportion of adult breeding birds to different colonies appropriately.

2.4.2.2 Within the breeding season the total abundance of birds within the Hornsea Four will contain a mixture of breeding adults, sabbatical adults, sub-adults and juveniles which needs to be accounted for within the apportionment process.

2.4.2.3 In order to calculate the number of breeding adults from the FFC SPA within the Hornsea Four area, the Applicant has relied upon values from the BDMPS to understand the age breakdown of the species of interest. This is due to many seabird species (including kittiwake, guillemot, razorbill and puffin) having the same plumage after six months as they do when adults, therefore creating a bias in any site-specific data sets, regardless of being boat-based or aerial digital-based. Therefore, survey data sets may make mis-leading assumptions when considering all birds in 'adult' plumage to be breeding birds, as many may be immature individuals or adults taking a sabbatical. As is well documented, many seabird species are long-lived and do not breed for the first time until their fourth or fifth year, therefore a considerable amount of 'adult plumage' birds are not breeding adult birds. Furthermore, there is also the potential for site-specific data to underestimate the ratio of adult to juvenile birds, as is the case with auk species whereby juveniles can only be distinguished in the post-dispersal period when they are attended to by the breeding adult male which results in a 50% adult to juvenile split which can be considered unrealistic.

To ensure a robust assessment the age breakdown used within the Applicant used scientifically researched data from the wider BDMPS, as these rely on a larger data set and are considered to be more reliable to inform the baseline and assessment process.

2.4.2.4 A proportion of adult birds within the breeding season will be sabbatical birds free roaming the North Sea whilst taking a break from breeding activities (Marine Scotland 2017). A sabbatical rate of 10% for gannet and kittiwake populations and 7% for auk species was recently agreed by Marine Scotland for inclusion in revised Forth and Tay OWF applications (Neart na Gaoithe OWF, Seagreen Alpha and Bravo OWF, and Inch Cape OWF) in relation to the Forth Islands SPA and Firth of Forth and St. Andrews Bay Complex SPA, designated for breeding gannets, kittiwakes, guillemot, razorbill and puffin (Marine Scotland 2017). With similarities in the seabird assemblage and distance to colonies between the OWFs within the Forth and Tay region and Hornsea Four in relation to the waters out from the FFC SPA these values have been applied for use in this assessment of designated features from FFC SPA during the breeding season.

2.4.2.5 A summary of the Applicant's final apportionment values accounting the results of the SNH apportionment tool, breeding adult to juvenile proportion and sabbatical rate is presented in **Table 2**.

2.4.2.6 Outside of the breeding bio-season, when the population found within Hornsea Four contains a mix of birds from different UK breeding colonies and breeding colonies from further away (e.g. Furness 2015; Dunn et al. 2020), then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. For gannet, kittiwake, razorbill and puffin, this apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. The proportion of birds within Hornsea Four which can be apportioned to the FFC SPA during the non-breeding season is summarised in **Table 2**.

2.4.2.7 Despite agreement on the non-breeding apportionment for guillemot at EP#11 equating to 4.41% using the method described above (agreement OFF-ORN-6.13 as set out in Evidence Plan Logs which are appendices to the Hornsea Four Evidence Plan (**B1.1.1: Evidence Plan (APP130)**), at EP#14 Natural England requested that a bespoke method to apportionment in the non-breeding bio-season to incorporate the potential for a higher proportion of guillemots apportioned to the FFC SPA. This was to account for the potential for a higher proportion of birds during the post dispersal months of August and September that may be from FFC SPA (agreement OFF-ORN-2.52 as set out in Evidence Plan Logs which are appendices to the Hornsea Four Evidence Plan (**B1.1.1: Evidence Plan (APP130)**).

2.4.2.8 In order to accommodate Natural England's request, the Applicant formulated a weighted apportionment approach to the non-breeding season apportionment which allowed for substantially more (75%) guillemots in the non-breeding season to be apportioned to the FFC SPA during the post-dispersal months of August and September, whilst still producing only a single impact value for guillemot in the non-breeding season as assessed for all other OWFs in the UK. Evidence in support of an influx of birds from more northern colonies being a wider regional phenomenon during this period for guillemot dispersing across the North Sea, from July through to September and even into October, are provided in the report on **Indirect Effects, Forage Fish and Ornithology** (**G5.7**). Therefore, the use of and assumption

of a high proportion of birds being from the FFC SPA colony during August and September, whilst accounting for a proportion being from more northern colonies appears to be justified. However, it has become apparent to the Applicant from the work completed for the report on **Indirect Effects, Forage Fish and Ornithology** (**G5.7**) that the pulse of increased density within the post-breeding dispersal months of August and September is not a unique phenomenon to Hornsea Four and in fact is seen in the majority of the North Sea OWFs. The more northern areas of the Southern North Sea and Northern North Sea are subjected to a wider and more generalised influx of birds from more northern colonies (including those off the northeast coast of England and those in Scotland). This is supported by the guillemot distribution studies of their dispersion from the Isle of May from July to September (St John Glew, 2018), which is likely to be similar to other northern colonies and correlates with increases in their numbers across the Southern North Sea during this period. This provides a rationale and evidence for the higher abundances recorded within OWF zones within the more northern reaches of the Southern North Sea (including the Hornsea and Dogger Bank zones), which is likely to be similar across the wider region with a more uniform distribution of guillemots from multiple colonies spread from the north east coasts of Scotland and England out to the UK's maritime border with other European countries and beyond into the central North Sea during this period (Buckingham et al, 2018). Therefore, it is only natural to expect that although it is likely that birds within the Hornsea Four array area during the post-breeding dispersal months of August and September contain a high proportion of birds from the FFC SPA colony there will also be substantial numbers contributing to the population from other more northerly colonies, as birds have spread more widely during this period, therefore reducing the overall risk from individual OWFs to specific colonies.

2.4.2.9 Furthermore, the reasoning behind Natural England's request for a bespoke approach for Hornsea Four was due to Natural England's concerns relating to connectivity between Hornsea Four and the Flamborough Front, which again from the work completed for the report on **Indirect Effects, Forage Fish and Ornithology** (**G5.7**). However, the findings of this report provide evidence that the Flamborough Front is more typically located to the north of the Hornsea Four array area and it may be that the higher catch rates of commercial fish in those waters is in part related to the front system. However, the presence of higher density hotspots for seabirds and forage fish to the south of the Hornsea Four array area is not likely to be linked to any front systems and is more likely to be a consequence of the natural bathymetry occurring there of shallower waters.. Similar conclusions were made from the review of thermal front modelling and productivity mapping identified forage fish, commercial fisheries and bird distribution, with higher densities of auks from the site-specific survey data to the north and to the south of the Hornsea Four array area matching the areas of higher productivity and fisheries activities. Therefore, it is evident that the Hornsea Four array area is of lesser importance both with regards to the occurrence of regular thermal fronts and any associated increased productivity in comparison to other areas, which was further demonstrated from as the location of the Flamborough Front is consistently to the north of the array area, which is likely to again explain the higher productivity occurring to the north of this area too.

2.4.2.10 Based on these finding the Applicant considers that there is considerable precaution within the weighted mean approach, which more accurately considers the incidence of

guillemots being more likely to be connected to the FFC SPA during the months of August and September, whilst also acknowledging that birds from further afield make up a considerable proportion during this period. When considering the weighted mean approach this means a much greater proportion of birds across the non-breeding season (13.12%) are attributed to FFC SPA in comparison to using the standard apportionment rate of 4.41% as used for all other OWFs within UK North Sea and English Channel BDMPS area. The precautionary nature of the approach taken by the Applicant is demonstrated through the provision of predicted impacts using both the Applicant's approach (13.12%) in comparison to the standard approach taken by other OWF impact assessment of guillemots (4.41%) in this report.

Table 2: Applicant's seasonal apportioning rates for predicted impacts from Hornsea Four to the FFC SPA.

Bio-season	Gannet	Kittiwake	Guillemot	Razorbill	Puffin
Return Migration	6.23%	7.19%	N/A	3.38%	N/A
Migration-free Breeding	61.20%	58.17%	N/A	55.80%	N/A
Post-breeding Migration	4.85%	5.44%	N/A	3.38%	N/A
Migration-free Winter	N/A	N/A	N/A	2.74%	N/A
Breeding	N/A	N/A	55.80%	N/A	89.28%
Non-breeding	N/A	N/A	13.12%	N/A	0.41%

2.4.3 Natural England's Apportionment Approach

2.4.3.1 On the 27th May Natural England provided the Applicant with their preferred approach to apportioning impacts to the FFC SPA for gannet, kittiwake, guillemot and razorbill ahead of being submitted into examination at Deadline 5. The Applicant has reviewed the apportionment approaches provided and have provided assessments accordingly following Natural England's preferred approach. A summary of Natural England's apportioning approach is provided below.

2.4.3.2 For kittiwake and gannet, Natural England requested that all 'adult type' birds be considered breeding adult birds, no sabbatical rate to be included and all impacts during the breeding season should be apportioned to the FFC SPA. During the non-breeding season apportioning of impacts follows the same approach taken by the Applicant. The number of 'adult type' birds has been calculated using the age classifications in **G5.9 Revised Ornithology Baseline** for the Hornsea Four AfL plus 4 km buffer dataset.

2.4.3.3 For guillemot and razorbill, Natural England requested that all birds regardless of age and potential for sabbaticals be considered breeding adults, resulting in 100% apportionment during the breeding season.

2.4.3.4 For puffin, Natural England did not provide any formal advice on how to apportion puffin breeding season predicted impacts, based on the advice provided for the other two auks

species the Applicant has assumed 100% apportionment in the breeding season regardless of age and potential for sabbaticals.

2.4.3.5 For guillemot, Natural England have requested that the non-breeding season is now split into two separate seasons, resulting in an additional impact assessment for guillemot in the non-breeding season. The additional season is defined as the chick rearing/moult period made up of the months of August to September with an apportionment rate of 60% and the remaining non-breeding period made up of the months of October to February with an apportionment rate of 4.41%.

2.4.3.6 For Razorbill, Natural England have requested that the post-breeding migration bio-season (renamed to the chick rearing/moult period) apportionment is increased to 66% and the remaining non-breeding bio-seasons remain the standard apportioning rates as used by the Applicant.

2.4.3.7 For puffin, Natural England did not provide any formal advice on how to apportion puffin non-breeding bio-season predicted impacts, therefore the Applicant has applied the standard non-breeding season rate of 0.41%.

2.4.3.8 A summary of the seasonal apportioning rates following Natural England's recommendations is presented in Table 3. The Applicant awaits the formal submission of this additional guidance from Natural England into the examination before providing the ExA with a full response. However, it should be noted that the Applicant does not agree with all the assumptions or methods put forward and intends to provide the ExA with a formal response following deadline 5.

Table 3: Natural England's seasonal apportioning rates for predicted impacts from Hornsea Four to the FFC SPA.

Bio-season	Gannet	Kittiwake	Guillemot	Razorbill	Puffin
Return Migration	6.23%	7.19%	N/A	3.38%	N/A
Migration-free Breeding	90.48%	94.45%	N/A	100%	N/A
Post-breeding Migration	4.85%	5.44%	N/A	N/A	N/A
Migration-free Winter	N/A	N/A	N/A	2.74%	N/A
Breeding	N/A	N/A	100%	N/A	100%
Chick rearing/moult	N/A	N/A	60%	66.00%	N/A
Non-breeding	N/A	N/A	4.41%	N/A	0.41%

2.5 Cumulative and In-combination Assessments

2.5.1.1 The criteria for identification of projects for inclusion within cumulative and in-combination assessments is described within A2.5 Environmental Statement Volume A2 Chapter 5 Offshore and Intertidal Ornithology (APP-017) and B2.2: Report to Inform Appropriate Assessment (APP-167-APP-178). The Applicant has used the latest predicted impacts for

projects included within the cumulative and in-combination as informed from the latest documents submitted to the Planning Inspectorate.

2.5.1.2 Following the latest conclusions from the Secretary of State in relation to the kittiwake feature of the FFC SPA requiring compensation for predicted impacts from Norfolk Boreas, Norfolk Vanguard, East Anglia One North and East Anglia Two, predicted impacts from these projects have been removed from the in-combination assessment of kittiwake feature in line with previous guidance for Hornsea Project Three.

2.6 Population Viability Analysis (PVA)

2.6.1.1 Revised PVA has been completed and is presented within **G4.7 Ornithological Assessment Sensitivity Report**.

3 EIA Alone Level Impacts

3.1 Gannet

3.1.1 Construction Phase Impacts (Applicant's Approach)

Table 4: Gannet construction phase bio-season displacement estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of gannets subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*30-40% Disp; 1% Mort*	*Breeding 20-30% Disp, Non-breeding 30-32.5% Disp; 1%% Mort*	*30-40% Disp; 1%% Mort*	*Breeding 20-30% Disp, Non-breeding 30-32.5% Disp; 1%% Mort*
Return migration (Dec-Mar)	401	248,385	46,448	1.2-1.6	1.2-1.5	0.00-0.00%	0.00-0.00%
Migration-free breeding (Apr-Aug)	976	400,326	74,861	2.9-3.9	2.0-2.9	0.00-0.01%	0.00-0.00%
Post-breeding migration (Sep-Nov)	790	456,298	85,328	2.4-3.2	2.4-3.0	0.00-0.00%	0.00-0.00%
Annual (BDMPS)	**2,167**	**456,298**	**85,328**	**6.5-8.7**	**5.5-7.4**	**0.01-0.01%**	**0.01-0.01%**
Annual (biogeographic)	**2,167**	**1,180,000**	**220,660**	**6.5-8.7**	**5.5-7.4**	**0.00-0.00%**	**0.00-0.00%**

3.1.2 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 5: Gannet operation and maintenance phase bio-season displacement estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of gannets subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*
Return migration (Dec-Mar)	401	248,385	46,448	2.4-3.2	2.4-3.0	0.01-0.01%	0.01-0.01%
Migration-free breeding (Apr-Aug)	976	400,326	74,861	5.9-7.8	3.9-5.9	0.01-0.01%	0.01-0.01%
Post-breeding migration (Sep-Nov)	790	456,298	85,328	4.7-6.3	4.7-5.9	0.01-0.01%	0.01-0.01%
Annual (BDMPS)	**2,167**	**456,298**	**85,328**	**13.0-17.3**	**11.1-14.8**	**0.02-0.02%**	**0.01-0.02%**
Annual (biogeographic)	**2,167**	**1,180,000**	**220,660**	**13.0-17.3**	**11.1-14.8**	**0.01-0.01%**	**0.01-0.01%**

Table 6: Gannet operation and maintenance phase annual displacement matrix for Hornsea Four (Applicant's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	1	1	1	2	4	7	9	11	13	15	17	20	22
10	2	4	7	9	11	22	43	65	87	108	130	152	173	195	217
20	4	9	13	17	22	43	87	130	173	217	260	303	347	390	433
30	7	13	20	26	33	65	130	195	260	325	390	455	520	585	650
40	9	17	26	35	43	87	173	260	347	433	520	607	693	780	867
50	11	22	33	43	54	108	217	325	433	542	650	758	867	975	1,084
60	13	26	39	52	65	130	260	390	520	650	780	910	1,040	1,170	1,300
70	15	30	46	61	76	152	303	455	607	758	910	1,062	1,214	1,365	1,517
80	17	35	52	69	87	173	347	520	693	867	1,040	1,214	1,387	1,560	1,734
90	20	39	59	78	98	195	390	585	780	975	1,170	1,365	1,560	1,755	1,950
100	22	43	65	87	108	217	433	650	867	1,084	1,300	1,517	1,734	1,950	2,167

Table 7: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	1.8 (*0.9-17.1*)	248,385	46,448	0.00% (*0.00-0.04%*)
Migration-free breeding (Apr-Aug)	11.0 (*6.5-19.4*)	400,326	74,861	0.02% (*0.01-0.03%*)
Post-breeding migration (Sep-Nov)	4.4 (*2.8-8.7*)	456,298	85,328	0.01% (*0.00-0.01%*)
Annual (BDMPS)	**17.3 (*10.3-45.3*)**	**456,298**	**85,328**	**0.02% (*0.01-0.05%*)**
Annual (biogeographic)	**17.3 (*10.3-45.3*)**	**1,180,000**	**220,660**	**0.01% (*0.00-0.02%*)**

Table 8: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 70% (Applicant's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	0.55	248,385	46,448	0.00%
Migration-free breeding (Apr-Aug)	3.30	400,326	74,861	0.00%
Post-breeding migration (Sep-Nov)	1.32	456,298	85,328	0.00%
Annual (BDMPS)	**5.18**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**5.18**	**1,180,000**	**220,660**	**0.00%**

Table 9: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 60% (Applicant's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	0.74	248,385	46,448	0.00%
Migration-free breeding (Apr-Aug)	4.40	400,326	74,861	0.01%
Post-breeding migration (Sep-Nov)	1.76	456,298	85,328	0.00%
Annual (BDMPS)	**6.90**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**6.90**	**1,180,000**	**220,660**	**0.00%**

Table 10: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 65% (Applicant's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	0.64	248,385	46,448	0.00%
Migration-free breeding (Apr-Aug)	3.85	400,326	74,861	0.01%
Post-breeding migration (Sep-Nov)	1.54	456,298	85,328	0.00%
Annual (BDMPS)	**6.04**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**6.04**	**1,180,000**	**220,660**	**0.00%**

Table 11: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 75% (Applicant's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	0.46	248,385	46,448	0.00%
Migration-free breeding (Apr-Aug)	2.75	400,326	74,861	0.00%
Post-breeding migration (Sep-Nov)	1.10	456,298	85,328	0.00%
Annual (BDMPS)	**4.31**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**4.31**	**1,180,000**	**220,660**	**0.00%**

Table 12: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 80% (Applicant's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	0.37	248,385	46,448	0.00%
Migration-free breeding (Apr-Aug)	2.20	400,326	74,861	0.00%
Post-breeding migration (Sep-Nov)	0.88	456,298	85,328	0.00%
Annual (BDMPS)	**3.45**	**456,298**	**85,328**	**0.00%**
Annual (biogeographic)	**3.45**	**1,180,000**	**220,660**	**0.00%**

3.1.3 Construction Phase Impacts (Natural England's Approach)

Table 13: Gannet construction phase bio-season displacement estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of gannets subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*30% Disp; 1-10% Mort*	*40% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*40% Disp; 1-10% Mort*
Return migration (Dec-Feb)	401	248,385	46,448	1.2-12.0	1.6-16.0	0.00-0.03%	0.00-0.03%
Breeding (Mar-Sep)	976	400,326	74,861	2.9-29.3	3.9-39.0	0.00-0.04%	0.01-0.05%
Post-breeding migration (Oct-Nov)	790	456,298	85,328	2.4-23.7	3.2-31.6	0.00-0.03%	0.00-0.04%
Annual (BDMPS)	**2,167**	**456,298**	**85,328**	**6.5-65.0**	**8.7-86.7**	**0.01-0.08%**	**0.01-0.10%**
Annual (biogeographic)	**2,167**	**1,180,000**	**220,660**	**6.5-65.0**	**8.7-86.7**	**0.00-0.03%**	**0.00-0.04%**

3.1.4 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 14: Gannet operation and maintenance phase bio-season displacement estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of gannets subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*60% Disp; 1-10% Mort*	*80% Disp; 1-10% Mort*	*60% Disp; 1-10% Mort*	*80% Disp; 1-10% Mort*
Return migration (Dec-Feb)	401	248,385	46,448	2.4-24.1	3.2-32.1	0.01-0.05%	0.01-0.07%
Breeding (Mar-Sep)	976	400,326	74,861	5.9-58.6	7.8-78.1	0.01-0.08%	0.01-0.10%
Post-breeding migration (Oct-Nov)	790	456,298	85,328	4.7-47.4	6.3-63.2	0.01-0.06%	0.01-0.07%
Annual (BDMPS)	**2,167**	**456,298**	**85,328**	**13.0-130.0**	**17.3-173.4**	**0.02-0.15%**	**0.02-0.20%**
Annual (biogeographic)	**2,167**	**1,180,000**	**220,660**	**13.0-130.0**	**17.3-173.4**	**0.01-0.06%**	**0.01-0.08%**

Table 15: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Feb)	1.3 (*0.1-41.6*)	248,385	46,448	0.00% (*0.00-0.09%*)
Breeding (Mar-Sep)	15.6 (*2.3-63.6*)	400,326	74,861	0.02% (*0.00-0.08%*)
Post-breeding migration (Oct-Nov)	5.2 (*0.8-19.4*)	456,298	85,328	0.01% (*0.00-0.02%*)
Annual (BDMPS)	**22.3 (*3.3-124.5*)**	**456,298**	**85,328**	**0.03% (*0.00-0.15%*)**
Annual (biogeographic)	**22.3 (*3.3-124.5*)**	**1,180,000**	**220,660**	**0.01% (*0.00-0.06%*)**

Table 16: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 70% (Natural England's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Feb)	0.39	248,385	46,448	0.00%
Breeding (Mar-Sep)	4.72	400,326	74,861	0.01%
Post-breeding migration (Oct-Nov)	1.57	456,298	85,328	0.00%
Annual (BDMPS)	**6.69**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**6.69**	**1,180,000**	**220,660**	**0.00%**

Table 17: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 60% (Natural England's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Feb)	0.52	248,385	46,448	0.00%
Breeding (Mar-Sep)	6.30	400,326	74,861	0.01%
Post-breeding migration (Oct-Nov)	2.10	456,298	85,328	0.00%
Annual (BDMPS)	**8.92**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**8.92**	**1,180,000**	**220,660**	**0.00%**

Table 18: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 65% (Natural England's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Feb)	0.46	248,385	46,448	0.00%
Breeding (Mar-Sep)	5.51	400,326	74,861	0.01%
Post-breeding migration (Oct-Nov)	1.83	456,298	85,328	0.00%
Annual (BDMPS)	**7.80**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**7.80**	**1,180,000**	**220,660**	**0.00%**

Table 19: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 75% (Natural England's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Feb)	0.33	248,385	46,448	0.00%
Breeding (Mar-Sep)	3.94	400,326	74,861	0.01%
Post-breeding migration (Oct-Nov)	1.31	456,298	85,328	0.00%
Annual (BDMPS)	**5.57**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**5.57**	**1,180,000**	**220,660**	**0.00%**

Table 20: Gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 80% (Natural England's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Feb)	0.26	248,385	46,448	0.00%
Breeding (Mar-Sep)	3.15	400,326	74,861	0.00%
Post-breeding migration (Oct-Nov)	1.05	456,298	85,328	0.00%
Annual (BDMPS)	**4.46**	**456,298**	**85,328**	**0.01%**
Annual (biogeographic)	**4.46**	**1,180,000**	**220,660**	**0.00%**

3.2 Great black-backed gull

3.2.1 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 21: Great black-backed gull operation and maintenance phase bio-season collision estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Seasonal sCRM totals BO3 (per annum)	Regional baseline populations and baseline mortality rates		BO2 Increase in baseline mortality (%)	BO3 Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*		
Breeding (Apr–Aug)	0.7 (*0.6-1.0*)	0.4 (*0.3-0.6*)	26,917	4,307	0.02% (*0.01-0.02%*)	0.01% (*0.01-0.01%*)
Non-breeding (Sep–Mar)	6.7 (*2.5-25.1*)	4.0 (*1.5-14.8*)	91,399	14,624	0.05% (*0.02-0.17%*)	0.03% (*0.01-0.10%*)
Annual (BDMPS)	**7.4 (*3.0-26.1*)**	**4.4 (*1.8-15.3*)**	**91,399**	**14,624**	**0.05% (*0.02-0.18%*)**	**0.03% (*0.01-0.10%*)**
Annual (biogeographic)	**7.4 (*3.0-26.1*)**	**4.4 (*1.8-15.3*)**	**235,000**	**37,600**	**0.02% (*0.01-0.07%*)**	**0.01% (*0.00-0.04%*)**

3.2.2 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 22: Great black-backed gull operation and maintenance phase bio-season collision estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Seasonal sCRM totals BO3 (per annum)	Regional baseline populations and baseline mortality rates		BO2 Increase in baseline mortality (%)	BO3 Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*		
Breeding (Apr–Aug)	0.8 (*0.4-1.8*)	0.5 (*0.2-1.7*)	26,917	4,307	0.02% (*0.01-0.04%*)	0.01% (*0.01-0.04%*)
Non-breeding (Sep–Mar)	8.8 (*1.8-48.3*)	5.0 (*1.0-43.6*)	91,399	14,624	0.06% (*0.01-0.33%*)	0.04% (*0.01-0.30%*)
Annual (BDMPS)	**9.6 (2.3-50.2)**	**5.7 (1.2-45.2)**	**91,399**	**14,624**	**0.07% (0.02-0.34%)**	**0.04% (0.01-0.31%)**
Annual (biogeographic)	**9.6 (2.3-50.2)**	**5.7 (1.2-45.2)**	**235,000**	**37,600**	**0.03% (0.01-0.13%)**	**0.02% (0.00-0.12%)**

3.3 Kittiwake

3.3.1 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 23: Kittiwake operation and maintenance phase bio-season collision estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Jan-Apr)	13.5 (*6.4-27.2*)	627,816	97,939	0.01% (*0.01-0.03%*)
Migration-free breeding (May-Jul)	35.4 (*21.3-58.6*)	839,456	130,955	0.03% (*0.02-0.04%*)
Post-breeding migration (Aug-Dec)	31.7 (*15.5-63.2*)	829,937	129,470	0.02% (*0.01-0.05%*)
Annual (BDMPS)	**80.6 (*43.3-148.9*)**	**1,237,264**	**193,013**	**0.04% (*0.02-0.08%*)**
Annual (biogeographic)	**80.6 (*43.3-148.9*)**	**5,100,000**	**795,600**	**0.01% (*0.01-0.02%*)**

3.3.2 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 24: Kittiwake operation and maintenance phase bio-season collision estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Jan-Feb)	4.6 (*1.2-9.8*)	627,816	97,939	0.01% (*0.00-0.01%*)
Migration-free breeding (Mar-Aug)	74.5 (*22.6-159.6*)	839,456	130,955	0.06% (*0.02-0.12%*)
Post-breeding migration (Sep-Dec)	13.9 (*2.3-35.9*)	829,937	129,470	0.01% (*0.00-0.03%*)
Annual (BDMPS)	**93.0 (*26.1-205.3*)**	**1,237,264**	**193,013**	**0.05% (*0.01-0.11%*)**
Annual (biogeographic)	**93.0 (*26.1-205.3*)**	**5,100,000**	**795,600**	**0.01% (*0.00-0.03%*)**

3.4 Guillemot

3.4.1 Construction Phase Impacts (Applicant's Approach)

Table 25: Guillemot construction phase bio-season displacement estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of guillemots subject to mortality (individuals per annum)	Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	*25% Disp; 1% Mort*	*25% Disp; 1% Mort*
Breeding (Mar-Jul)	9,382	2,045,078	282,221	23.5	0.01%
Non-breeding weighted mean peak (Aug-Feb)	20,326	1,617,306	223,188	50.8	0.02%
Annual (BDMPS)	**29,708**	**2,139,238**	**295,215**	**74.3**	**0.03%**
Annual (biogeographic)	**29,708**	**4,125,000**	**569,250**	**74.3**	**0.01%**

3.4.2 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 26: Guillemot operation and maintenance phase bio-season displacement estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of guillemots subject to mortality (individuals per annum)	Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Breeding (Mar-Jul)	9,382	2,045,078	282,221	46.9	0.02%
Non-breeding weighted mean peak (Aug-Feb)	20,326	1,617,306	223,188	101.6	0.05%
Annual (BDMPS)	**29,708**	**2,139,238**	**295,215**	**148.5**	**0.05%**
Annual (biogeographic)	**29,708**	**4,125,000**	**569,250**	**148.5**	**0.03%**

Table 27: Guillemot operation and maintenance phase annual displacement matrix for Hornsea Four (Applicant's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	3	6	9	12	15	30	59	89	119	149	178	208	238	267	297
10	30	59	89	119	149	297	594	891	1,188	1,485	1,782	2,080	2,377	2,674	2,971
20	59	119	178	238	297	594	1,188	1,782	2,377	2,971	3,565	4,159	4,753	5,347	5,942
30	89	178	267	356	446	891	1,782	2,674	3,565	4,456	5,347	6,239	7,130	8,021	8,912
40	119	238	356	475	594	1,188	2,377	3,565	4,753	5,942	7,130	8,318	9,507	10,695	11,883
50	149	297	446	594	743	1,485	2,971	4,456	5,942	7,427	8,912	10,398	11,883	13,369	14,854
60	178	356	535	713	891	1,782	3,565	5,347	7,130	8,912	10,695	12,477	14,260	16,042	17,825
70	208	416	624	832	1,040	2,080	4,159	6,239	8,318	10,398	12,477	14,557	16,637	18,716	20,796
80	238	475	713	951	1,188	2,377	4,753	7,130	9,507	11,883	14,260	16,637	19,013	21,390	23,767
90	267	535	802	1,069	1,337	2,674	5,347	8,021	10,695	13,369	16,042	18,716	21,390	24,064	26,737
100	297	594	891	1,188	1,485	2,971	5,942	8,912	11,883	14,854	17,825	20,796	23,767	26,737	29,708

3.4.3 Construction Phase Impacts (Natural England's Approach)

Table 28: Guillemot construction phase bio-season displacement estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of guillemots subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*
Breeding (Mar-Jul)	9,382	2,045,078	282,221	14.1-32.8	140.7-328.4	0.00-0.01%	0.05-0.12%
Non-breeding mean peak (Aug-Feb)	36,965	1,617,306	223,188	55.5-129.4	554.5-1,293.8	0.02-0.06%	0.25-0.58%
Annual (BDMPS)	**46,347**	**2,139,238**	**295,215**	**69.5-162.2**	**695.2-1,622.2**	**0.02-0.05%**	**0.24-0.55%**
Annual (biogeographic)	**46,347**	**4,125,000**	**569,250**	**69.5-162.2**	**162.2-1,622.2**	**0.01-0.03%**	**0.12-0.28%**

3.4.4 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 29: Guillemot operation and maintenance phase bio-season displacement estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of guillemots subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Breeding (Mar-Jul)	9,382	2,045,078	282,221	28.2-281.5	65.7-656.7	0.01-0.10%	0.02-0.23%
Non-breeding mean peak (Aug-Feb)	36,965	1,617,306	223,188	110-9-1,109.0	258.8-2,587.6	0.05-0.50%	0.12-1.16%
Annual (BDMPS)	**46,347**	**2,139,238**	**295,215**	**139.0-1,390.4**	**324.4-3,244.3**	**0.05-0.47%**	**0.11-1.10%**
Annual (biogeographic)	**46,347**	**4,125,000**	**569,250**	**139.0-1,390.4**	**324.4-3,244.3**	**0.02-0.24%**	**0.06-0.57%**

Table 30: Guillemot operation and maintenance phase annual displacement matrix for Hornsea Four (Natural England's Approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	5	9	14	19	23	46	93	139	185	232	278	324	371	417	463
10	46	93	139	185	232	463	927	1,390	1,854	2,317	2,781	3,244	3,708	4,171	4,635
20	93	185	278	371	463	927	1,854	2,781	3,708	4,635	5,562	6,489	7,416	8,342	9,269
30	139	278	417	556	695	1,390	2,781	4,171	5,562	6,952	8,342	9,733	11,123	12,514	13,904
40	185	371	556	742	927	1,854	3,708	5,562	7,416	9,269	11,123	12,977	14,831	16,685	18,539
50	232	463	695	927	1,159	2,317	4,635	6,952	9,269	11,587	13,904	16,221	18,539	20,856	23,174
60	278	556	834	1,112	1,390	2,781	5,562	8,342	11,123	13,904	16,685	19,466	22,247	25,027	27,808
70	324	649	973	1,298	1,622	3,244	6,489	9,733	12,977	16,221	19,466	22,710	25,954	29,199	32,443
80	371	742	1,112	1,483	1,854	3,708	7,416	11,123	14,831	18,539	22,247	25,954	29,662	33,370	37,078
90	417	834	1,251	1,668	2,086	4,171	8,342	12,514	16,685	20,856	25,027	29,199	33,370	37,541	41,712
100	463	927	1,390	1,854	2,317	4,635	9,269	13,904	18,539	23,174	27,808	32,443	37,078	41,712	46,347

3.5 Razorbill

3.5.1 Construction Phase Impacts (Applicant's Approach)

Table 31: Razorbill construction phase bio-season displacement estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of razorbills subject to mortality (individuals per annum)	Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	*25% Disp; 1% Mort*	*25% Disp; 1% Mort*
Return migration (Jan-Mar)	449	591,874	114,232	1.1	0.00%
Migration-free breeding (Apr-Jul)	386	158,031	30,500	1.0	0.00%
Post-breeding migration (Aug-Oct)	4,311	591,874	114,232	10.8	0.01%
Migration-free winter (Nov-Dec)	455	218,622	42,194	1.1	0.00%
Annual (BDMPS)	**5,600**	**592,462**	**114,345**	**14.0**	**0.01%**
Annual (biogeographic)	**5,600**	**1,707,000**	**329,451**	**14.0**	**0.00%**

3.5.2 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 32: Razorbill operation and maintenance phase bio-season displacement estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of razorbills subject to mortality (individuals per annum)	Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Return migration (Jan-Mar)	449	591,874	114,232	2.2	0.00%
Migration-free breeding (Apr-Jul)	386	158,031	30,500	1.9	0.01%
Post-breeding migration (Aug-Oct)	4,311	591,874	114,232	21.6	0.02%
Migration-free winter (Nov-Dec)	455	218,622	42,194	2.3	0.01%
Annual (BDMPS)	**5,600**	**592,462**	**114,345**	**28.0**	**0.02%**
Annual (biogeographic)	**5,600**	**1,707,000**	**329,451**	**28.0**	**0.01%**

Table 33: Razorbill operation and maintenance phase annual displacement matrix for Hornsea Four.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	1	2	2	3	6	11	17	22	28	34	39	45	50	56
10	6	11	17	22	28	56	112	168	224	280	336	392	448	504	560
20	11	22	34	45	56	112	224	336	448	560	672	784	896	1,008	1,120
30	17	34	50	67	84	168	336	504	672	840	1,008	1,176	1,344	1,512	1,680
40	22	45	67	90	112	224	448	672	896	1,120	1,344	1,568	1,792	2,016	2,240
50	28	56	84	112	140	280	560	840	1,120	1,400	1,680	1,960	2,240	2,520	2,800
60	34	67	101	134	168	336	672	1,008	1,344	1,680	2,016	2,352	2,688	3,024	3,360
70	39	78	118	157	196	392	784	1,176	1,568	1,960	2,352	2,744	3,136	3,528	3,920
80	45	90	134	179	224	448	896	1,344	1,792	2,240	2,688	3,136	3,584	4,032	4,480
90	50	101	151	202	252	504	1,008	1,512	2,016	2,520	3,024	3,528	4,032	4,536	5,040
100	56	112	168	224	280	560	1,120	1,680	2,240	2,800	3,360	3,920	4,480	5,040	5,600

3.5.3 Construction Phase Impacts (Natural England's Approach)

Table 34: Razorbill construction phase bio-season displacement estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of razorbills subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*
Return migration (Jan-Mar)	449	591,874	114,232	0.7-1.6	6.7-15.7	0.00-0.00%	0.01-0.01%
Migration-free breeding (Apr-Jul)	386	158,031	30,500	0.6-1.4	5.8-13.5	0.00-0.00%	0.02-0.04%
Post-breeding migration (Aug-Oct)	4,311	591,874	114,232	6.5-15.1	64.7-150.9	0.01-0.01%	0.06-0.13%
Migration-free winter (Nov-Dec)	455	218,622	42,194	0.7-1.6	6.9-15.9	0.00-0.00%	0.02-0.13%
Annual (BDMPS)	**5,600**	**592,462**	**114,345**	**8.4-19.6**	**84.0-196.0**	**0.01-0.02%**	**0.07-0.17%**
Annual (biogeographic)	**5,600**	**1,707,000**	**329,451**	**8.4-19.6**	**84.0-196.0**	**0.00-0.01%**	**0.03-0.06%**

3.5.4 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 35: Razorbill operation and maintenance phase bio-season displacement estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of razorbills subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Return migration (Jan-Mar)	449	591,874	114,232	1.4-13.5	3.1-31.4	0.00-0.01%	0.00-0.03%
Migration-free breeding (Apr-Jul)	386	158,031	30,500	1.2-11.6	2.7-27.0	0.00-0.04%	0.01-0.09%
Post-breeding migration (Aug-Oct)	4,311	591,874	114,232	12.9-129.3	30.2-301.8	0.01-0.11%	0.03-0.26%
Migration-free winter (Nov-Dec)	455	218,622	42,194	1.4-13.6	3.2-31.8	0.00-0.03%	0.01-0.08%
Annual (BDMPS)	**5,600**	**592,462**	**114,345**	**16.8-168.0**	**39.2-392.0**	**0.01-0.03%**	**0.15-0.34%**
Annual (biogeographic)	**5,600**	**1,707,000**	**329,451**	**16.8-168.0**	**39.2-392.0**	**0.01-0.05%**	**0.01-0.12%**

3.6 Puffin

3.6.1 Construction Phase Impacts (Applicant's Approach)

Table 36: Puffin construction phase bio-season displacement estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of puffins subject to mortality (individuals per annum)	Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	*25% Disp; 1% Mort*	*25% Disp; 1% Mort*
Breeding (Mar-Jul)	203	868,689	152,021	0.5	0.00%
Non-breeding (Aug-Feb)	442	231,957	40,592	1.1	0.00%
Annual (BDMPS)	**644**	**938,585**	**164,252**	**1.6**	**0.00%**
Annual (biogeographic)	**644**	**11,840,000**	**2,072,000**	**1.6**	**0.00%**

3.6.2 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 37: Puffin operation and maintenance phase bio-season displacement estimates for Hornsea Four (Applicant's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of puffins subject to mortality (individuals per annum)	Increase in baseline mortality (%)
		Population (individuals)	*Baseline mortality (per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Breeding (Mar-Jul)	203	868,689	152,021	1.0	0.00%
Non-breeding (Aug-Feb)	442	231,957	40,592	2.2	0.01%
Annual (BDMPS)	**644**	**938,585**	**164,252**	**3.2**	**0.00%**
Annual (biogeographic)	**644**	**11,840,000**	**2,072,000**	**3.2**	**0.00%**

Table 38: Puffin operation and maintenance phase annual displacement matrix for Hornsea Four.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	1	1	2	3	3	4	5	5	6	6
10	1	1	2	3	3	6	13	19	26	32	39	45	52	58	64
20	1	3	4	5	6	13	26	39	52	64	77	90	103	116	129
30	2	4	6	8	10	19	39	58	77	97	116	135	155	174	193
40	3	5	8	10	13	26	52	77	103	129	155	180	206	232	258
50	3	6	10	13	16	32	64	97	129	161	193	226	258	290	322
60	4	8	12	15	19	39	77	116	155	193	232	271	309	348	387
70	5	9	14	18	23	45	90	135	180	226	271	316	361	406	451
80	5	10	15	21	26	52	103	155	206	258	309	361	412	464	516
90	6	12	17	23	29	58	116	174	232	290	348	406	464	522	580
100	6	13	19	26	32	64	129	193	258	322	387	451	516	580	644

3.6.3 Construction Phase Impacts (Natural England's Approach)

Table 39: Puffin construction phase bio-season displacement estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of puffins subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*
Breeding (Mar-Jul)	203	868,689	152,021	0.3-0.7	3.0-7.1	0.00-0.00%	0.00-0.00%
Non-breeding (Aug-Feb)	442	231,957	40,592	0.7-1.6	6.6-15.5	0.00-0.00%	0.02-0.04%
Annual (BDMPS)	**644**	**938,585**	**164,252**	**1.0-2.3**	**9.7-22.6**	**0.00-0.00%**	**0.01-0.01%**
Annual (biogeographic)	**644**	**11,840,000**	**2,072,000**	**1.0-2.3**	**9.7-22.6**	**0.00-0.00%**	**0.00-0.00%**

3.6.4 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 40: Puffin operation and maintenance phase bio-season displacement estimates for Hornsea Four (Natural England's approach).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of guillemots subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
		Population (individuals)	*Baseline mortality (per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Breeding (Mar-Jul)	203	868,689	152,021	0.6-6.1	1.4-14.2	0.00-0.00%	0.00-0.01%
Non-breeding (Aug-Feb)	442	231,957	40,592	1.3-13.3	3.1-30.9	0.00-0.03%	0.01-0.08%
Annual (BDMPS)	**644**	**938,585**	**164,252**	**1.9-19.3**	**4.5-45.1**	**0.00-0.01%**	**0.00-0.03%**
Annual (biogeographic)	**644**	**11,840,000**	**2,072,000**	**1.9-19.3**	**4.5-45.1**	**0.00-0.00%**	**0.00-0.00%**

4 EIA Cumulative Level Impacts

4.1 Gannet

Table 41: Cumulative bio-season and total abundance estimates for gannet from all Tier 1 & 2 projects for the North Sea and English Channel for displacement.

Project	Breeding	Autumn	Spring	Annual	Tier
Beatrice	151	0	0	151	1a
Blyth Demonstration Site	-	-	-	-	1a
Dudgeon	53	25	11	89	1a
EOWDC	35	5	0	40	1a
Galloper	360	907	276	1,543	1a
Greater Gabbard	252	69	105	426	1a
Gunfleet Sands	0	12	9	21	1a
Humber Gateway	-	-	-	-	1a
Hywind 2 Demonstration	10	0	4	14	1a
Kentish Flats	-	-	-	-	1a
Kentish Flats Extension	0	13	0	13	1a
Lincs	-	-	-	-	1a
London Array	-	-	-	-	1a
Lynn and Inner Dowsing	-	-	-	-	1a
Methil	23	0	0	23	1a
Race Bank	92	32	29	153	1a
Rampion	0	590	0	590	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	47	31	2	80	1a
Teesside	1	0	0	1	1a
Thanet	-	-	-	-	1a
Westermost Rough	-	-	-	-	1a
East Anglia One	161	3,638	76	3,875	1b
Hornsea Project One	671	694	250	1,615	1b
Hornsea Project Two	457	1,140	124	1,721	1b
Moray East	564	292	27	883	1b
Triton Knoll	211	15	24	250	1b
Kincardine	120	0	0	120	1b
Dogger Bank Creyke Beck A	518	916	176	1,610	1c
Dogger Bank Creyke Beck B	637	1,132	218	1,987	1c
Dogger Bank Teesside A	968	379	226	1,573	1c
East Anglia Three	412	1,269	524	2,205	1c
Inch Cape	2,398	703	212	3,313	1c
Moray West	2,827	439	144	3,410	1c
Neart na Gaoithe	1,987	552	281	2,820	1c
Seagreen Alpha	1,716	296	138	2,150	1c
Seagreen Bravo	1,240	368	194	1,802	1c

Project	Breeding	Autumn	Spring	Annual	Tier
Sofia	1,282	508	238	2,028	1c
Hornsea Three	1,333	984	524	2,841	1c
Norfolk Boreas	1,229	1,723	526	3,478	1c
Norfolk Vanguard	271	2,453	437	3,161	1c
East Anglia ONE North	149	468	44	661	1c
East Anglia TWO	192	891	192	1,275	1c
Hornsea Four (Applicant's/Natural England's Approach)	976	790	401	2,167	1d
Total (consented projects only)	21,343	21,334	5,412	48,089	
Dudgeon Extension Project	361	343	47	751	2
Sheringham Shoal Extension Project	40	295	0	335	2
Rampion 2	98	78	45	221	2
North Falls	-	-	-	-	2
Five Estuaries	-	-	-	-	2
Total (All Projects)	**21,842**	**22,050**	**5,504**	**49,396**	

Table 42: Gannet cumulative operation and maintenance phase bio-season displacement estimates all Tier 1 & 2 projects for the North Sea and English Channel (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of gannets subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
			Population (individuals)	*Baseline mortality (per annum)*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*
Return migration (Dec-Feb)	H4 plus all consented projects only	5,412	248,385	46,448	32.5-43.3	32.5-40.6	0.07-0.09%	0.07-0.09%
	All projects	5,504			33.0-44.0	33.0-41.3	0.07-0.09%	0.07-0.09%
Breeding (Mar-Sep)	H4 plus all consented projects only	21,343	400,326	74,861	128.1-170.7	85.4-128.1	0.17-0.23%	0.11-0.17%
	All projects	21,842			131.1-174.7	87.4-131.1	0.18-0.23%	0.12-0.18%
Post-breeding migration (Oct-Nov)	H4 plus all consented projects only	21,334	456,298	85,328	128.0-170.7	128.0-160.0	0.15-0.20%	0.15-0.19%
	All projects	22,050			132.3-176.4	132.3-165.4	0.16-0.21%	0.16-0.19%
Annual (BDMPS)	**H4 plus all consented projects only**	**48,089**	**456,298**	**85,328**	**288.5-384.7**	**245.8-328.7**	**0.34-0.45%**	**0.29-0.39%**
	All projects	**49,396**			**296.4-395.2**	**252.7-337.7**	**0.35-0.46%**	**0.30-0.40%**
Annual (biogeographic)	**H4 plus all consented projects only**	**48,089**	**1,180,000**	**220,660**	**288.5-384.7**	**245.8-328.7**	**0.13-0.17%**	**0.11-0.15%**
	All projects	**49,396**			**296.4-395.2**	**252.7-337.7**	**0.13-0.18%**	**0.11-0.15%**

Table 43: Gannet cumulative operation and maintenance phase bio-season displacement estimates all Tier 1 & 2 projects for the North Sea and English Channel (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of gannets subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
			Population (individuals)	*Baseline mortality (per annum)*	*60% Disp; 1-10% Mort*	*80% Disp; 1-10% Mort*	*60% Disp; 1-10% Mort*	*80% Disp; 1-10% Mort*
Return migration (Dec-Mar)	H4 plus all consented projects only	5,412	248,385	46,448	32.5-324.7	43.3-433.0	0.07-0.70%	0.09-0.93%
	All projects	5,504			33.0-330.2	44.0-440.3	0.07-0.71%	0.09-0.95%
Migration-free breeding (Apr-Aug)	H4 plus all consented projects only	21,343	400,326	74,861	128.1-1,280.6	170.7-1,707.4	0.17-1.71%	0.23-2.28%
	All projects	21,842			131.1-1,310.5	174.7-1,747.4	0.18-1.75%	0.23-2.33%
Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	21,334	456,298	85,328	128.0-1,280.0	170.7-1,706.7	0.15-1.50%	0.20-2.00%
	All projects	22,050			132.3-1,323.0	176.4-1,764.0	0.16-1.55%	0.21-2.07%
Annual (BDMPS)	**H4 plus all consented projects only**	**48,089**	**456,298**	**85,328**	**288.5-2,885.3**	**384.7-3,847.1**	**0.34-3.38%**	**0.45-4.51%**
	All projects	**49,396**			**296.4-2,963.8**	**395.2-3,951.7**	**0.35-3.47%**	**0.46-4.63%**
Annual (biogeographic)	**H4 plus all consented projects only**	**48,089**	**1,180,000**	**220,660**	**288.5-2,885.3**	**384.7-3,847.1**	**0.13-1.31%**	**0.17-1.74%**
	All projects	**49,396**			**296.4-2,963.8**	**395.2-3,951.7**	**0.13-1.34%**	**0.18-1.79%**

Table 44: Gannet cumulative operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects for the North Sea and English Channel.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	5	10	15	20	25	49	99	148	198	247	296	346	395	445	494
10	49	99	148	198	247	494	988	1,482	1,976	2,470	2,964	3,458	3,952	4,446	4,940
20	99	198	296	395	494	988	1,976	2,964	3,952	4,940	5,928	6,915	7,903	8,891	9,879
30	148	296	445	593	741	1,482	2,964	4,446	5,928	7,409	8,891	10,373	11,855	13,337	14,819
40	198	395	593	790	988	1,976	3,952	5,928	7,903	9,879	11,855	13,831	15,807	17,783	19,758
50	247	494	741	988	1,235	2,470	4,940	7,409	9,879	12,349	14,819	17,289	19,758	22,228	24,698
60	296	593	889	1,186	1,482	2,964	5,928	8,891	11,855	14,819	17,783	20,746	23,710	26,674	29,638
70	346	692	1,037	1,383	1,729	3,458	6,915	10,373	13,831	17,289	20,746	24,204	27,662	31,119	34,577
80	395	790	1,186	1,581	1,976	3,952	7,903	11,855	15,807	19,758	23,710	27,662	31,613	35,565	39,517
90	445	889	1,334	1,778	2,223	4,446	8,891	13,337	17,783	22,228	26,674	31,119	35,565	40,011	44,456
100	494	988	1,482	1,976	2,470	4,940	9,879	14,819	19,758	24,698	29,638	34,577	39,517	44,456	49,396

Table 45: Cumulative bio-season collision risk estimates for gannet from all Tier 1 & 2 projects for the North Sea and English Channel.

Project	Breeding	Autumn	Spring	Annual	Tier
Beatrice	37.4	48.8	9.5	95.7	1a
Blyth Demonstration Site	3.5	2.1	2.8	8.4	1a
Dudgeon	22.3	38.9	19.1	80.3	1a
East Anglia One	3.4	131.0	6.3	140.7	1a
EOWDC	4.2	5.1	0.1	9.3	1a
Galloper	18.1	30.9	12.6	61.6	1a
Greater Gabbard	14.0	8.8	4.8	27.5	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	11.5	32.0	22.5	66.0	1a
Humber Gateway	1.9	1.1	1.5	4.5	1a
Hywind 2 Demonstration	5.6	0.8	0.8	7.2	1a
Kentish Flats	1.4	0.8	1.1	3.3	1a
Kentish Flats Extension	-	-	-	0.0	1a
Kincardine	3.0	0.0	0.0	3.0	1a
Lincs, Lynn & Inner Dowsing	2.3	1.4	1.9	5.6	1a
London Array	2.3	1.4	1.8	5.5	1a
Methil	6.0	0.0	0.0	6.0	1a
Race Bank	33.7	11.7	4.1	49.5	1a
Rampion	36.2	63.5	2.1	101.8	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	14.1	3.5	0.0	17.6	1a
Teesside	4.9	1.7	0.0	6.7	1a
Thanet	1.1	0.0	0.0	1.1	1a
Westermost Rough	0.2	0.1	0.2	0.5	1a
Hornsea Project Two	7.0	14.0	6.0	27.0	1b
Moray East	80.6	35.4	8.9	124.9	1b
Neart na Gaoithe	143.0	47.0	23.0	213.0	1b
Seagreen Alpha & Bravo	800.8	49.3	65.8	915.9	1b
Triton Knoll	26.8	64.1	30.1	121.0	1b
Dogger Bank A & B	81.1	83.5	54.4	219.0	1c
Dogger Bank C & Sofia	14.8	10.1	10.8	35.7	1c
East Anglia Three	6.1	33.3	9.6	49.0	1c
Hornsea Three	10.1	4.5	4.3	18.9	1c
Hornsea Three (Applicant's value)	3.0	2.0	2.0	6.0	1c
Inch Cape	336.9	29.2	5.2	371.3	1c
Moray West	10.0	2.0	1.0	13.0	1c
Norfolk Boreas	14.1	12.7	3.9	30.7	1d
Norfolk Vanguard	8.2	18.6	5.3	32.1	1d

Project	Breeding	Autumn	Spring	Annual	Tier
East Anglia ONE North	12.4	11.0	1.1	24.5	1d
East Anglia TWO	12.5	23.1	4.0	39.6	1d
Hornsea Four (Applicant's Approach)	11.0	4.4	1.8	17.3	1d
Hornsea Four (Natural England's Approach)	15.8	5.2	1.3	22.3	1d
Total Applicant's Approach (consented projects only)	**1,805.5**	**827.8**	**328.5**	**2,960.7**	
Total Natural England's Approach (consented projects only)	**1,810.2**	**828.6**	**327.9**	**2,965.7**	
Dudgeon Extension Project	3.6	4.9	0.4	9.0	2
Sheringham Shoal Extension Project	0.3	1.4	0.0	1.8	2
Rampion 2	9.7	4.0	1.4	15.1	2
North Falls	-	-	-	-	2
Five Estuaries	-	-	-	-	2
Total Applicant's Approach (All Projects)	**1,819.2**	**838.2**	**330.2**	**2,986.6**	
Total Natural England's Approach (All Projects)	**1,823.9**	**839.0**	**329.7**	**2,991.6**	

Table 46: Gannet cumulative operation and maintenance phase bio-season collision estimates for all Tier 1 & 2 projects for the North Sea and English Channel (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	H4 plus all consented projects only	328.5	248,385	46,448	0.71%
	All projects	330.2			0.71%
Migration-free breeding (Apr-Aug)	H4 plus all consented projects only	1,805.5	400,326	74,861	2.41%
	All projects	1,819.2			2.43%
Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	827.8	456,298	85,328	0.97%
	All projects	838.2			0.98%
Annual (BDMPS)	**H4 plus all consented projects only**	**2,960.7**	**456,298**	**85,328**	**3.47%**
	All projects	**2,986.6**			**3.50%**
Annual (biogeographic)	**H4 plus all consented projects only**	**2,960.7**	**1,180,000**	**220,660**	**1.34%**
	All projects	**2,986.6**			**1.35%**

Table 47: Gannet cumulative operation and maintenance phase bio-season collision estimates for all Tier 1 & 2 projects for the North Sea and English Channel (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	H4 plus all consented projects only	327.9	248,385	46,448	0.71%
	All projects	329.7			0.71%
Migration-free breeding (Apr-Aug)	H4 plus all consented projects only	1,810.2	400,326	74,861	2.42%
	All projects	1,823.9			2.44%
Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	828.6	456,298	85,328	0.97%
	All projects	839.0			0.98%
Annual (BDMPS)	**H4 plus all consented projects only**	**2,965.7**	**456,298**	**85,328**	**3.48%**
	All projects	**2,991.6**			**3.51%**
Annual (biogeographic)	**H4 plus all consented projects only**	**2,965.7**	**1,180,000**	**220,660**	**1.34%**
	All projects	**2,991.6**			**1.36%**

4.2 Great black-backed gull

Table 48: Cumulative bio-season collision risk estimates for great black-backed gull from all Tier 1 & 2 projects for the North Sea.

Project	Breeding	Non-breeding	Annual	Tier
Beatrice	30.2	120.8	151.0	1a
Blyth Demonstration Site	1.3	5.1	6.3	1a
Dudgeon	0.0	0.0	0.0	1a
East Anglia One	0.0	46.0	46.0	1a
EOWDC	0.6	2.4	3.0	1a
Galloper	4.5	18.0	22.5	1a
Greater Gabbard	15.0	60.0	75.0	1a
Gunfleet Sands	-	-	-	1a
Hornsea Project One	17.2	68.6	85.8	1a
Humber Gateway	1.3	5.1	6.3	1a
Hywind 2 Demonstration	0.3	4.5	4.8	1a
Kentish Flats	-	-	-	1a
Kentish Flats Extension	0.10	0.2	0.3	1a
Kincardine	0.0	0.0	0.0	1a
Lincs, Lynn & Inner Dowsing	0.0	0.0	0.0	1a
London Array	-	-	-	1a
Methil	0.8	0.8	1.6	1a
Race Bank	0.0	0.0	0.0	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	0.00	0.0	0.0	1a
Teesside	8.7	34.8	43.6	1a
Thanet	0.1	0.4	0.5	1a
Westermost Rough	0.00	0.0	0.1	1a
Hornsea Project Two	3.0	20.0	23.0	1b
Moray East	9.5	25.5	35.0	1b
Neart na Gaoithe	0.9	3.6	4.5	1b
Seagreen Alpha & Bravo	13.4	53.4	66.8	1b
Triton Knoll	24.4	97.6	122.0	1b
Dogger Bank A & B	5.80	23.3	29.1	1c
Dogger Bank C & Sofia	6.4	25.5	31.9	1c
East Anglia Three	4.6	34.4	39.0	1c
Inch Cape	0.0	36.8	36.8	1c
Moray West	4.0	5.0	9.0	1c
Hornsea Three	8.5	27.1	35.6	1c
Hornsea Three (Applicant's values)	4.0	12.0	16.0	1c
Norfolk Boreas	6.9	28.7	35.6	1c
Norfolk Vanguard	4.5	21.5	26.0	1c

Project	Breeding	Non-breeding	Annual	Tier
East Anglia ONE North	3.7	1.2	5.0	1c
East Anglia TWO	3.5	3.4	6.9	1c
Hornsea Four (Applicant's Approach; BO3)	0.4	4.0	4.4	1d
Hornsea Four (Natural England's; BO3 Approach)	0.5	5.2	5.7	1d
Total Applicant's Approach (consented projects only)	**183.6**	**789.7**	**973.4**	
Total Natural England's Approach (consented projects only)	**183.7**	**790.9**	**974.7**	
Dudgeon Extension Project	0.3	1.6	1.9	2
Sheringham Shoal Extension Project	0.0	5.3	5.3	2
Rampion 2	0.9	3.1	4.0	2
North Falls	-	-	-	2
Five Estuaries	-	-	-	2
Total Applicant's Approach (All Projects)	**184.9**	**799.6**	**984.5**	
Total Natural England's Approach (All Projects)	**184.9**	**800.8**	**985.8**	

Table 49: Great-black backed gull cumulative operation and maintenance phase bio-season collision estimates all Tier 1 & 2 projects for the North Sea (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	
Breeding (Apr-Aug)	H4 plus all consented projects only	183.6	26,917	4,307	4.26%
	All projects	184.9			4.29%
Non-breeding (Sep-Mar)	H4 plus all consented projects only	789.7	91,399	14,624	5.40%
	All projects	799.6			5.47%
Annual (BDMPS)	**H4 plus all consented projects only**	**973.4**	**91,399**	**14,624**	**6.66%**
	All projects	**984.5**			**6.73%**
Annual (Biogeographic)	**H4 plus all consented projects only**	**973.4**	**235,000**	**37,600**	**2.59%**
	All projects	**984.5**			**2.62%**

Table 50: Great-black backed gull cumulative operation and maintenance phase bio-season collision estimates all Tier 1 & 2 projects for the North Sea (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	
Breeding (Apr-Aug)	H4 plus all consented projects only	183.7	26,917	4,307	4.27%
	All projects	184.9			4.29%
Non-breeding (Sep-Mar)	H4 plus all consented projects only	790.9	91,399	14,624	5.41%
	All projects	800.8			5.48%
Annual (BDMPS)	**H4 plus all consented projects only**	**974.7**	**91,399**	**14,624**	**6.67%**
	All projects	**985.8**			**6.74%**
Annual (Biogeographic)	**H4 plus all consented projects only**	**974.7**	**235,000**	**37,600**	**2.59%**
	All projects	**985.8**			**2.62%**

4.3 Kittiwake

Table 51: Cumulative bio-season collision risk estimates for kittiwake from all Tier 1 & 2 projects for the North Sea.

Project	Breeding	Autumn	Spring	Annual	Tier
Beatrice	94.7	10.7	39.8	145.2	1a
Blyth Demonstration Site	1.7	2.3	1.4	5.4	1a
Dudgeon	-	-	-	-	1a
East Anglia One	1.8	160.4	46.8	209.0	1a
EOWDC	11.8	5.8	1.1	18.7	1a
Galloper	6.3	27.8	31.8	65.9	1a
Greater Gabbard	1.1	15.0	11.4	27.5	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	44.0	55.9	20.9	120.8	1a
Humber Gateway	1.9	3.2	1.9	7.0	1a
Hywind 2 Demonstration	16.6	0.9	0.9	18.3	1a
Kentish Flats	0.0	0.9	0.7	1.6	1a
Kentish Flats Extension	0.0	0.0	2.7	2.7	1a
Kincardine	22.0	9.0	1.0	32.0	1a
Lincs, Lynn & Inner Dowsing	0.7	0.7	1.2	2.6	1a
London Array	1.4	2.3	1.8	5.5	1a
Methil	0.4	0.0	0.0	0.4	1a
Race Bank	1.9	23.9	5.6	31.4	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	-	-	-	-	1a
Teesside	38.4	24.0	2.5	64.9	1a
Thanet	0.2	0.5	0.4	1.1	1a
Westermost Rough	0.1	0.2	0.1	0.5	1a
Hornsea Project Two	16.0	9.0	3.0	28.0	1b
Moray East	43.6	2.0	19.3	64.9	1b
Neart na Gaoithe	32.9	56.1	4.4	93.4	1b
Seagreen Alpha & Bravo	153.1	313.1	247.6	713.8	1b
Triton Knoll	24.6	139.0	45.4	209.0	1b
Dogger Bank A & B	288.6	135.0	295.4	719.0	1c

Project	Breeding	Autumn	Spring	Annual	Tier
Dogger Bank C & Sofia	136.9	90.7	216.9	444.5	1c
East Anglia Three	6.1	69.0	37.6	112.7	1c
Hornsea Three	76.2	38.5	6.1	120.8	1c
Hornsea Three (Applicant's values)	9.0	6.0	3.0	18.0	1c
Inch Cape	13.1	224.8	63.5	301.4	1c
Moray West	79.0	24.0	7.0	109.0	1c
Norfolk Boreas	13.3	32.2	11.9	57.5	1d
Norfolk Vanguard	21.8	16.4	19.3	57.5	1c
East Anglia ONE North	40.4	8.1	3.5	52.0	1c
East Anglia TWO	29.5	5.4	7.4	42.3	1c
Hornsea Four (Applicant's Approach)	35.4	31.7	13.5	80.6	1d
Hornsea Four (Natural England's Approach)	74.5	13.9	4.6	93.0	1d
Total Applicant's Approach (consented projects only)	**1,264.5**	**1,544.5**	**1,176.8**	**3,984.9**	
Total Natural England's Approach (consented projects only)	**1,303.6**	**1,526.7**	**1,167.9**	**3,997.2**	
Dudgeon Extension Project	17.24	8.55	2.20	27.99	2
Sheringham Shoal Extension Project	0.89	1.91	0.00	2.80	2
North Falls	-	-	-	-	2
Five Estuaries	-	-	-	-	2
Total Applicant's Approach (All Projects)	**1,282.7**	**1,554.9**	**1,179.0**	**4,015.7**	
Total Natural England's Approach (All Projects)	**1,321.7**	**1,537.2**	**1,170.1**	**4,028.0**	

Table 52: Kittiwake cumulative operation and maintenance phase bio-season collision estimates all Tier 1 & 2 projects for the North Sea (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	H4 plus all consented projects only	1,176.8	627,816	97,939	1.20%
	All projects	1,179.0			1.20%
Migration-free breeding (Apr-Aug)	H4 plus all consented projects only	1,264.5	839,456	130,955	0.97%
	All projects	1,282.7			0.98%
Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	1,544.5	829,937	129,470	1.19%
	All projects	1,554.9			1.20%
Annual (BDMPS)	**H4 plus all consented projects only**	**3,984.9**	**1,237,264**	**193,013**	**2.06%**
	All projects	**4,015.7**			**2.08%**
Annual (biogeographic)	**H4 plus all consented projects only**	**3,984.9**	**5,100,000**	**795,600**	**0.50%**
	All projects	**4,015.7**			**0.50%**

Table 53: Kittiwake cumulative operation and maintenance phase bio-season collision estimates all Tier 1 & 2 projects for the North Sea (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	Regional baseline populations and baseline mortality rates		Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	
Return migration (Dec-Mar)	H4 plus all consented projects only	1,167.9	627,816	97,939	1.19%
	All projects	1,170.1			1.19%
Migration-free breeding (Apr-Aug)	H4 plus all consented projects only	1,303.6	839,456	130,955	1.00%
	All projects	1,321.7			1.01%
Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	1,526.7	829,937	129,470	1.18%
	All projects	1,537.2			1.19%
Annual (BDMPS)	**H4 plus all consented projects only**	**3,997.2**	**1,237,264**	**193,013**	**2.07%**
	All projects	**4,028.0**			**2.09%**
Annual (biogeographic)	**H4 plus all consented projects only**	**3,997.2**	**5,100,000**	**795,600**	**0.50%**
	All projects	**4,028.0**			**0.51%**

4.4 Guillemot

Table 54: Cumulative bio-season and total abundance estimates for guillemot form all Tier 1 & 2 projects for the North Sea and English Channel.

Project	Breeding Season	Non-breeding Season	Annual Total	Tier
Beatrice	13,610	2,755	16,365	1a
Blyth Demonstration Site	1,220	1,321	2,541	1a
Dudgeon	334	542	876	1a
EOWDC	547	225	772	1a
Galloper	305	593	898	1a
Greater Gabbard	345	548	893	1a
Gunfleet Sands	0	363	363	1a
Humber Gateway	99	138	237	1a
Hywind 2 Demonstration	249	2,136	2,385	1a
Kentish Flats Extension	0	4	4	1a
Kentish Flats	0	3	3	1a
Lincs, Lynn & Inner Dowsing	582	814	1,396	1a
London Array	192	377	569	1a
Methil	25	0	25	1a
Race Bank	361	708	1,069	1a
Rampion	10,887	15,536	26,423	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	390	715	1,105	1a
Teesside	267	901	1,168	1a
Thanet	18	124	142	1a
Westermost Rough	347	486	833	1a
East Anglia One	274	640	914	1b
Hornsea Project One	9,836	8,097	17,933	1b
Hornsea Project Two	7,735	13,164	20,899	1b
Moray East	9,820	547	10,367	1b
Triton Knoll	425	746	1,171	1b
Kincardine	632	0	632	1b
Dogger Bank Creyke Beck A	5,407	6,142	11,549	1c
Dogger Bank Creyke Beck B	9,479	10,621	20,100	1c
Dogger Bank Teesside A	3,283	2,268	5,551	1c
East Anglia Three	1,744	2,859	4,603	1c
Inch Cape	4,371	3,177	7,548	1c
Moray West	24,426	38,174	62,600	1c
Neart na Gaoithe	1,755	3,761	5,516	1c
Seagreen Alpha	13,606	4,688	18,294	1c
Seagreen Bravo	11,118	4,112	15,230	1c

Project	Breeding Season	Non-breeding Season	Annual Total	Tier
Sofia	5,211	3,701	8,912	1c
Hornsea Three	13,374	17,772	31,146	1c
Norfolk Boreas	7,767	13,777	21,544	1c
Norfolk Vanguard	4,320	4,776	9,096	1c
East Anglia ONE North	4,183	1,888	6,071	1c
East Anglia TWO	2,077	1,675	3,752	1c
Hornsea Four (weighted Mean)	9,382	20,326	29,708	1d
Hornsea Four (Mean Peak)	9,382	36,965	46,347	1d
Total Applicant's Approach (consented projects only)	**180,003**	**191,200**	**371,203**	
Total Natural England's Approach (consented projects only)	**180,003**	**207,839**	**387,842**	
Dudgeon Extension Project	8,061	2,977	11,038	2
Sheringham Shoal Extension Project	610	599	1,209	2
Rampion 2	185	13,020	13,205	2
North Falls	-	-	-	2
Five Estuaries	-	-	-	2
Total Applicant's Approach (All Projects)	**188,859**	**207,796**	**396,655**	
Total Natural England's Approach (All Projects)	**188,859**	**224,435**	**413,294**	

Table 55: Guillemot cumulative operation and maintenance phase bio-season displacement estimates all Tier 1 & 2 projects for the North Sea and English Channel (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of guillemots subject to mortality (individuals per annum)	Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Breeding (Mar-Jul)	H4 plus all consented projects only	180,003	2,045,078	282,221	900.0	0.32%
	All projects	188,859			944.3	0.33%
Non-breeding weighted mean approach (Aug-Feb)	H4 plus all consented projects only	191,200	1,617,306	223,188	956.0	0.43%
	All projects	207,796			1,039.0	0.47%
Annual (BDMPS)	**H4 plus all consented projects only**	**371,203**	**2,139,238**	**295,215 295,215**	**1,856.0**	**0.63%**
	All projects	**396,655**			**1,983.3**	**0.67%**
Annual (biogeographic)	**H4 plus all consented projects only**	**371,203**	**4,125,000**	**569,250**	**1,856.0**	**0.33%**
	All projects	**396,655**			**1,983.3**	**0.35%**

Table 56: Guillemot cumulative operation and maintenance phase bio-season displacement estimates all Tier 1 & 2 projects for the North Sea and English Channel (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of guillemots subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
			Population (individuals)	*Baseline mortality (per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Breeding (Mar-Jul)	H4 plus all consented projects only	180,003	2,045,078	282,221	540.0-5,400.1	1,260.0-12,600.2	0.2-1.9%	0.4-4.5%
	All projects	188,859			566.6-5,665.8	1,322.0-13,220.1	0.2-2.0%	0.5-4.7%
Non-breeding weighted mean approach (Aug-Feb)	H4 plus all consented projects only	207,839	1,617,306	223,188	623.5-6,235.2	1,454.9-14,548.7	0.3-2.8%	0.7-6.5%
	All projects	224,435			673.3-6,733.1	1,571.0-15,710.5	0.3-3.0%	0.7-7.0%
Annual (BDMPS)	**H4 plus all consented projects only**	**387,842**	**2,139,238**	**295,215**	**1,163.5-11,635.3**	**2,714.9-27,148.9**	**0.4-3.9%**	**0.9-9.2%**
	All projects	**413,294**			**1,239.9-12,398.8**	**2,893.1-28,930.6**	**0.4-4.2%**	**1.0-9.8%**
Annual (biogeographic)	**H4 plus all consented projects only**	**387,842**	**4,125,000**	**569,250**	**1,163.5-11,635.3**	**2,714.9-27,148.9**	**0.2-2.0%**	**0.5-4.8%**
	All projects	**413,294**			**1,239.9-12,398.8**	**2,893.1-28,930.6**	**0.2-2.2%**	**0.5-5.1%**

Table 57: Guillemot cumulative operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects for the North Sea and English Channel (Applicant's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	40	79	119	159	198	397	793	1,190	1,587	1,983	2,380	2,777	3,173	3,570	3,967
10	397	793	1,190	1,587	1,983	3,967	7,933	11,900	15,866	19,833	23,799	27,766	31,732	35,699	39,666
20	793	1,587	2,380	3,173	3,967	7,933	15,866	23,799	31,732	39,666	47,599	55,532	63,465	71,398	79,331
30	1,190	2,380	3,570	4,760	5,950	11,900	23,799	35,699	47,599	59,498	71,398	83,298	95,197	107,097	118,997
40	1,587	3,173	4,760	6,346	7,933	15,866	31,732	47,599	63,465	79,331	95,197	111,063	126,930	142,796	158,662
50	1,983	3,967	5,950	7,933	9,916	19,833	39,666	59,498	79,331	99,164	118,997	138,829	158,662	178,495	198,328
60	2,380	4,760	7,140	9,520	11,900	23,799	47,599	71,398	95,197	118,997	142,796	166,595	190,394	214,194	237,993
70	2,777	5,553	8,330	11,106	13,883	27,766	55,532	83,298	111,063	138,829	166,595	194,361	222,127	249,893	277,659
80	3,173	6,346	9,520	12,693	15,866	31,732	63,465	95,197	126,930	158,662	190,394	222,127	253,859	285,592	317,324
90	3,570	7,140	10,710	14,280	17,849	35,699	71,398	107,097	142,796	178,495	214,194	249,893	285,592	321,291	356,990
100	3,967	7,933	11,900	15,866	19,833	39,666	79,331	118,997	158,662	198,328	237,993	277,659	317,324	356,990	396,655

Table 58: Guillemot cumulative operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects for the North Sea and English Channel (Natural England's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	41	83	124	165	207	413	827	1,240	1,653	2,066	2,480	2,893	3,306	3,720	4,133
10	413	827	1,240	1,653	2,066	4,133	8,266	12,399	16,532	20,665	24,798	28,931	33,064	37,196	41,329
20	827	1,653	2,480	3,306	4,133	8,266	16,532	24,798	33,064	41,329	49,595	57,861	66,127	74,393	82,659
30	1,240	2,480	3,720	4,960	6,199	12,399	24,798	37,196	49,595	61,994	74,393	86,792	99,191	111,589	123,988
40	1,653	3,306	4,960	6,613	8,266	16,532	33,064	49,595	66,127	82,659	99,191	115,722	132,254	148,786	165,318
50	2,066	4,133	6,199	8,266	10,332	20,665	41,329	61,994	82,659	103,324	123,988	144,653	165,318	185,982	206,647
60	2,480	4,960	7,439	9,919	12,399	24,798	49,595	74,393	99,191	123,988	148,786	173,583	198,381	223,179	247,976
70	2,893	5,786	8,679	11,572	14,465	28,931	57,861	86,792	115,722	144,653	173,583	202,514	231,445	260,375	289,306
80	3,306	6,613	9,919	13,225	16,532	33,064	66,127	99,191	132,254	165,318	198,381	231,445	264,508	297,572	330,635
90	3,720	7,439	11,159	14,879	18,598	37,196	74,393	111,589	148,786	185,982	223,179	260,375	297,572	334,768	371,965
100	4,133	8,266	12,399	16,532	20,665	41,329	82,659	123,988	165,318	206,647	247,976	289,306	330,635	371,965	413,294

4.5 Razorbill

Table 59: Cumulative bio-season and total abundance estimates for razorbill form all Tier 1 & 2 projects for the North Sea and English Channel for displacement.

Project	Migration-free breeding	Post-breeding Migration	Non-migratory Wintering	Return Migration	Annual Total	Tier
Beatrice	873	833	555	833	3,094	1a
Blyth Demonstration Site	121	91	61	91	364	1a
Dudgeon	256	346	745	346	1,693	1a
EOWDC	161	64	7	26	258	1a
Galloper	44	43	106	394	587	1a
Greater Gabbard	0	0	387	84	471	1a
Gunfleet Sands	0	0	30	0	30	1a
Humber Gateway	27	20	13	20	80	1a
Hywind 2 Demonstration	30	719	10		759	1a
Kentish Flats Extension	-	-	-	-	-	1a
Kentish Flats I	-	-	-	-	-	1a
Lincs, Lynn & Inner Dowsing	45	34	22	34	134	1a
London Array	14	20	14	20	68	1a
Methil	4	0	0	0	4	1a
Race Bank	28	42	28	42	140	1a
Rampion	630	66	1,244	3,327	5,267	1a
Scroby Sands	-	-	-	-	-	1a
Sheringham Shoal	106	1,343	211	30	1,690	1a
Teesside	16	61	2	20	99	1a
Thanet	3	0	14	21	37	1a
Westermost Rough	91	121	152	91	455	1a
East Anglia One	16	26	155	336	533	1b
Hornsea Project One	1,109	4,812	1,518	1,803	9,242	1b
Hornsea Project Two	2,511	4,221	720	1,668	9,119	1b
Moray East	2,423	1,103	30	168	3,724	1b
Triton Knoll	40	254	855	117	1,266	1b
Kincardine	22	0	0	0	22	1b
Dogger Bank Creyke Beck A	1,250	1,576	1,728	4,149	8,703	1c

Project	Migration-free breeding	Post-breeding Migration	Non-migratory Wintering	Return Migration	Annual Total	Tier
Dogger Bank Creyke Beck B	1,538	2,097	2,143	5,119	10,897	1c
Dogger Bank Teesside A	834	310	959	1,919	4,022	1c
East Anglia Three	1,807	1,122	1,499	1,524	5,952	1c
Inch Cape	1,436	2,870	651		4,957	1c
Moray West	2,808	3,544	184	3,585	10,121	1c
Neart na Gaoithe	331	5,492	508		6,331	1c
Seagreen Alpha	5,876	0	1,103	0	6,979	1c
Seagreen Bravo	3,698	0	1,272	0	4,970	1c
Sofia	1,153	592	1,426	2,953	6,125	1c
Hornsea Three	630	2,020	3,649	2,105	8,404	1c
Norfolk Boreas	630	263	1,065	345	2,303	1c
Norfolk Vanguard	879	866	839	924	3,508	1c
East Anglia ONE North	403	85	54	207	749	1c
East Anglia TWO	281	44	136	230	692	1c
Hornsea Four (Applicant's/Natural England's Approach)	386	4,311	455	449	5,600	1d
Total (consented projects only)	**32,510**	**39,411**	**24,550**	**32,980**	**129,448**	
Dudgeon Extension Project	824	3,649	576	272	5,321	2
Sheringham Shoal Extension Project	240	646	590	148	1,624	2
Rampion 2	44	18	22	2,130	2,214	2
North Falls	-	-	-	-	-	2
Five Estuaries	-	-	-	-	-	2
Total (All Projects)	**33,618**	**43,724**	**25,738**	**35,530**	**138,607**	

Table 60: Razorbill cumulative operation and maintenance phase bio-season displacement estimates all Tier 1 & 2 projects for the North Sea and English Channel (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of razorbills subject to mortality (individuals per annum)	Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Return Migration (Jan-Mar)	H4 plus all consented projects only	32,980	591,874	114,232	164.9	0.14%
	All projects	35,530			177.6	0.16%
Migration-free breeding (Apr-Jul)	H4 plus all consented projects only	32,510	158,031	30,500	162.5	0.53%
	All projects	33,618			168.1	0.55%
Post-breeding migration (Aug-Oct)	H4 plus all consented projects only	39,411	591,874	114,232	197.1	0.17%
	All projects	43,724			218.6	0.19%
Migration-free winter (Nov-Dec)	H4 plus all consented projects only	24,550	218,622	42,194	122.8	0.29%
	All projects	25,738			128.7	0.30%
Annual (BDMPS)	**H4 plus all consented projects only**	**129,448**	**592,462**	**114,345**	**647.2**	**0.57%**
	All projects	**138,607**			**693.0**	**0.61%**
Annual (biogeographic)	**H4 plus all consented projects only**	**129,448**	**1,707,000**	**329,451**	**647.2**	**0.20%**
	All projects	**138,607**			**693.0**	**0.21%**

Table 61: Razorbill cumulative operation and maintenance phase bio-season displacement estimates all Tier 1 & 2 projects for the North Sea and English Channel (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of razorbills subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
			Population (individuals)	*Baseline mortality (per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Return Migration (Jan-Mar)	H4 plus all consented projects only	32,980	591,874	114,232	98.9-989.4	230.9-2,308.6	0.1-0.9%	0.2-2.0%
	All projects	35,530			106.6-1,065.9	248.7-2,487.1	0.1-0.9%	0.2-2.2%
Migration-free breeding (Apr-Jul)	H4 plus all consented projects only	32,510	158,031	30,500	97.5-975.3	227.6-2,275.7	0.3-3.2%	0.7-7.5%
	All projects	33,618			100.9-1,008.5	235.3-2,353.2	0.3-3.3%	0.8-7.7%
Post-breeding migration (Aug-Oct)	H4 plus all consented projects only	39,411	591,874	114,232	118.2-1,182.3	275.9-2,758.8	0.1-1.0%	0.2-2.4%
	All projects	43,724			131.2-1,311.7	306.1-3,060.7	0.1-1.1%	0.3-2.7%
Migration-free winter (Nov-Dec)	H4 plus all consented projects only	24,550	218,622	42,194	73.7-736.5	171.9-1,718.5	0.2-1.7%	0.4-4.1%
	All projects	25,738			77.2-772.1	180.2-1,801.7	0.2-1.8%	0.4-4.3%
Annual (BDMPS)	**H4 plus all consented projects only**	**129,448**	**592,462**	**114,345**	**388.3-3,883.5**	**906.1-9,061.4**	**0.34-3.40%**	**0.79-7.92%**
	All projects	**138,607**			**415.8-4,158.2**	**970.3-9,702.5**	**0.36-3.64%**	**0.85-8.49%**

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of razorbills subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
			Population (individuals)	*Baseline mortality (per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Annual (biogeographic)	**H4 plus all consented projects only**	**129,448**	**1,707,000**	**329,451**	**388.3-3,883.5**	**906.1-9,061.4**	**0.1-1.2%**	**0.3-2.8%**
	All projects	**138,607**			**415.8-4,158.2**	**970.3-9,702.5**	**0.1-1.3%**	**0.3-2.9%**

Table 62: Razorbill cumulative operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects for the North Sea and English Channel.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	14	28	42	55	69	139	277	416	554	693	832	970	1,109	1,247	1,386
10	139	277	416	554	693	1,386	2,772	4,158	5,544	6,930	8,316	9,702	11,089	12,475	13,861
20	277	554	832	1,109	1,386	2,772	5,544	8,316	11,089	13,861	16,633	19,405	22,177	24,949	27,721
30	416	832	1,247	1,663	2,079	4,158	8,316	12,475	16,633	20,791	24,949	29,107	33,266	37,424	41,582
40	554	1,109	1,663	2,218	2,772	5,544	11,089	16,633	22,177	27,721	33,266	38,810	44,354	49,899	55,443
50	693	1,386	2,079	2,772	3,465	6,930	13,861	20,791	27,721	34,652	41,582	48,512	55,443	62,373	69,304
60	832	1,663	2,495	3,327	4,158	8,316	16,633	24,949	33,266	41,582	49,899	58,215	66,531	74,848	83,164
70	970	1,940	2,911	3,881	4,851	9,702	19,405	29,107	38,810	48,512	58,215	67,917	77,620	87,322	97,025
80	1,109	2,218	3,327	4,435	5,544	11,089	22,177	33,266	44,354	55,443	66,531	77,620	88,708	99,797	110,886
90	1,247	2,495	3,742	4,990	6,237	12,475	24,949	37,424	49,899	62,373	74,848	87,322	99,797	112,272	124,746
100	1,386	2,772	4,158	5,544	6,930	13,861	27,721	41,582	55,443	69,304	83,164	97,025	110,886	124,746	138,607

4.6 Puffin

Table 63: Cumulative bio-season and total abundance estimates for puffin form all Tier 1 & 2 projects for the North Sea and English Channel.

Project	Breeding Season	Non-breeding Season	Annual Total	Tier
Beatrice	2,858	2,435	5,293	1a
Blyth Demonstration Site	235	123	358	1a
Dudgeon	1	3	4	1a
EOWDC	42	82	124	1a
Galloper	0	1	1	1a
Greater Gabbard	0	1	1	1a
Gunfleet Sands	-	-	-	1a
Humber Gateway	15	10	25	1a
Hywind 2 Demonstration	119	85	204	1a
Kentish Flats	-	-	-	1a
Kentish Flats Extension	3	6	9	1a
Lincs, Lynn and Inner Dowsing	3	6	9	1a
London Array	0	1	1	1a
Methil	8	0	8	1a
Race Bank	1	10	11	1a
Rampion	7	0	7	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	4	26	30	1a
Teesside	35	18	53	1a
Thanet	0	0	0	1a
Westermost Rough	61	35	96	1a
East Anglia One	16	32	48	1b
Hornsea Project One	1,070	1,257	2,327	1b
Hornsea Project Two	468	2,039	2,507	1b
Moray East	2,795	656	3,451	1b
Triton Knoll	23	71	94	1b
Kincardine	19	0	19	1b
Dogger Bank Creyke Beck A	37	295	332	1c
Dogger Bank Creyke Beck B	102	743	845	1c
Dogger Bank Teesside A	34	273	307	1c
East Anglia Three	181	307	488	1c
Inch Cape	2,956	2,688	5,644	1c
Moray West	1,115	3,966	5,081	1c
Neart na Gaoithe	2,562	2,103	4,665	1c

Project	Breeding Season	Non-breeding Season	Annual Total	Tier
Seagreen Alpha	2,572	1,526	4,098	1c
Seagreen Bravo	3,582	3,863	7,445	1c
Sofia	35	329	364	1c
Hornsea Three	253	67	320	1c
Norfolk Boreas	0	23	23	1c
Norfolk Vanguard	67	112	179	1c
East Anglia One North	-	-	-	1c
East Anglia Two	15	0	15	1c
Hornsea Four (Applicant's/Natural England's Approach)	203	442	644	1d
Total (consented projects only)	**21,496**	**23,632**	**45,128**	
Dudgeon Extension Project	0	17	17	2
Sheringham Shoal Extension Project	0	11	11	2
Rampion 2	6	0	6	2
North Falls	-	-	-	2
Five Estuaries	-	-	-	2
Total (All Projects)	**21,502**	**23,659**	**45,161**	

Table 64: Puffin cumulative operation and maintenance phase bio-season displacement estimates all Tier 1 & 2 projects for the North Sea and English Channel (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of puffins subject to mortality (individuals per annum)	Increase in baseline mortality (%)
			Population (individuals)	*Baseline mortality (per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Breeding (Mar-Jul)	H4 plus all consented projects only	21,496	868,689	152,021	107.5	0.07%
	All projects	21,502			107.5	0.07%
Non-breeding (Aug-Feb)	H4 plus all consented projects only	23,632	231,957	40,592	118.2	0.29%
	All projects	23,659			118.3	0.29%
Annual (BDMPS)	H4 plus all consented projects only	45,128	938,585	164,252	225.6	0.14%
	All projects	45,161			225.8	0.14%
Annual (biogeographic)	H4 plus all consented projects only	45,128	11,840,000	2,072,000	225.6	0.01%
	All projects	45,161			225.8	0.01%

Table 65: Puffin cumulative operation and maintenance phase bio-season displacement estimates all Tier 1 & 2 projects for the North Sea and English Channel (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	Regional baseline populations and baseline mortality rates		Estimated number of puffins subject to mortality (individuals per annum)		Increase in baseline mortality (%)	
			Population (individuals)	*Baseline mortality (per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Breeding (Mar-Jul)	H4 plus all consented projects only	21,496	868,689	152,021	64.5-644.9	150.5-1,504.7	0.04-0.42%	0.10-0.99%
	All projects	21,502			64.5-645.1	150.5-1,505.2	0.04-0.42%	0.10-0.99%
Non-breeding (Aug-Feb)	H4 plus all consented projects only	23,632	231,957	40,592	70.9-709.0	165.4-1,654.2	0.17-1.75%	0.41-4.08%
	All projects	23,659			71.0-709.8	165.6-1,656.1	0.17-0.175%	0.41-4.08%
Annual (BDMPS)	H4 plus all consented projects only	45,128	938,585	164,252	135.4-1,353.8	315.9-3,159.0	0.08-0.82%	0.19-1.92%
	All projects	45,161			135.5-1,354.8	316.1-3,161.3	0.08-0.82%	0.19-1.92%
Annual (biogeographic)	H4 plus all consented projects only	129,448	11,840,000	2,072,000	135.4-1,353.8	315.9-3,159.0	0.01-0.07%	0.02-0.15%
	All projects	138,607			135.5-1,354.8	316.1-3,161.3	0.01-0.07%	0.02-0.15%

Table 66: Puffin cumulative operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects for the North Sea and English Channel.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	5	9	14	18	23	45	90	135	181	226	271	316	361	406	452
10	45	90	135	181	226	452	903	1,355	1,806	2,258	2,710	3,161	3,613	4,064	4,516
20	90	181	271	361	452	903	1,806	2,710	3,613	4,516	5,419	6,323	7,226	8,129	9,032
30	135	271	406	542	677	1,355	2,710	4,064	5,419	6,774	8,129	9,484	10,839	12,193	13,548
40	181	361	542	723	903	1,806	3,613	5,419	7,226	9,032	10,839	12,645	14,452	16,258	18,064
50	226	452	677	903	1,129	2,258	4,516	6,774	9,032	11,290	13,548	15,806	18,064	20,322	22,581
60	271	542	813	1,084	1,355	2,710	5,419	8,129	10,839	13,548	16,258	18,968	21,677	24,387	27,097
70	316	632	948	1,265	1,581	3,161	6,323	9,484	12,645	15,806	18,968	22,129	25,290	28,451	31,613
80	361	723	1,084	1,445	1,806	3,613	7,226	10,839	14,452	18,064	21,677	25,290	28,903	32,516	36,129
90	406	813	1,219	1,626	2,032	4,064	8,129	12,193	16,258	20,322	24,387	28,451	32,516	36,580	40,645
100	452	903	1,355	1,806	2,258	4,516	9,032	13,548	18,064	22,581	27,097	31,613	36,129	40,645	45,161

5 FFC SPA Alone Impacts

5.1 Gannet

5.1.1 Construction Phase Impacts (Applicant's Approach)

Table 67: FFC SPA gannet construction phase bio-season displacement estimates for Hornsea Four (Applicant's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of gannets subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30-40% Disp; 1% Mort*	*Breeding 20-30% Disp, Non-breeding 30-32.5% Disp; 1% Mort*	*30-40% Disp; 1% Mort*	*Breeding 20-30% Disp, Non-breeding 30-32.5% Disp; 1% Mort*
Return migration (Dec-Mar)	25.0	16,938	1,372	0.1-0.1	0.1-0.1	0.01-0.01%	0.01-0.01%
		26,784	2,170			0.00-0.00%	0.00-0.00%
Migration-free breeding (Apr-Aug)	597.3	16,938	1,372	1.8-2.4	1.2-1.8	0.13-0.17%	0.09-0.13%
		26,784	2,170			0.08-0.11%	0.06-0.08%
Post-breeding migration (Sep-Nov)	38.3	16,938	1,372	0.1-0.2	0.1-0.1	0.01-0.01%	0.01-0.01%
		26,784	2,170			0.01-0.01%	0.01-0.01%
Annual	**660.6**	**16,938**	**1,372**	**2.0-2.6**	**1.4-2.0**	**0.14-0.19%**	**0.10-0.15%**
		26,784	**2,170**			**0.09-0.12%**	**0.06-0.09%**

5.1.2 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 68: FFC SPA gannet operation and maintenance phase bio-season displacement estimates for Hornsea Four (Applicant's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of gannets subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*
Return migration (Dec-Mar)	25.0	16,938	1,372	0.2-0.2	0.2-0.2	0.01-0.01%	0.01-0.01%
		26,784	2,170			0.01-0.01%	0.01-0.01%
Migration-free breeding (Apr-Aug)	597.3	16,938	1,372	3.6-4.8	2.4-3.6	0.26-0.35%	0.17-0.26%
		26,784	2,170			0.17-0.22%	0.11-0.17%
Post-breeding migration (Sep-Nov)	38.3	16,938	1,372	0.2-0.3	0.2-0.3	0.02-0.02%	0.02-0.02%
		26,784	2,170			0.01-0.01%	0.01-0.01%
Annual	**660.6**	**16,938**	**1,372**	**4.0-5.3**	**2.8-4.1**	**0.29-0.39%**	**0.20-0.30%**
		26,784	**2,170**			**0.18-0.24%**	**0.13-0.19%**

Table 69: FFC SPA gannet operation and maintenance phase annual displacement matrix for Hornsea Four (Applicant's approach to apportionment).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	1	1	2	3	3	4	5	5	6	7
10	1	1	2	3	3	7	13	20	26	33	40	46	53	59	66
20	1	3	4	5	7	13	26	40	53	66	79	92	106	119	132
30	2	4	6	8	10	20	40	59	79	99	119	139	159	178	198
40	3	5	8	11	13	26	53	79	106	132	159	185	211	238	264
50	3	7	10	13	17	33	66	99	132	165	198	231	264	297	330
60	4	8	12	16	20	40	79	119	159	198	238	277	317	357	396
70	5	9	14	18	23	46	92	139	185	231	277	324	370	416	462
80	5	11	16	21	26	53	106	159	211	264	317	370	423	476	528
90	6	12	18	24	30	59	119	178	238	297	357	416	476	535	595
100	7	13	20	26	33	66	132	198	264	330	396	462	528	595	661

Table 70: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four (Applicant's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Mar)	0.1 (*0.1-1.1*)	16,938	1,372	0.01% (*0.00-0.08%*)
		26,784	2,170	0.01% (*0.00-0.05%*)
Migration-free breeding (Apr-Aug)	6.7 (*4.0-11.9*)	16,938	1,372	0.49% (*0.29-0.87%*)
		26,784	2,170	0.31% (*0.18-0.55%*)
Post-breeding migration (Sep-Nov)	0.2 (*0.1-0.4*)	16,938	1,372	0.02% (*0.01-0.03%*)
		26,784	2,170	0.01% (*0.01-0.02%*)
Annual	**7.1 (*4.2-13.4*)**	**16,938**	**1,372**	**0.51% (*0.31-0.97%*)**
		26,784	**2,170**	**0.33% (*0.19-0.62%*)**

Table 71: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 70% (Applicant's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Mar)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Migration-free breeding (Apr-Aug)	2.0	16,938	1,372	0.15%
		26,784	2,170	0.09%
Post-breeding migration (Sep-Nov)	0.1	16,938	1,372	0.01%
		26,784	2,170	0.00%
Annual	**2.1**	**16,938**	**1,372**	**0.15%**
		26,784	**2,170**	**0.10%**

Table 72: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 60% (Applicant's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Mar)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Migration-free breeding (Apr-Aug)	2.7	16,938	1,372	0.20%
		26,784	2,170	0.12%
Post-breeding migration (Sep-Nov)	0.1	16,938	1,372	0.01%
		26,784	2,170	0.00%
Annual	**2.8**	**16,938**	**1,372**	**0.21%**
		26,784	**2,170**	**0.13%**

Table 73: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 65% (Applicant's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Mar)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Migration-free breeding (Apr-Aug)	2.4	16,938	1,372	0.17%
		26,784	2,170	0.11%
Post-breeding migration (Sep-Nov)	0.1	16,938	1,372	0.01%
		26,784	2,170	0.00%
Annual	**2.5**	**16,938**	**1,372**	**0.18%**
		26,784	**2,170**	**0.11%**

Table 74: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 75% (Applicant's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Mar)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Migration-free breeding (Apr-Aug)	1.7	16,938	1,372	0.12%
		26,784	2,170	0.08%
Post-breeding migration (Sep-Nov)	0.1	16,938	1,372	0.00%
		26,784	2,170	0.00%
Annual	**1.8**	**16,938**	**1,372**	**0.13%**
		26,784	**2,170**	**0.08%**

Table 75: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 80% (Applicant's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Mar)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Migration-free breeding (Apr-Aug)	1.3	16,938	1,372	0.10%
		26,784	2,170	0.06%
Post-breeding migration (Sep-Nov)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Annual	**1.4**	**16,938**	**1,372**	**0.10%**
		26,784	**2,170**	**0.07%**

5.1.3 Construction Phase Impacts (Natural England's Approach)

Table 76: FFC SPA gannet construction phase bio-season displacement estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of gannets subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30% Disp; 1-10% Mort*	*40% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*40% Disp; 1-10% Mort*
Return migration (Dec-Feb)	25.0	16,938	1,372	0.1-0.8	0.1-1.0	0.01-0.05%	0.01-0.07%
		26,784	2,170			0.00-0.03%	0.00-0.05%
Breeding (Mar-Sep)	883.1	16,938	1,372	2.6-26.5	3.5-35.3	0.19-1.93%	0.26-2.57%
		26,784	2,170			0.12-1.22%	0.16-1.63%
Post-breeding migration (Oct-Nov)	38.3	16,938	1,372	0.1-1.1	0.2-1.5	0.01-0.08%	0.01-0.11%
		26,784	2,170			0.01-0.05%	0.01-0.07%
Annual	**946.4**	**16,938**	**1,372**	**2.8-28.4**	**3.8-37.9**	**0.21-0.28%**	**0.28-2.76%**
		26,784	**2,170**			**0.13-1.31%**	**0.17-1.74%**

5.1.4 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 77: FFC SPA gannet operation and maintenance phase bio-season displacement estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of gannets subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*60% Disp; 1-10% Mort*	*80% Disp; 1-10% Mort*	*60% Disp; 1-10% Mort*	*80% Disp; 1-10% Mort*
Return migration (Dec-Feb)	25.0	16,938	1,372	0.2-1.5	0.2-2.0	0.01-0.11%	0.01-0.15%
		26,784	2,170	0.2-1.5	0.2-2.0	0.01-0.07%	0.01-0.09%
Breeding (Mar-Sep)	883.1	16,938	1,372	5.3-53.0	7.1-70.6	0.39-3.86%	0.51-5.15%
		26,784	2,170	5.3-53.0	7.1-70.6	0.24-2.44%	0.33-3.26%
Post-breeding migration (Oct-Nov)	38.3	16,938	1,372	0.2-2.3	0.3-3.1	0.02-0.17%	0.02-0.22%
		26,784	2,170	0.2-2.3	0.3-3.1	0.01-0.11%	0.01-0.14%
Annual	**946.4**	**16,938**	**1,372**	**5.7-56.8**	**7.6-75.7**	**0.41-4.14%**	**0.55-5.52%**
		26,784	**2,170**	**5.7-56.8**	**7.6-75.7**	**0.26-2.62%**	**0.35-3.49%**

Table 78: FFC SPA gannet operation and maintenance phase annual displacement matrix for Hornsea Four (Natural England's approach to apportionment).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	1	2	3	4	5	6	7	8	9	9
10	1	2	3	4	5	9	19	28	38	47	57	66	76	85	95
20	2	4	6	8	9	19	38	57	76	95	114	132	151	170	189
30	3	6	9	11	14	28	57	85	114	142	170	199	227	256	284
40	4	8	11	15	19	38	76	114	151	189	227	265	303	341	379
50	5	9	14	19	24	47	95	142	189	237	284	331	379	426	473
60	6	11	17	23	28	57	114	170	227	284	341	397	454	511	568
70	7	13	20	26	33	66	132	199	265	331	397	464	530	596	662
80	8	15	23	30	38	76	151	227	303	379	454	530	606	681	757
90	9	17	26	34	43	85	170	256	341	426	511	596	681	767	852
100	9	19	28	38	47	95	189	284	379	473	568	662	757	852	946

Table 79: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Feb)	0.1 (*0.0-2.6*)	16,938	1,372	0.01% (*0.00-0.19%*)
		26,784	2,170	0.00% (*0.00-0.12%*)
Breeding (Mar-Sep)	14.3 (*2.1-57.5*)	16,938	1,372	1.04% (*0.15-4.19%*)
		26,784	2,170	0.66% (*0.10-2.65%*)
Post-breeding migration (Oct-Nov)	0.3 (*0.0-0.9*)	16,938	1,372	0.02% (*0.00-0.07%*)
		26,784	2,170	0.01% (*0.00-0.04%*)
Annual	**14.6 (*2.1-61.0*)**	**16,938**	**1,372**	**1.06% (*0.15-4.45%*)**
		26,784	**2,170**	**0.67% (*0.10-2.81%*)**

Table 80: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 70% (Natural England's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Feb)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Breeding (Mar-Sep)	4.3	16,938	1,372	0.31%
		26,784	2,170	0.20%
Post-breeding migration (Oct-Nov)	0.1	16,938	1,372	0.01%
		26,784	2,170	0.00%
Annual	**4.4**	**16,938**	**1,372**	**0.32%**
		26,784	**2,170**	**0.20%**

Table 81: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 60% (Natural England's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Feb)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Breeding (Mar-Sep)	5.7	16,938	1,372	0.42%
		26,784	2,170	0.26%
Post-breeding migration (Oct-Nov)	0.1	16,938	1,372	0.01%
		26,784	2,170	0.00%
Annual	**5.8**	**16,938**	**1,372**	**0.43%**
		26,784	**2,170**	**0.27%**

Table 82: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 65% (Natural England's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Feb)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Breeding (Mar-Sep)	5.0	16,938	1,372	0.36%
		26,784	2,170	0.23%
Post-breeding migration (Oct-Nov)	0.1	16,938	1,372	0.01%
		26,784	2,170	0.00%
Annual	**5.1**	**16,938**	**1,372**	**0.37%**
		26,784	**2,170**	**0.24%**

Table 83: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 75% (Natural England's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Feb)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Breeding (Mar-Sep)	3.6	16,938	1,372	0.26%
		26,784	2,170	0.16%
Post-breeding migration (Oct-Nov)	0.1	16,938	1,372	0.00%
		26,784	2,170	0.00%
Annual	**3.6**	**16,938**	**1,372**	**0.27%**
		26,784	**2,170**	**0.17%**

Table 84: FFC SPA gannet operation and maintenance phase bio-season collision estimates for Hornsea Four including macro avoidance reduction of 80% (Natural England's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Feb)	0.0	16,938	1,372	0.00%
		26,784	2,170	0.00%
Breeding (Mar-Sep)	2.9	16,938	1,372	0.21%
		26,784	2,170	0.13%
Post-breeding migration (Oct-Nov)	0.1	16,938	1,372	0.00%
		26,784	2,170	0.00%
Annual	**2.9**	**16,938**	**1,372**	**0.21%**
		26,784	**2,170**	**0.13%**

5.2 Kittiwake

5.2.1 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 85: FFC SPA kittiwake operation and maintenance phase bio-season collision estimates for Hornsea Four (Applicant's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Jan-Apr)	1.0 (*0.5-2.0*)	167,400	24,440	0.00% (*0.00-0.01%*)
		103,070	15,048	0.01% (*0.00-0.01%*)
Migration-free breeding (May-Jul)	20.6 (*12.434.1*)	167,400	24,440	0.08% (*0.05-0.14%*)
		103,070	15,048	0.14% (*0.08-0.23%*)
Post-breeding migration (Aug-Dec)	1.7 (*0.8-3.4*)	167,400	24,440	0.01% (*0.00-0.01%*)
		103,070	15,048	0.01% (*0.01-0.02%*)
Annual	**23.3 (13.7-39.4)**	**167,400**	**24,440**	**0.10% (0.06-0.16%)**
		103,070	**15,048**	**0.15% (0.09-0.26%)**

5.2.2 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 86: FFC SPA kittiwake operation and maintenance phase bio-season collision estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal sCRM totals BO2 (per annum)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Jan-Feb)	0.3 (*0.1-0.7*)	167,400	24,440	0.00% (*0.00-0.00%*)
		103,070	15,048	0.00% (*0.00-0.00%*)
Migration-free breeding (Mar-Aug)	70.3 (*21.4-150.8*)	167,400	24,440	0.29% (*0.09-0.62%*)
		103,070	15,048	0.47% (*0.14-1.00%*)
Post-breeding migration (Sep-Dec)	0.8 (0.1-2.0)	167,400	24,440	0.00% (*0.00-0.01%*)
		103,070	15,048	0.01% (*0.00-0.01%*)
Annual	**71.4 (*21.6-153.4*)**	**167,400**	**24,440**	**0.29% (*0.09-0.62%*)**
		103,070	**15,048**	**0.47% (*0.14-1.02%*)**

5.3 Guillemot

5.3.1 Construction Phase Impacts (Applicant's Approach)

Table 87: FFC SPA guillemot construction phase bio-season displacement estimates for Hornsea Four (Applicant's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*25% Disp; 1% Mort*	*25% Disp; 1% Mort*
Breeding (Mar-Jul)	5,235.0	83,214	5,076	13.1	0.26%
		121,754	7,427		0.18%
Non-breeding weighted mean approach (Aug-Feb)	2,665.9	83,214	5,076	6.7	0.13%
		121,754	7,427		0.09%
Annual	**7,900.9**	**83,214**	**5,076**	**19.8**	**0.39%**
		121,754	**7,427**		**0.27%**

5.3.2 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 88: FFC SPA guillemot operation and maintenance phase bio-season displacement estimates for Hornsea Four (Applicant's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Breeding (Mar-Jul)	5,235.0	83,214	5,076	26.2	0.52%
		121,754	7,427		0.35%
Non-breeding weighted mean approach (Aug-Feb)	2,665.9	83,214	5,076	13.3	0.26%
		121,754	7,427		0.18%
Annual	**7,900.9**	**83,214**	**5,076**	**39.5**	**0.78%**
		121,754	**7,427**		**0.53%**

Table 89: FFC SPA guillemot operation and maintenance phase annual displacement matrix for Hornsea Four (Applicant's approach to apportionment).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	2	2	3	4	8	16	24	32	40	47	55	63	71	79
10	8	16	24	32	40	79	158	237	316	395	474	553	632	711	790
20	16	32	47	63	79	158	316	474	632	790	948	1,106	1,264	1,422	1,580
30	24	47	71	95	119	237	474	711	948	1,185	1,422	1,659	1,896	2,133	2,370
40	32	63	95	126	158	316	632	948	1,264	1,580	1,896	2,212	2,528	2,844	3,160
50	40	79	119	158	198	395	790	1,185	1,580	1,975	2,370	2,765	3,160	3,555	3,950
60	47	95	142	190	237	474	948	1,422	1,896	2,370	2,844	3,318	3,792	4,266	4,741
70	55	111	166	221	277	553	1,106	1,659	2,212	2,765	3,318	3,871	4,425	4,978	5,531
80	63	126	190	253	316	632	1,264	1,896	2,528	3,160	3,792	4,425	5,057	5,689	6,321
90	71	142	213	284	356	711	1,422	2,133	2,844	3,555	4,266	4,978	5,689	6,400	7,111
100	79	158	237	316	395	790	1,580	2,370	3,160	3,950	4,741	5,531	6,321	7,111	7,901

5.3.3 Construction Phase Impacts (Standard Approach to Apportionment)

Table 90: FFC SPA guillemot construction phase bio-season displacement estimates for Hornsea Four (Standard approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)			Increase in baseline mortality (%)		
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*25% Disp; 1% Mort*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*	*25% Disp; 1% Mort*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*
Breeding (Mar-Jul)	5,235.0	83,214	5,076	13.1	7.9-18.3	78.5-183.2	0.26%	0.15-0.36%	1.55-3.61%
		121,754	7,427				0.18%	0.11-0.25%	1.06-2.47%
Non-breeding mean peak (Aug-Feb)	1,630.9	83,214	5,076	4.1	2.4-5.7	24.5-57.1	0.08%	0.05-0.11%	0.48-1.12%
		121,754	7,427				0.05%	0.03-0.08%	0.33-0.77%
Annual	**6,865.9**	**83,214**	**5,076**	**17.2**	**10.3-24.0**	**103.0-240.3**	**0.34%**	**0.20-0.47%**	**2.03-4.73%**
		121,754	**7,427**				**0.23%**	**0.14-0.32%**	**1.39-3.24%**

5.3.4 Operation and Maintenance Phase Impacts (Standard Approach to Apportionment)

Table 91: FFC SPA guillemot operation and maintenance phase bio-season displacement estimates for Hornsea Four (Standard approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)			Increase in baseline mortality (%)		
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50% Disp; 1% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*50% Disp; 1% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Breeding (Mar-Jul)	5,235.0	83,214	5,076	26.2	15.7-157.1	36.6-366.5	0.52%	0.31-3.09%	0.72-7.22%
		121,754	7,427				0.35%	0.21-2.11%	0.49-4.93%
Non-breeding mean peak (Aug-Feb)	1,630.9	83,214	5,076	8.2	4.9-48.9	1.4-114.2	0.16%	0.10-0.96%	0.22-2.25%
		121,754	7,427				0.11%	0.07-0.66%	0.15-1.54%
Annual	**6,865.9**	**83,214**	**5,076**	**34.3**	**20.6-206.0**	**48.1-480.6**	**0.68%**	**0.41-4.06%**	**0.95-9.47%**
		121,754	**7,427**				**0.46%**	**0.28-2.77%**	**0.65-6.47%**

Table 92: FFC SPA guillemot operation and maintenance phase annual displacement matrix for Hornsea Four (Standard Approach to Apportionment).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	1	2	3	3	7	14	21	27	34	41	48	55	62	69
10	7	14	21	27	34	69	137	206	275	343	412	481	549	618	687
20	14	27	41	55	69	137	275	412	549	687	824	961	1,099	1,236	1,373
30	21	41	62	82	103	206	412	618	824	1,030	1,236	1,442	1,648	1,854	2,060
40	27	55	82	110	137	275	549	824	1,099	1,373	1,648	1,922	2,197	2,472	2,746
50	34	69	103	137	172	343	687	1,030	1,373	1,716	2,060	2,403	2,746	3,090	3,433
60	41	82	124	165	206	412	824	1,236	1,648	2,060	2,472	2,884	3,296	3,708	4,120
70	48	96	144	192	240	481	961	1,442	1,922	2,403	2,884	3,364	3,845	4,326	4,806
80	55	110	165	220	275	549	1,099	1,648	2,197	2,746	3,296	3,845	4,394	4,943	5,493
90	62	124	185	247	309	618	1,236	1,854	2,472	3,090	3,708	4,326	4,943	5,561	6,179
100	69	137	206	275	343	687	1,373	2,060	2,746	3,433	4,120	4,806	5,493	6,179	6,866

5.3.5 Construction Phase Impacts (Natural England's Approach)

Table 93: FFC SPA guillemot construction phase bio-season displacement estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*15-35% Disp; 0.5% Mort*	*15-35% Disp; 10% Mort*	*15-35% Disp; 0.5% Mort*	*15-35% Disp; 10% Mort*
Breeding (Mar-Jul)	9,381.8	83,214	5,076	14.1-32.8	140.7-328.4	0.28-0.65%	2.77-6.47%
		121,754	7,427			0.19-0.44%	1.89-4.42%
Chick Rearing/ moult (Aug-Sep)	22,179.1	83,214	5,076	33.3-77.6	332.7-776.3	0.66-1.53%	6.55-15.29%
		121,754	7,427			0.45-1.05%	4.48-10.45%
Remaining non-breeding (Oct-Feb)	748.0	83,214	5,076	1.1-2.6	11.2-26.2	0.02-0.05%	0.22-0.52%
		121,754	7,427			0.02-0.04%	0.15-0.35%
Annual	**32,308.9**	**83,214**	**5,076**	**48.5-113.1**	**484.6-1,130.8**	**0.95-2.23%**	**9.55-22.28%**
		121,754	**7,427**			**0.65-1.52%**	**6.53-15.23%**

5.3.6 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 94: FFC SPA Guillemot operation and maintenance phase bio-season displacement estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Breeding (Mar-Jul)	9,381.8	83,214	5,076	28.1-281.5	65.7-656.7	0.55-5.54%	1.29-12.94%
		121,754	7,427			0.38-3.79%	0.88-8.84%
Chick Rearing/ moult (Aug-Sep)	22,179.1	83,214	5,076	66.5-665.4	155.3-1,552.5	1.31-13.11%	3.06-30.59%
		121,754	7,427			0.90-8.96%	2.09-20.90%
Remaining non-breeding (Oct-Feb)	748.0	83,214	5,076	2.2-22.4	5.2-52.4	0.04-0.44%	0.10-1.03%
		121,754	7,427			0.03-0.30%	0.07-0.71%
Annual	**32,308.9**	**83,214**	**5,076**	**96.9-969.3**	**226.2-2,261.6**	**1.91-19.09%**	**4.46-44.55%**
		121,754	**7,427**			**1.31-13.05%**	**3.05-30.45%**

Table 95: FFC SPA guillemot operation and maintenance phase annual displacement matrix for Hornsea Four (Natural England's approach to apportionment).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	3	6	10	13	16	32	65	97	129	162	194	226	258	291	323
10	32	65	97	129	162	323	646	969	1,292	1,615	1,939	2,262	2,585	2,908	3,231
20	65	129	194	258	323	646	1,292	1,939	2,585	3,231	3,877	4,523	5,169	5,816	6,462
30	97	194	291	388	485	969	1,939	2,908	3,877	4,846	5,816	6,785	7,754	8,723	9,693
40	129	258	388	517	646	1,292	2,585	3,877	5,169	6,462	7,754	9,046	10,339	11,631	12,924
50	162	323	485	646	808	1,615	3,231	4,846	6,462	8,077	9,693	11,308	12,924	14,539	16,154
60	194	388	582	775	969	1,939	3,877	5,816	7,754	9,693	11,631	13,570	15,508	17,447	19,385
70	226	452	678	905	1,131	2,262	4,523	6,785	9,046	11,308	13,570	15,831	18,093	20,355	22,616
80	258	517	775	1,034	1,292	2,585	5,169	7,754	10,339	12,924	15,508	18,093	20,678	23,262	25,847
90	291	582	872	1,163	1,454	2,908	5,816	8,723	11,631	14,539	17,447	20,355	23,262	26,170	29,078
100	323	646	969	1,292	1,615	3,231	6,462	9,693	12,924	16,154	19,385	22,616	25,847	29,078	32,309

5.4 Razorbill

5.4.1 Construction Phase Impacts (Applicant's/Standard Approach)

Table 96: FFC SPA razorbill construction phase bio-season displacement estimates for Hornsea Four (Applicant's/Standard approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*25% Disp; 1% Mort*	*25% Disp; 1% Mort*
Return migration (Jan-Mar)	15.2	21,140	2,220	0.4	0.02%
		40,506	4,253		0.01%
Migration-free breeding (Apr-Jul)	215.1	21,140	2,220	0.0	0.00%
		40,506	4,253		0.00%
Post-breeding migration (Aug-Oct)	145.7	21,140	2,220	1.0	0.04%
		40,506	4,253		0.02%
Migration-free winter (Nov-Dec)	12.5	21,140	2,220	0.0	0.00%
		40,506	4,253		0.00%
Annual	**388.5**	**21,140**	**2,220**	**1.0**	**0.04%**
		40,506	**4,253**		**0.02%**

5.4.2 Operation and Maintenance Phase Impacts (Applicant's/Standard Approach)

Table 97: FFC SPA razorbill operation and maintenance phase bio-season displacement estimates for Hornsea Four (Applicant's/ Standard approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Return migration (Jan-Mar)	15.2	21,140	2,220	0.1	0.00%
		40,506	4,253		0.00%
Migration-free breeding (Apr-Jul)	215.1	21,140	2,220	1.1	0.05%
		40,506	4,253		0.03%
Post-breeding migration (Aug-Oct)	145.7	21,140	2,220	0.7	0.03%
		40,506	4,253		0.02%
Migration-free winter (Nov-Dec)	12.5	21,140	2,220	0.1	0.00%
		40,506	4,253		0.00%
Annual	**388.5**	**21,140**	**2,220**	**1.9**	**0.09%**
		40,506	**4,253**		**0.05%**

5.4.3 Construction Phase Impacts (Standard Approach to Apportionment)

Table 98: FFC SPA razorbill construction phase bio-season displacement estimates for Hornsea Four (Standard approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*
Return migration (Jan-Mar)	15.2	21,140	2,220	0.2-0.5	2.2-5.1	0.01-0.02%	0.10-0.23%
		40,506	4,253			0.01-0.01%	0.05-0.12%
Migration-free breeding (Apr-Jul)	215.1	21,140	2,220	0.0-0.0	0.2-0.4	0.00-0.00%	0.01-0.02%
		40,506	4,253			0.00-0.00%	0.00-0.01%
Post-breeding migration (Aug-Oct)	145.7	21,140	2,220	0.6-1.4	5.8-13.6	0.03-0.06%	0.26-0.61%
		40,506	4,253			0.01-0.03%	0.14-0.32%
Migration-free winter (Nov-Dec)	12.5	21,140	2,220	0.0-0.0	0.2-0.4	0.00-0.00%	0.01-0.02%
		40,506	4,253			0.00-0.00%	0.00-0.01%
Annual	**388.5**	**21,140**	**2,220**	**0.6-1.4**	**5.8-13.6**	**0.03-0.06%**	**0.26-0.61%**
		40,506	**4,253**			**0.01-0.03%**	**0.14-0.32%**

5.4.4 Operation and Maintenance Phase Impacts (Standard Approach to Apportionment)

Table 99: FFC SPA razorbill operation and maintenance phase bio-season displacement estimates for Hornsea Four (Standard approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Return migration (Jan-Mar)	15.2	21,140	2,220	0.0-0.5	0.1-1.1	0.00-0.02%	0.00-0.05%
		40,506	4,253			0.00-0.01%	0.00-0.02%
Migration-free breeding (Apr-Jul)	215.1	21,140	2,220	0.6-6.5	1.5-15.1	0.03-0.29%	0.07-0.68%
		40,506	4,253			0.02-0.15%	0.04-0.35%
Post-breeding migration (Aug-Oct)	145.7	21,140	2,220	0.4-4.4	1.0-10.2	0.02-0.20%	0.05-0.46%
		40,506	4,253			0.01-0.10%	0.02-0.24%
Migration-free winter (Nov-Dec)	12.5	21,140	2,220	0.0-0.4	0.1-0.9	0.00-0.02%	0.00-0.04%
		40,506	4,253			0.00-0.01%	0.00-0.02%
Annual	**388.5**	**21,140**	**2,220**	**1.2-11.7**	**2.7-27.2**	**0.05-0.53%**	**0.12-1.23%**
		40,506	**4,253**			**0.03-0.27%**	**0.06-0.64%**

Table 100: Razorbill operation and maintenance phase annual displacement matrix for Hornsea Four (Applicant's/ Standard approach to apportionment).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	0	1	1	2	2	2	3	3	3	4
10	0	1	1	2	2	4	8	12	16	19	23	27	31	35	39
20	1	2	2	3	4	8	16	23	31	39	47	54	62	70	78
30	1	2	3	5	6	12	23	35	47	58	70	82	93	105	117
40	2	3	5	6	8	16	31	47	62	78	93	109	124	140	155
50	2	4	6	8	10	19	39	58	78	97	117	136	155	175	194
60	2	5	7	9	12	23	47	70	93	117	140	163	186	210	233
70	3	5	8	11	14	27	54	82	109	136	163	190	218	245	272
80	3	6	9	12	16	31	62	93	124	155	186	218	249	280	311
90	3	7	10	14	17	35	70	105	140	175	210	245	280	315	350
100	4	8	12	16	19	39	78	117	155	194	233	272	311	350	388

5.4.5 Construction Phase Impacts (Natural England's Approach)

Table 101: FFC SPA razorbill construction phase bio-season displacement estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*
Return migration (Jan-Mar)	15.2	21,140	2,220	4.3-10.0	42.7-99.6	0.19-0.45%	1.92-4.49%
		40,506	4,253			0.10-0.23%	1.00-2.34%
Migration-free breeding (Apr-Jul)	385.5	21,140	2,220	0.0-0.0	0.2-0.4	0.00-0.00%	0.01-0.02%
		40,506	4,253			0.00-0.00%	0.00-0.01%
Post-breeding migration (Aug-Oct)	2,845.4	21,140	2,220	4.9-11.4	48.9-114.1	0.22-0.51%	2.20-5.14%
		40,506	4,253			0.11-0.27%	1.15-2.68%
Migration-free winter (Nov-Dec)	12.5	21,140	2,220	0.0-0.0	0.2-0.4	0.00-0.00%	0.01-0.02%
		40,506	4,253			0.00-0.00%	0.00-0.01%
Annual	3,258.6	21,140	2,220	4.9-11.4	48.9-114.1	0.22-0.51%	2.20-5.14%
		40,506	4,253			0.11-0.27%	1.15-2.68%

5.4.6 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 102: Razorbill operation and maintenance phase bio-season displacement estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Return migration (Jan-Mar)	15.2	21,140	2,220	0.0-0.5	0.1-1.1	0.00-0.02%	0.00-0.05%
		40,506	4,253			0.00-0.01%	0.00-0.02%
Migration-free breeding (Apr-Jul)	385.5	21,140	2,220	1.2-11.6	2.7-27.0	0.05-0.52%	0.12-1.22%
		40,506	4,253			0.03-0.27%	0.06-0.63%
Post-breeding migration (Aug-Oct)	2,845.4	21,140	2,220	8.5-85.4	19.9-199.2	0.38-3.85%	0.90-8.97%
		40,506	4,253			0.20-2.01%	0.47-4.68%
Migration-free winter (Nov-Dec)	12.5	21,140	2,220	0.0-0.4	0.1-0.9	0.00-0.02%	0.00-0.04%
		40,506	4,253			0.00-0.01%	0.00-0.02%
Annual	3,258.6	21,140	2,220	9.8-97.8	22.8-228.1	0.44-4.40%	1.03-10.28%
		40,506	4,253			0.23-2.30%	0.54-5.36%

Table 103: FFC SPA razorbill operation and maintenance phase annual displacement matrix for Hornsea Four (Natural England's approach to apportionment).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	1	1	1	2	3	7	10	13	16	20	23	26	29	33
10	3	7	10	13	16	33	65	98	130	163	196	228	261	293	326
20	7	13	20	26	33	65	130	196	261	326	391	456	521	587	652
30	10	20	29	39	49	98	196	293	391	489	587	684	782	880	978
40	13	26	39	52	65	130	261	391	521	652	782	912	1,043	1,173	1,303
50	16	33	49	65	81	163	326	489	652	815	978	1,140	1,303	1,466	1,629
60	20	39	59	78	98	196	391	587	782	978	1,173	1,369	1,564	1,760	1,955
70	23	46	68	91	114	228	456	684	912	1,140	1,369	1,597	1,825	2,053	2,281
80	26	52	78	104	130	261	521	782	1,043	1,303	1,564	1,825	2,085	2,346	2,607
90	29	59	88	117	147	293	587	880	1,173	1,466	1,760	2,053	2,346	2,639	2,933
100	33	65	98	130	163	326	652	978	1,303	1,629	1,955	2,281	2,607	2,933	3,259

5.5 Puffin

5.5.1 Construction Phase Impacts (Applicant's Approach)

Table 104: FFC SPA puffin construction phase bio-season displacement estimates for Hornsea Four (Applicant's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA latest colony (2017/2018) population and baseline mortality rate		Estimated number of puffins subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*25% Disp; 1% Mort*	*25% Disp; 1% Mort*
Breeding (Apr-Jul)	181.0	3,579	336	0.5	0.13%
Non-breeding (Aug-Mar)	1.8	3,579	336	0.0	0.00%
Annual	**182.8**	**3,579**	**336**	**0.5**	**0.14%**

5.5.2 Operation and Maintenance Phase Impacts (Applicant's Approach)

Table 105: FFC SPA puffin operation and maintenance phase bio-season displacement estimates for Hornsea Four (Applicant's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA latest colony (2017/2018) population and baseline mortality rate		Estimated number of puffins subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Breeding (Apr-Jul)	181.0	3,579	336	0.9	0.27%
Non-breeding (Aug-Mar)	1.8	3,579	336	0.0	0.00%
Annual	**182.8**	**3,579**	**336**	**0.9**	**0.27%**

Table 106: FFC SPA puffin operation and maintenance phase annual displacement matrix for Hornsea Four.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2
10	0	0	1	1	1	2	4	5	7	9	11	13	15	16	18
20	0	1	1	1	2	4	7	11	15	18	22	26	29	33	37
30	1	1	2	2	3	5	11	16	22	27	33	38	44	49	55
40	1	1	2	3	4	7	15	22	29	37	44	51	59	66	73
50	1	2	3	4	5	9	18	27	37	46	55	64	73	82	91
60	1	2	3	4	5	11	22	33	44	55	66	77	88	99	110
70	1	3	4	5	6	13	26	38	51	64	77	90	102	115	128
80	1	3	4	6	7	15	29	44	59	73	88	102	117	132	146
90	2	3	5	7	8	16	33	49	66	82	99	115	132	148	165
100	2	4	5	7	9	18	37	55	73	91	110	128	146	165	183

5.5.3 Construction Phase Impacts (Natural England's Approach)

Table 107: FFC SPA puffin construction phase bio-season displacement estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA latest colony (2017/2018) population and baseline mortality rate		Estimated number of puffins subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*	*15-35% Disp; 1% Mort*	*15-35% Disp; 10% Mort*
Breeding (Apr-Jul)	181.0	3,579	336	0.3-0.7	3.0-7.1	0.09-0.21%	0.90-2.11%
Non-breeding (Aug-Mar)	1.8	3,579	336	0.0-0.0	0.0-0.1	0.00-0.00%	0.01-0.02%
Annual	**182.8**	**3,579**	**336**	**0.3-0.7**	**3.1-7.2**	**0.09-21%**	**0.91-2.13%**

5.5.4 Operation and Maintenance Phase Impacts (Natural England's Approach)

Table 108: FFC SPA puffin operation and maintenance phase bio-season displacement estimates for Hornsea Four (Natural England's approach to apportionment).

Bio-season (months)	Seasonal abundance (array area & 2 km buffer)	FFC SPA latest colony (2017/2018) population and baseline mortality rate		Estimated number of puffins subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
		Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Breeding (Apr-Jul)	181.0	3,579	336	0.6-6.1	1.4-14.2	0.18-1.81%	0.42-4.22%
Non-breeding (Aug-Mar)	1.8	3,579	336	0.0-0.1	0.0-0.1	0.00-0.02%	0.00-0.04%
Annual	**182.8**	**3,579**	**336**	**0.6-6.1**	**1.4-14.3**	**0.18-1.82%**	**0.43-4.26%**

Table 109: FFC SPA puffin operation and maintenance phase annual displacement matrix for Hornsea Four (Natural England's approach to apportionment).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2
10	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
20	0	1	1	2	2	4	8	12	16	20	25	29	33	37	41
30	1	1	2	2	3	6	12	18	25	31	37	43	49	55	61
40	1	2	2	3	4	8	16	25	33	41	49	57	65	74	82
50	1	2	3	4	5	10	20	31	41	51	61	72	82	92	102
60	1	2	4	5	6	12	25	37	49	61	74	86	98	110	123
70	1	3	4	6	7	14	29	43	57	72	86	100	115	129	143
80	2	3	5	7	8	16	33	49	65	82	98	115	131	147	164
90	2	4	6	7	9	18	37	55	74	92	110	129	147	166	184
100	2	4	6	8	10	20	41	61	82	102	123	143	164	184	205

6 FFC SPA In-combination Impacts

6.1 Gannet

Table 110: FFC SPA gannet in-combination bio-season and total abundance estimates from all Tier 1 & 2 projects.

Project	Breeding	Autumn	Spring	Annual	Tier
Beatrice	0	0	0	0	1a
Blyth Demonstration Site	-	-	-	-	1a
Dudgeon	53	1	1	55	1a
EOWDC	0	0	0	0	1a
Galloper	0	44	17	61	1a
Greater Gabbard	0	3	7	10	1a
Gunfleet Sands	0	1	1	1	1a
Humber Gateway	-	-	-	-	1a
Hywind 2 Demonstration	0	0	0	0	1a
Kentish Flats	-	-	-	-	1a
Kentish Flats Extension	0	1	0	1	1a
Lincs	-	-	-	-	1a
London Array	-	-	-	-	1a
Lynn and Inner Dowsing	-	-	-	-	1a
Methil	0	0	0	0	1a
Race Bank	92	2	2	95	1a
Rampion	0	28	0	28	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	47	2	0	49	1a
Teesside	1	0	0	1	1a
Thanet	-	-	-	-	1a
Westermost Rough	-	-	-	-	1a
East Anglia One	161	175	5	340	1b
Hornsea Project One	671	33	16	720	1b
Hornsea Project Two	457	55	8	519	1b
Moray East	0	14	2	16	1b
Triton Knoll	211	1	2	213	1b
Kincardine	0	0	0	0	1b
Dogger Bank A	259	44	11	314	1c
Dogger Bank B	319	54	14	386	1c
Dogger Bank C	484	18	14	516	1c
East Anglia Three	412	61	33	505	1c
Inch Cape	0	34	13	47	1c
Moray West	0	21	9	30	1c
Neart na Gaoithe	0	27	17	44	1c
Seagreen Alpha	0	14	9	23	1c

Project	Breeding	Autumn	Spring	Annual	Tier
Seagreen Bravo	0	18	12	30	1c
Sofia	641	24	15	680	1c
Hornsea Three (Applicant's approach)	539	47	33	619	1c
Hornsea Three (NE's approach)	844	47	33	924	1c
Norfolk Boreas	1,229	83	33	1,344	1c
Norfolk Vanguard	271	118	27	416	1c
East Anglia ONE North	149	23	3	174	1c
East Anglia TWO	192	43	12	247	1c
Hornsea Four Applicant's Approach	597	38	25	661	1d
Hornsea Four Natural England's Approach	883	38	25	946	1d
Total Applicant's Approach (consented projects only)	**7,628**	**1,071**	**369**	**9,068**	
Total Natural England's Approach (consented projects only)	**7,914**	**1,071**	**369**	**9,354**	
Dudgeon Extension Project	361	16	3	380	2
Sheringham Shoal Extension Project	40	14	0	54	2
Rampion 2	0	4	3	7	2
North Falls	-	-	-	-	2
Five Estuaries	-	-	-	-	2
Total Applicant's Approach (All Projects)	**8,029**	**1,105**	**375**	**9,509**	
Total Natural England's Approach (All Projects)	**8,315**	**1,105**	**375**	**9,795**	

Table 111: FFC SPA gannet in-combination operation and maintenance phase bio-season displacement estimates from all Tier 1 & 2 projects (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of gannets subject to mortality (Breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*
Return migration (Dec-Mar)	H4 plus all consented projects only	369.1	16,938	1,372	2.2-3.0	2.2-2.8	0.16-0.22%	0.16-0.20%
	All projects	375.1			2.3-3.0	2.3-2.8	0.16-0.22%	0.16-0.21%
	H4 plus all consented projects only	369.1	26,784	2,170	2.2-3.0	2.2-2.8	0.10-0.14%	0.10-0.13%
	All projects	375.1			2.3-3.0	2.3-2.8	0.10-0.14%	0.10-0.13%
Migration-free breeding (Apr-Aug)	H4 plus all consented projects only	7,628.3	16,938	1,372	45.8-61.0	30.5-45.8	3.34-4.45%	2.22-3.34%
	All projects	8,029.3			48.2-64.2	32.1-48.2	3.51-4.68%	2.34-3.51%
	H4 plus all consented projects only	7,628.3	26,784	2,170	45.8-61.0	30.5-45.8	2.11-2.81%	1.41-2.11%
	All projects	8,029.3			48.2-64.2	32.1-48.2	2.22-2.96%	1.48-2.22%
Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	1,071.0	16,938	1,372	6.4-8.6	6.4-8.0	0.47-0.62%	0.47-0.59%
	All projects	1,105.0			6.6-8.8	6.6-8.3	0.48-0.64%	0.48-0.60%
	H4 plus all consented projects only	1,071.0	26,784	2,170	6.4-8.6	6.4-8.0	0.30-0.39%	0.30-0.37%
	All projects	1,105.0			6.6-8.8	6.6-8.3	0.31-0.41%	0.31-0.38%
Annual	**H4 plus all consented projects only**	**9,068.4**	**16,938**	**1,372**	**54.4-72.5**	**39.2-56.6**	**3.97-5.29%**	**2.85-4.12%**
	All projects	**9,509.4**			**57.1-76.1**	**41.0-59.3**	**4.16-5.54%**	**2.99-4.32%**

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of gannets subject to mortality (Breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*	*60-80% Disp; 1% Mort*	*Breeding 40-60% Disp, Non-breeding 60-75% Disp; 1% Mort*
	H4 plus all consented projects only	**9,068.4**	**26,784**	**2,170**	**54.4-72.5**	**39.2-56.6**	**2.51-3.34%**	**1.80-2.61%**
	All projects	**9,509.4**			**57.1-76.1**	**41.0-59.3**	**2.63-3.51%**	**1.89-2.73%**

Table 112: FFC SPA gannet in-combination operation and maintenance phase bio-season displacement estimates from all Tier 1 & 2 projects (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of gannets subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*60 Disp; 1-10% Mort*	*80 Disp; 1-10% Mort*	*60 Disp; 1-10% Mort*	*80 Disp; 1-10% Mort*
Return migration (Dec-Mar)	H4 plus all consented projects only	369.1	16,938	1,372	2.2-22.1	3.0-29.5	0.16-1.61%	0.22-2.15%
	All projects	375.1			2.3-22.5	3.0-30.0	0.16-1.64%	0.22-2.19%
	H4 plus all consented projects only	369.1	26,784	2,170	2.2-22.1	3.0-29.5	0.10-1.02%	0.14-1.36%
	All projects	375.1			2.3-22.5	3.0-30.0	0.10-1.04%	0.14-1.38%
Breeding (Apr-Aug)	H4 plus all consented projects only	7914.1	16,938	1,372	47.5-474.8	63.3-633.1	3.46-34.61%	4.61-46.15%
	All projects	8315.1			49.9-498.9	66.5-665.2	3.64-36.36%	4.85-48.49%
	H4 plus all consented projects only	7914.1	26,784	2,170	47.5-474.8	63.3-633.1	2.19-21.89%	2.92-29.18%
	All projects	8315.1			49.9-498.8	66.5-665.2	2.30-23.00%	3.07-30.66%
Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	1071.0	16,938	1,372	6.4-64.3	8.6-85.7	0.47-4.68%	0.62-6.25%
	All projects	1105.0			6.6-66.3	8.8-88.4	0.48-4.83%	0.64-6.44%
	H4 plus all consented projects only	1071.0	26,784	2,170	6.4-64.3	8.6-85.7	0.30-2.96%	0.39-3.95%
	All projects	1105.0			6.6-66.3	8.8-88.4	0.31-3.06%	0.41-4.07%
Annual	**H4 plus all consented projects only**	**9354.2**	**16,938**	**1,372**	**56.1-561.3**	**74.8-748.3**	**4.09-40.91%**	**5.45-54.54%**
	All projects	**9795.2**			**58.8-587.7**	**78.4-783.6**	**4.28-42.84%**	**5.71-57.12%**

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of gannets subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*60 Disp; 1-10% Mort*	*80 Disp; 1-10% Mort*	*60 Disp; 1-10% Mort*	*80 Disp; 1-10% Mort*
	H4 plus all consented projects only	**9354.2**	**26,784**	**2,170**	**56.1-561.3**	**74.8-748.3**	**2.59-25.87%**	**3.45-34.49%**
	All projects	**9795.2**			**58.8-587.7**	**78.3-783.6**	**2.71-27.09%**	**3.61-36.12%**

Table 113: FFC SPA gannet in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects (Applicant's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	2	3	4	5	10	19	29	38	48	57	67	76	86	95
10	10	19	29	38	48	95	190	285	380	475	571	666	761	856	951
20	19	38	57	76	95	190	380	571	761	951	1,141	1,331	1,522	1,712	1,902
30	29	57	86	114	143	285	571	856	1,141	1,426	1,712	1,997	2,282	2,568	2,853
40	38	76	114	152	190	380	761	1,141	1,522	1,902	2,282	2,663	3,043	3,423	3,804
50	48	95	143	190	238	475	951	1,426	1,902	2,377	2,853	3,328	3,804	4,279	4,755
60	57	114	171	228	285	571	1,141	1,712	2,282	2,853	3,423	3,994	4,565	5,135	5,706
70	67	133	200	266	333	666	1,331	1,997	2,663	3,328	3,994	4,660	5,325	5,991	6,657
80	76	152	228	304	380	761	1,522	2,282	3,043	3,804	4,565	5,325	6,086	6,847	7,608
90	86	171	257	342	428	856	1,712	2,568	3,423	4,279	5,135	5,991	6,847	7,703	8,558
100	95	190	285	380	475	951	1,902	2,853	3,804	4,755	5,706	6,657	7,608	8,558	9,509

Table 114: FFC SPA gannet in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects (Natural England's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	2	3	4	5	10	20	29	39	49	59	69	78	88	98
10	10	20	29	39	49	98	196	294	392	490	588	686	784	882	980
20	20	39	59	78	98	196	392	588	784	980	1,175	1,371	1,567	1,763	1,959
30	29	59	88	118	147	294	588	882	1,175	1,469	1,763	2,057	2,351	2,645	2,939
40	39	78	118	157	196	392	784	1,175	1,567	1,959	2,351	2,743	3,134	3,526	3,918
50	49	98	147	196	245	490	980	1,469	1,959	2,449	2,939	3,428	3,918	4,408	4,898
60	59	118	176	235	294	588	1,175	1,763	2,351	2,939	3,526	4,114	4,702	5,289	5,877
70	69	137	206	274	343	686	1,371	2,057	2,743	3,428	4,114	4,800	5,485	6,171	6,857
80	78	157	235	313	392	784	1,567	2,351	3,134	3,918	4,702	5,485	6,269	7,052	7,836
90	88	176	264	353	441	882	1,763	2,645	3,526	4,408	5,289	6,171	7,052	7,934	8,816
100	98	196	294	392	490	980	1,959	2,939	3,918	4,898	5,877	6,857	7,836	8,816	9,795

Table 115: FFC SPA gannet in-combination bio-season collision estimates from all Tier 1 & 2 projects.

Project	Breeding	Autumn	Spring	Annual	Tier
Beatrice	0.0	2.3	0.6	2.9	1a
Blyth Demonstration Site	0.0	0.1	0.2	0.3	1a
Dudgeon	22.3	1.9	1.2	25.3	1a
East Anglia One	3.4	6.3	0.4	10.1	1a
EOWDC	0.0	0.3	0.0	0.3	1a
Galloper	0.0	1.5	0.8	2.3	1a
Greater Gabbard	0.0	0.4	0.3	0.7	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	11.5	1.5	1.4	14.4	1a
Humber Gateway	1.9	0.1	0.1	2.0	1a
Hywind 2 Demonstration	0.0	0.0	0.1	0.1	1a
Kentish Flats	0.0	0.0	0.1	0.1	1a
Kentish Flats Extension	-	-	-	-	1a
Kincardine	0.0	0.0	0.0	0.0	1a
Lincs, Lynn & Inner Dowsing	2.3	0.1	0.1	2.5	1a
London Array	0.0	0.1	0.1	0.2	1a
Methil	0.0	0.0	0.0	0.0	1a
Race Bank	33.7	0.6	0.3	34.5	1a
Rampion	0.0	3.1	0.1	3.2	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	14.1	0.2	0.0	14.3	1a
Teesside	2.4	0.1	0.0	2.5	1a
Thanet	0.0	0.0	0.0	0.0	1a
Westermost Rough	0.2	0.0	0.0	0.2	1a
Hornsea Project Two	7.0	0.7	0.4	8.0	1b
Moray East	0.0	1.7	0.6	2.3	1b
Neart na Gaoithe	0.0	2.3	1.4	3.7	1b
Seagreen Alpha & Bravo	0.0	2.4	4.1	6.4	1b
Triton Knoll	26.8	3.1	1.9	31.7	1b
Dogger Bank A & B	40.6	4.0	3.4	47.9	1c
Dogger Bank C & Sofia	7.4	0.5	0.7	8.5	1c
East Anglia Three	6.1	1.6	0.6	8.3	1c
Hornsea Three	6.4	0.2	0.3	6.9	1c
Hornsea Three Applicant's values	1.0	0.0	0.0	1.0	1c
Inch Cape	0.0	1.4	0.3	1.7	1c
Moray West	0.0	0.1	0.1	0.2	1c
Norfolk Boreas	14.2	0.6	0.2	15.1	1c
Norfolk Vanguard	8.2	0.9	0.3	9.4	1c
East Anglia ONE North	12.4	0.5	0.1	13.0	1c
East Anglia TWO	12.5	1.1	0.2	13.8	1c

Project	Breeding	Autumn	Spring	Annual	Tier
Hornsea Four Applicant's Approach	6.7	0.2	0.1	7.1	1d
Hornsea Four NE Approach	14.3	0.3	0.1	14.6	1d
Total Applicant's Approach (consented projects only)	**241.1**	**39.7**	**20.2**	**300.8**	
Total Natural England's Approach Approach (consented projects only)	**248.6**	**39.7**	**20.2**	**308.4**	
Dudgeon Extension Project	3.6	0.2	0.0	3.9	2
Sheringham Shoal Extension Project	0.3	0.1	0.0	0.4	2
Rampion 2	0.0	16.6	8.9	25.5	2
North Falls	-	-	-	-	2
Five Estuaries	-	-	-	-	2
Total Applicant's Approach (All Projects)	**245.0**	**56.6**	**29.1**	**330.6**	
Total Natural England's Approach (All Projects)	**252.5**	**56.6**	**29.1**	**338.1**	

Table 116: FFC SPA gannet in-combination operation and maintenance phase bio-season collision estimates from all Tier 1 & 2 (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	FFC SPA Citation and latest colony (2017) population		Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Mar)	H4 plus all consented projects only	20.2	16,938	1,372	1.47%
	All projects	29.1			2.12%
	H4 plus all consented projects only	20.2	26,784	2,170	0.93%
	All projects	29.1			1.34%
Migration-free breeding (Apr-Aug)	H4 plus all consented projects only	241.1	16,938	1,372	17.57%
	All projects	245.0			17.86%
	H4 plus all consented projects only	241.1	26,784	2,170	11.11%
	All projects	245.0			11.29%

Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	39.7	16,938	1,372	2.89%
	All projects	56.6			4.12%
	H4 plus all consented projects only	39.7	26,784	2,170	1.83%
	All projects	56.6			2.61%
Annual	**H4 plus all consented projects only**	**300.8**	**16,938**	**1,372**	**21.93%**
	All projects	**330.6**			**24.09%**
	H4 plus all consented projects only	**300.8**	**26,784**	**2,170**	**13.87%**
	All projects	**330.6**			**15.24%**

Table 117: FFC SPA gannet in-combination operation and maintenance phase bio-season collision estimates from all Tier 1 & 2 projects (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	FFC SPA Citation and latest colony (2017) population		Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Dec-Mar)	H4 plus all consented projects only	20.2	16,938	1,372	1.47%
	All projects	29.1			2.12%
	H4 plus all consented projects only	20.2	26,784	2,170	0.93%
	All projects	29.1			1.34%
Migration-free breeding (Apr-Aug)	H4 plus all consented projects only	248.6	16,938	1,372	18.12%
	All projects	252.5			18.41%
	H4 plus all consented projects only	248.6	26,784	2,170	11.46%
	All projects	252.5			11.64%

Post-breeding migration (Sep-Nov)	H4 plus all consented projects only	39.7	16,938	1,372	2.89%
	All projects	56.6			4.13%
	H4 plus all consented projects only	39.7	26,784	2,170	1.83%
	All projects	56.6			2.61%
Annual	**H4 plus all consented projects only**	**308.4**	**16,938**	**1,372**	**22.48%**
	All projects	**338.1**			**24.64%**
	H4 plus all consented projects only	**308.4**	**26,784**	**2,170**	**14.21%**
	All projects	**338.1**			**15.58%**

6.2 Kittiwake

Table 118: FFC SPA kittiwake in-combination bio-season collision estimates from all Tier 1 & 2 projects.

Project	Breeding	Autumn	Spring	Annual	Tier
Beatrice	0.0	0.6	2.9	3.5	1a
Blyth Demonstration Site	0.0	0.1	0.1	0.2	1a
Dudgeon	-	-	-	-	1a
East Anglia One	0.0	8.7	3.4	12.0	1a
EOWDC	0.0	0.3	0.1	0.4	1a
Galloper	0.0	1.5	2.3	3.8	1a
Greater Gabbard	0.0	0.8	0.8	1.6	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	36.5	3.0	1.5	41.0	1a
Humber Gateway	1.9	0.2	0.1	2.2	1a
Hywind 2 Demonstration	0.0	0.1	0.1	0.1	1a
Kentish Flats	0.0	0.1	0.1	0.1	1a
Kentish Flats Extension	0.0	0.0	0.2	0.2	1a
Kincardine	0.0	0.5	0.1	0.6	1a
Lincs, Lynn & Inner Dowsing	0.7	0.1	0.1	0.8	1a
London Array	0.0	0.1	0.1	0.3	1a
Methil	0.0	0.0	0.0	0.0	1a
Race Bank	1.9	1.3	0.4	3.6	1a
Rampion	0.0	2.0	2.1	4.2	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	-	-	-	-	1a
Teesside	0.0	1.3	0.2	1.5	1a
Thanet	0.0	0.0	0.0	0.1	1a
Westermost Rough	0.1	0.0	0.0	0.1	1a
Hornsea Project Two	13.3	0.5	0.2	14.0	1b
Moray East	0.0	0.1	1.4	1.5	1b
Neart na Gaoithe	0.0	3.0	0.3	3.4	1b
Seagreen Alpha & Bravo	0.0	16.9	17.8	34.7	1b
Triton Knoll	24.6	7.5	3.3	35.4	1b
Dogger Bank A & B	55.8	7.3	21.3	84.3	1c
Dogger Bank C & Sofia	26.4	4.9	15.6	46.9	1c
East Anglia Three	0.0	3.7	2.7	6.4	1c
Hornsea Three	0.0	0.0	0.0	0.0	1c
Inch Cape	0.0	12.1	4.6	16.7	1c

Project	Breeding	Autumn	Spring	Annual	Tier
Moray West	0.0	1.3	0.5	1.8	1c
Norfolk Boreas	0.0 (11.4)	0.0 (1.7)	0.0 (0.9)	0.0 (14.0)	1c
Norfolk Vanguard	0.0 (18.7)	0.0 (0.9)	0.0 (1.4)	0.0 (21.0)	1c
East Anglia ONE North	0.0 (0.0)	0.0 (0.4)	0.0 (0.3)	0.0 (0.7)	1c
East Anglia TWO	0.0 (0.0)	0.0 (0.3)	0.0 (0.5)	0.0 (0.8)	1c
Hornsea Four (Applicant's Approach)	20.6	1.7	1.0	23.3	1d
Hornsea Four (Natural England's Approach)	70.3	0.8	0.3	71.4	1d
Total Applicant's Approach (consented projects only)	**181.8**	**79.7**	**83.3**	**344.8**	
Total Natural England's Approach (consented projects only)	**231.5**	**78.8**	**82.6**	**392.9**	
Dudgeon Extension Project	17.2	0.5	0.2	17.9	2
Sheringham Shoal Extension Project	0.9	0.1	0.0	1.0	2
Rampion 2	0.0	0.1	0.5	0.6	2
North Falls	-	-	-	-	2
Five Estuaries	-	-	-	-	2
Total Applicant's Approach (All Projects)	**199.9**	**80.4**	**84.0**	**364.3**	
Total Natural England's Approach (All Projects)	**249.7**	**79.4**	**83.3**	**412.4**	

Table 119: FFC SPA kittiwake in-combination operation and maintenance phase bio-season collision estimates from all Tier 1 & 2 projects (Applicant's England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	FFC SPA Citation and latest colony (2017) population		Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Jan-Apr)	H4 plus all consented projects only	83.3	167,400	24,440	0.34%
	All projects	84.0			0.34%
	H4 plus all consented projects only	83.3	103,070	15,048	0.55%
	All projects	84.0			0.56%
Migration-free breeding (May-Jul)	H4 plus all consented projects only	181.8	167,400	24,440	0.74%
	All projects	199.9			0.82%
	H4 plus all consented projects only	181.8	103,070	15,048	1.21%
	All projects	199.9			1.33%

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	FFC SPA Citation and latest colony (2017) population		Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Post-breeding migration (Aug-Dec)	H4 plus all consented projects only	79.7	167,400	24,440	0.33%
	All projects	80.4			0.33%
	H4 plus all consented projects only	79.7	103,070	15,048	0.53%
	All projects	80.4			0.53%
Annual	**H4 plus all consented projects only**	**344.8**	**167,400**	**24,440**	**1.41%**
	All projects	**364.3**			**1.49%**
	H4 plus all consented projects only	**344.8**	**26,784**	**2,170**	**2.29%**
	All projects	**364.3**			**2.42%**

Table 120: FFC SPA kittiwake in-combination operation and maintenance phase bio-season collision estimates from all Tier 1 & 2 projects (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal CRM totals (per annum)	FFC SPA Citation and latest colony (2017) population		Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	
Return migration (Jan-Feb)	H4 plus all consented projects only	82.6	167,400	24,440	0.34%
	All projects	83.3			0.34%
	H4 plus all consented projects only	82.6	103,070	15,048	0.55%
	All projects	83.3			0.55%
Migration-free breeding (May-Aug)	H4 plus all consented projects only	231.5	167,400	24,440	0.95%
	All projects	249.7			1.02%
	H4 plus all consented projects only	231.5	103,070	15,048	1.54%
	All projects	249.7			1.66%

Post-breeding migration (Sep-Dec)	H4 plus all consented projects only	78.8	167,400	24,440	0.32%
	All projects	79.4			0.32%
	H4 plus all consented projects only	78.8	103,070	15,048	0.52%
	All projects	79.4			0.53%
Annual	**H4 plus all consented projects only**	**392.9**	**167,400**	**24,440**	**1.61%**
	All projects	**412.4**			**1.69%**
	H4 plus all consented projects only	**392.9**	**26,784**	**2,170**	**2.61%**
	All projects	**412.4**			**2.74%**

6.3 Guillemot

Table 121: FFC SPA guillemot in-combination bio-season and total abundance estimates from all Tier 1 & 2 projects.

Project	Breeding	Non-breeding	Annual	Tier
Beatrice	0	121	121	1a
Blyth Demonstration Site	0	58	58	1a
Dudgeon	0	24	24	1a
EOWDC	0	10	10	1a
Galloper	0	26	26	1a
Greater Gabbard	0	24	24	1a
Gunfleet Sands	0	16	16	1a
Humber Gateway	99	6	105	1a
Hywind 2 Demonstration	0	94	94	1a
Kentish Flats Extension	0	0	0	1a
Kentish Flats	0	0	0	1a
Lincs, Lynn & Inner Dowsing	0	36	36	1a
London Array	0	17	17	1a
Methil	0	0	0	1a
Race Bank	0	31	31	1a
Rampion	0	684	684	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	0	32	32	1a
Teesside	267	40	307	1a
Thanet	0	6	6	1a
Westermost Rough	347	21	368	1a
East Anglia One	0	28	28	1b
Hornsea Project One	4,554	356	4,910	1b
Hornsea Project Two	3,581	579	4,161	1b
Moray East	0	24	24	1b
Triton Knoll	425	33	458	1b
Kincardine	0	0	0	1b
Dogger Bank Creyke Beck A	1,893	270	2,163	1c
Dogger Bank Creyke Beck B	3,318	467	3,785	1c
Dogger Bank Teesside A	1,149	100	1,249	1c

Project	Breeding	Non-breeding	Annual	Tier
East Anglia Three	0	126	126	1c
Inch Cape	0	140	140	1c
Moray West	0	1,680	1,680	1c
Neart na Gaoithe	0	166	166	1c
Seagreen Alpha	0	206	206	1c
Seagreen Bravo	0	181	181	1c
Sofia	1,824	163	1,987	1c
Hornsea Three	8,502	782	9,284	1c
Norfolk Boreas	0	606	606	1c
Norfolk Vanguard	0	210	210	1c
East Anglia ONE North	0	83	83	1c
East Anglia TWO	0	74	74	1c
Hornsea Four Applicant's Approach (weighted mean peak)	5,235	2,666	7,901	1d
Hornsea Four Standard Approach (mean peak)	5,235	1,631	6,866	1d
Hornsea Four NE Approach (mean peak)	9,382	22,927	22,179 + 748	1d
Total Applicant's Approach (consented projects only)	**31,194**	**10,185**	**41,378**	
Total Standard Approach (consented projects only)	**31,194**	**9,150**	**40,343**	
Total Natural England's Approach (consented projects only)	**35,340**	**30,446**	**65,786**	
Dudgeon Extension Project	0	355	355	2
Sheringham Shoal Extension Project	0	27	27	2
Rampion 2	0	574	574	2
North Falls	-	-	-	2
Five Estuaries	-	-	-	2

Project	Breeding	Non-breeding	Annual	Tier
Total Applicant's Approach (All Projects)	31,194	11,141	42,334	
Total Standard Approach (All Projects)	31,194	10,106	41,299	
Total Natural England's Approach (All Projects)	35,340	31,402	66,742	

Table 122: FFC SPA guillemot in-combination operation and maintenance phase bio-season displacement estimates from all Tier 1 & 2 projects (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50 Disp; 1% Mort*	*50 Disp; 1% Mort*
Breeding (Mar-Jul)	H4 plus all consented projects only	31,194	83,214	5,076	156.0	3.07%
	All projects	31,194			156.0	3.07%
	H4 plus all consented projects only	31,194	121,754	7,427	156.0	2.10%
	All projects	31,194			156.0	2.10%
Non-breeding (Aug-Feb)	H4 plus all consented projects only	10,185	83,214	5,076	50.9	1.00%
	All projects	11,141			55.7	1.10%
	H4 plus all consented projects only	10,185	121,754	7,427	50.9	0.69%

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50 Disp; 1% Mort*	*50 Disp; 1% Mort*
	All projects	11,141			55.7	0.75%
Annual	**H4 plus all consented projects only**	**41,378**	**83,214**	**5,076**	**206.9**	**4.08%**
	All projects	**42,334**			**211.7**	**4.17%**
	H4 plus all consented projects only	**41,378**	**121,754**	**7,427**	**206.9**	**2.79%**
	All projects	**42,334**			**211.7**	**2.85%**

Table 123: FFC SPA guillemot in-combination operation and maintenance phase bio-season displacement estimates from all Tier 1 & 2 projects (Standard approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)			Increase in baseline mortality (%)		
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30 Disp; 1-10% Mort*	*50 Disp; 1% Mort*	*70 Disp; 1-10% Mort*	*30 Disp; 1-10% Mort*	*50 Disp; 1% Mort*	*70 Disp; 1-10% Mort*
Breeding (Mar-Jul)	H4 plus all consented projects only	31,194	83,214	5,076	93.6-935.8	156.0	218.4-2,183.6	1.84-18.44%	3.07%	4.30-43.02%
	All projects	31,194			93.6-935.8	156.0	218.4-2,183.6	1.84-18.44%	3.07%	4.30-43.02%
	H4 plus all consented projects only	31,194	121,754	7,427	93.6-935.8	156.0	218.4-2,183.6	1.26-12.60%	2.10%	2.94-29.40%
	All projects	31,194			93.6-935.8	156.0	218.4-2,138.6	1.26-12.60%	2.10%	2.94-29.40%
Non-breeding (Aug-Feb)	H4 plus all consented projects only	9,150	83,214	5,076	27.4-274.5	45.7	64.0-640.5	0.54-5.41%	0.90%	1.26-12.62%
	All projects	10,106			30.3-303.2	50.5	70.7-707.4	0.60-5.97%	1.00%	1.39-13.94%
	H4 plus all consented projects only	9,150	121,754	7,427	27.4-274.5	45.7	64.0-640.5	0.37-3.70%	0.62%	0.86-8.62%
	All projects	10,106			30.3-303.2	50.5	70.7-707.4	0.41-4.08%	0.68%	0.95-9.52%

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)			Increase in baseline mortality (%)		
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30 Disp; 1-10% Mort*	*50 Disp; 1% Mort*	*70 Disp; 1-10% Mort*	*30 Disp; 1-10% Mort*	*50 Disp; 1% Mort*	*70 Disp; 1-10% Mort*
Annual	**H4 plus all consented projects only**	**40,343**	**83,214**	**5,076**	**121.0-1,210.3**	**201.7**	**282.4-2,824.0**	**2.38-23.84%**	**3.97%**	**5.56-55.63%**
	All projects	**41,299**			**123.9-1,239.0**	**206.5**	**289.1-2,890.9**	**2.44-24.41%**	**4.07%**	**5.70-56.95%**
	H4 plus all consented projects only	**40,343**	**121,754**	**7,427**	**121.0-1,210.3**	**201.7**	**282.4-2,824.0**	**1.63-16.30%**	**2.72%**	**3.80-38.02%**
	All projects	**41,299**			**123.9-1,239.0**	**206.5**	**289.1-2,890.9**	**1.67-16.68%**	**2.78%**	**3.89-38.92%**

Table 124: FFC SPA guillemot in-combination operation and maintenance phase bio-season displacement estimates from all Tier 1 & 2 projects (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*
Breeding (Mar-Jul)	H4 plus all consented projects only	35,340	83,214	5,076	106.0-1,060.2	247.4-2,473.8	2.09-20.89%	4.87-48.74%
	All projects	35,340			106.0-1,060.2	247.4-2,473.8	2.09-20.89%	4.87-48.74%
	H4 plus all consented projects only	35,340	121,754	7,427	106.0-1,060.2	247,4-2,473.8	1.43-14.28%	3.33-33.31%
	All projects	35,340			106.0-1,060.2	247.4-2,473.8	1.43-14.28%	3.33-33.31%
Non-breeding (Aug-Feb)	H4 plus all consented projects only	30,446	83,214	5,076	91.3-913.4	213.1-2,131.2	1.80-17.99%	4.20-41.99%
	All projects	31,402			94.2-942.1	219.8-2,198.1	1.86-18.56%	4.33-43.30%
	H4 plus all consented projects only	30,446	121,754	7,427	91.3-913.4	213.1-2,131.2	1.23-12.30%	2.87-28.70%
	All projects	31,402			94.2-942.1	219.8-2,198.1	1.27-12.68%	2.96-29.60%
Annual	H4 plus all consented projects only	**65,786**	**83,214**	**5,076**	**197.4-1,973.6**	**460.5-4,605.0**	**3.89-38.88%**	**9.07-90.72%**
	All projects	**66,742**			**200.2-2,002.3**	**467.2-4,672.0**	**3.94-39.45%**	**9.20-92.04%**
	H4 plus all consented projects only	**65,786**	**121,754**	**7,427**	**197.4-1,973.6**	**460.5-4,605.0**	**2.66-26.57%**	**6.20-62.00%**

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of guillemots subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*
	All projects	**66,742**			**200.2-2,002.3**	**467.2-4,672.0**	**2.70-26.96%**	**6.29-62.91%**

Table 125: FFC SPA guillemot in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects (Applicant's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	4	8	13	17	21	42	85	127	169	212	254	296	339	381	423
10	42	85	127	169	212	423	847	1,270	1,693	2,117	2,540	2,963	3,387	3,810	4,233
20	85	169	254	339	423	847	1,693	2,540	3,387	4,233	5,080	5,927	6,773	7,620	8,467
30	127	254	381	508	635	1,270	2,540	3,810	5,080	6,350	7,620	8,890	10,160	11,430	12,700
40	169	339	508	677	847	1,693	3,387	5,080	6,773	8,467	10,160	11,854	13,547	15,240	16,934
50	212	423	635	847	1,058	2,117	4,233	6,350	8,467	10,584	12,700	14,817	16,934	19,050	21,167
60	254	508	762	1,016	1,270	2,540	5,080	7,620	10,160	12,700	15,240	17,780	20,320	22,860	25,400
70	296	593	889	1,185	1,482	2,963	5,927	8,890	11,854	14,817	17,780	20,744	23,707	26,670	29,634
80	339	677	1,016	1,355	1,693	3,387	6,773	10,160	13,547	16,934	20,320	23,707	27,094	30,480	33,867
90	381	762	1,143	1,524	1,905	3,810	7,620	11,430	15,240	19,050	22,860	26,670	30,480	34,291	38,101
100	423	847	1,270	1,693	2,117	4,233	8,467	12,700	16,934	21,167	25,400	29,634	33,867	38,101	42,334

Table 126: FFC SPA guillemot in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects (Standard approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	4	8	12	17	21	41	83	124	165	206	248	289	330	372	413
10	41	83	124	165	206	413	826	1,239	1,652	2,065	2,478	2,891	3,304	3,717	4,130
20	83	165	248	330	413	826	1,652	2,478	3,304	4,130	4,956	5,782	6,608	7,434	8,260
30	124	248	372	496	619	1,239	2,478	3,717	4,956	6,195	7,434	8,673	9,912	11,151	12,390
40	165	330	496	661	826	1,652	3,304	4,956	6,608	8,260	9,912	11,564	13,216	14,868	16,520
50	206	413	619	826	1,032	2,065	4,130	6,195	8,260	10,325	12,390	14,455	16,520	18,585	20,650
60	248	496	743	991	1,239	2,478	4,956	7,434	9,912	12,390	14,868	17,346	19,824	22,301	24,779
70	289	578	867	1,156	1,445	2,891	5,782	8,673	11,564	14,455	17,346	20,237	23,127	26,018	28,909
80	330	661	991	1,322	1,652	3,304	6,608	9,912	13,216	16,520	19,824	23,127	26,431	29,735	33,039
90	372	743	1,115	1,487	1,858	3,717	7,434	11,151	14,868	18,585	22,301	26,018	29,735	33,452	37,169
100	413	826	1,239	1,652	2,065	4,130	8,260	12,390	16,520	20,650	24,779	28,909	33,039	37,169	41,299

Table 127: FFC SPA guillemot in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects (Natural England's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	7	13	20	27	33	67	133	200	267	334	400	467	534	601	667
10	67	133	200	267	334	667	1,335	2,002	2,670	3,337	4,005	4,672	5,339	6,007	6,674
20	133	267	400	534	667	1,335	2,670	4,005	5,339	6,674	8,009	9,344	10,679	12,014	13,348
30	200	400	601	801	1,001	2,002	4,005	6,007	8,009	10,011	12,014	14,016	16,018	18,020	20,023
40	267	534	801	1,068	1,335	2,670	5,339	8,009	10,679	13,348	16,018	18,688	21,357	24,027	26,697
50	334	667	1,001	1,335	1,669	3,337	6,674	10,011	13,348	16,686	20,023	23,360	26,697	30,034	33,371
60	400	801	1,201	1,602	2,002	4,005	8,009	12,014	16,018	20,023	24,027	28,032	32,036	36,041	40,045
70	467	934	1,402	1,869	2,336	4,672	9,344	14,016	18,688	23,360	28,032	32,704	37,376	42,047	46,719
80	534	1,068	1,602	2,136	2,670	5,339	10,679	16,018	21,357	26,697	32,036	37,376	42,715	48,054	53,394
90	601	1,201	1,802	2,403	3,003	6,007	12,014	18,020	24,027	30,034	36,041	42,047	48,054	54,061	60,068
100	667	1,335	2,002	2,670	3,337	6,674	13,348	20,023	26,697	33,371	40,045	46,719	53,394	60,068	66,742

6.4 Razorbill

Table 128: FFC SPA in-combination bio-season and total abundance estimates from all Tier 1 & 2 projects.

Project	Migration-free breeding	Post-breeding Migration	Non-migratory Wintering	Return Migration	Annual	Tier
Beatrice	0	28	15	28	72	1a
Blyth Demonstration Site	0	3	2	3	8	1a
Dudgeon	0	12	20	12	44	1a
EOWDC	0	2	0	1	3	1a
Galloper	0	2	3	13	18	1a
Greater Gabbard	0	0	11	3	13	1a
Gunfleet Sands	0	0	1	0	1	1a
Humber Gateway	0	1	0	1	2	1a
Hywind 2 Demonstration	0	24	0		25	1a
Kentish Flats	-	-	-	-	-	1a
Kentish Flats Extension	-	-	-	-	-	1a
Lincs, Lynn & Inner Dowsing	0	1	1	1	3	1a
London Array	0	1	0	1	2	1a
Methil	0	0	0	0	0	1a
Race Bank	0	1	1	1	4	1a
Rampion	0	2	34	113	149	1a
Scroby Sands	-	-	-	-	-	1a
Sheringham Shoal	0	46	6	1	52	1a
Teesside	0	2	0	1	3	1a
Thanet	0	0	0	1	1	1a
Westermost Rough	91	4	4	3	102	1a
East Anglia One	0	1	4	11	17	1b
Hornsea Project One	535	164	41	61	800	1b
Hornsea Project Two	1,210	144	19	57	1,430	1b
Moray East	0	38	1	6	44	1b
Triton Knoll	0	9	23	4	36	1b
Kincardine	0	0	0	0	0	1b
Dogger Bank Creyke Beck A	375	54	47	141	616	1c
Dogger Bank Creyke Beck B	461	71	58	174	765	1c

Project	Migration-free breeding	Post-breeding Migration	Non-migratory Wintering	Return Migration	Annual	Tier
Dogger Bank Teesside A	250	11	26	65	352	1c
East Anglia Three	0	38	41	52	130	1c
Inch Cape	0	98	18	-	115	1c
Moray West	0	121	5	122	247	1c
Neart na Gaoithe	0	187	14	-	200	1c
Seagreen Alpha	0	0	30	-	30	1c
Seagreen Bravo	0	0	34	-	34	1c
Sofia	346	20	39	100	505	1c
Hornsea Three	516	69	99	72	756	1c
Norfolk Boreas	0	9	29	12	49	1c
Norfolk Vanguard	0	30	23	31	84	1c
East Anglia ONE North	0	3	2	7	11	1d
East Anglia TWO	0	2	4	8	13	1c
Hornsea Four Applicant's/Standard Approach	215	146	12	15	388	1d
Hornsea Four NE Approach	386	2,845	12	15	3,259	1d
Total Applicant's/Standard Approach (consented projects only)	**3,999**	**1,339**	**664**	**1,121**	**7,124**	
Total Natural England's Approach (consented projects only)	**4,170**	**4,039**	**664**	**1,121**	**9,994**	
Dudgeon Extension Project	0	124	19	9	153	2
Sheringham Shoal Extension Project	0	22	16	5	43	2
Rampion 2	0	1	1	72	74	2
North Falls	-	-	-	-	-	2
Five Estuaries	-	-	-	-	-	2
Total Applicant's/Standard Approach (All Projects)	**3,999**	**1,486**	**700**	**1,207**	**7,394**	
Total Natural England's Approach (All Projects)	**4,170**	**4,186**	**700**	**1,207**	**10,264**	

Table 129: FFC SPA razorbill in-combination operation and maintenance phase bio-season displacement estimates from all Tier 1 & 2 projects (Applicant's/Standard approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50 Disp; 1% Mort*	*50 Disp; 1% Mort*
Return Migration (Jan-Mar)	H4 plus all consented projects only	1,121	21,140	2,220	5.6	0.25%
	All projects	1,207			6.0	0.27%
	H4 plus all consented projects only	1,121	40,506	4,253	5.6	0.13%
	All projects	1,207			6.0	0.14%
Migration-free breeding (Apr-Jul)	H4 plus all consented projects only	3,999	21,140	2,220	20.0	0.90%
	All projects	3,999			20.0	0.90%
	H4 plus all consented projects only	3,999	40,506	4,253	20.0	0.47%

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50 Disp; 1% Mort*	*50 Disp; 1% Mort*
	All projects	3,999			20.0	0.47%
Post-breeding migration (Aug-Oct)	H4 plus all consented projects only	1,339	21,140	2,220	6.7	0.30%
	All projects	1,486			7.4	0.33%
	H4 plus all consented projects only	1,339	40,506	4,253	6.7	0.16%
	All projects	1,486			7.4	0.17%
Migration-free winter (Nov-Dec)	H4 plus all consented projects only	664	21,140	2,220	3.3	0.15%
	All projects	700			3.5	0.16%

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50 Disp; 1% Mort*	*50 Disp; 1% Mort*
	H4 plus all consented projects only	664	40,506	4,253	3.3	0.08%
	All projects	700			3.5	0.08%
Annual	**H4 plus all consented projects only**	**7,124**	**21,140**	**2,220**	**35.6**	**1.60%**
	All projects	**7,394**			**37.0**	**1.67%**
	H4 plus all consented projects only	**7,124**	**40,506**	**4,253**	**35.6**	**0.84%**
	All projects	**7,394**			**37.0**	**0.87%**

Table 130: FFC SPA razorbill in-combination operation and maintenance phase bio-season displacement estimates from all Tier 1 & 2 projects (Standard approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*
Return migration (Jan-Mar)	H4 plus all consented projects only	1,121	21,140	2,220	3.4-33.6	7.8-78.5	0.15-1.52%	0.35-3.54%
	All projects	1,207			3.6-36.2	8.5-84.5	0.16-1.63%	0.38-3.81%
	H4 plus all consented projects only	1,121	40,506	4,253	3.4-33.6	7.8-78.5	0.08-0.79%	0.18-1.85%
	All projects	1,207			3.6-36.2	8.5-84.5	0.09-0.85%	0.20-1.99%
Migration-free breeding (Apr-Jul)	H4 plus all consented projects only	3,999	21,140	2,220	12.0-120.0	28.0-280.0	0.54-5.41%	1.26-12.61%
	All projects	3,999			12.0-120.0	28.0-280.0	0.54-5.41%	1.26-12.61
	H4 plus all consented projects only	3,999	40,506	4,253	12.0-120.0	28.0-280.0	0.28-2.82%	0.66-6.58%
	All projects	3,999			12.0-120.0	28.0-280.0	0.28-2.82%	0.66-6.58%
Post-breeding migration (Aug-Oct)	H4 plus all consented projects only	1,339	21,140	2,220	4.0-40.2	9.4-93.8	0.18-1.81%	0.42-4.22%
	All projects	1,486			4.5-44.6	10.4-104.0	0.20-2.01%	0.47-4.69%
	H4 plus all consented projects only	1,339	40,506	4,253	4.0-40.2	9.4-93.8	0.18-1.81%	0.22-2.20%
	All projects	1,486			4.5-44.6	10.4-104.0	0.20-2.01%	0.24-2.45%

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*
Migration-free winter (Nov-Dec)	H4 plus all consented projects only	664	21,140	2,220	2.0-19.9	4.6-46.5	0.09-0.90%	0.21-2.09%
	All projects	700			2.1-21.0	4.9-49.0	0.09-0.95%	0.22-2.21%
	H4 plus all consented projects only	664	40,506	4,253	2.0-19.9	4.6-46.5	0.05-0.47%	0.11-1.15%
	All projects	700			2.1-21.0	4.9-49.0	0.05-0.49%	0.12-1.15%
Annual	**H4 plus all consented projects only**	**7,124**	**21,140**	**2,220**	**21.4-213.7**	**49.9-498.7**	**0.96-9.63%**	**2.25-22.47%**
	All projects	**7,394**			**22.2-221.8**	**51.8-517.6**	**1.00-9.99%**	**2.33-23.32%**
	H4 plus all consented projects only	**7,124**	**40,506**	**4,253**	**21.4-213.7**	**49.9-498.7**	**0.50-5.02%**	**1.17-11.72%**
	All projects	**7,394**			**22.2-221.8**	**51.8-517.6**	**0.52-5.22%**	**1.22-12.17%**

Table 131: FFC SPA razorbill in-combination operation and maintenance phase bio-season displacement estimates from all Tier 1 & 2 projects (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults)*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*
Return migration (Jan-mar)	H4 plus all consented projects only	1,121	21,140	2,220	3.4-33.6	7.8-78.5	0.15-1.52%	0.35-3.54%
	All projects	1,207			3.6-36.2	8.5-84.5	0.16-1.63%	0.38-3.81%
	H4 plus all consented projects only	1,121	40,506	4,253	3.4-33.6	7.8-78.5	0.08-0.79%	0.18-1.85%
	All projects	1,207			3.6-36.2	8.5-84.5	0.09-0.85	0.20-1.99%
Migration-free breeding (Apr-Jul)	H4 plus all consented projects only	4,170	21,140	2,220	12.5-125.1	29.2-291.9	0.56-5.64%	1.31-13.15%
	All projects	4,170			12.5-125.1	29.2-291.9	0.56-5.64%	1.31-13.15%
	H4 plus all consented projects only	4,170	40,506	4,253	12.5-125.1	29.2-29.19	0.29-2.94%	0.69-6.86%
	All projects	4,170			12.5-125.1	29.2-291.9	0.29-2.94%	0.69-6.86%
Post-breeding migration (Aug-Oct)	H4 plus all consented projects only	4,039	21,140	2,220	12.1-121.2	28.3-282.7	0.55-5.46%	1.27-12.74%
	All projects	4,186			12.6-125.6	29.3-293.0	0.57-5.66%	1.32-13.20%
	H4 plus all consented projects only	4,039	40,506	4,253	12.1-121.2	28.3-282.7	0.28-2.85%	0.66-6.65%
	All projects	4,186			12.6-125.6	29.3-293.0	0.30-2.95%	0.69-6.89%
Migration-free	H4 plus all consented projects only	664	21,140	2,220	2.0-19.9	4.6-46.5	0.09-0.90%	0.21-2.09%
	All projects	700			2.1-21.0	4.9-49.0	0.09-0.95%	0.22-2.21%

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA Citation and latest colony (2017) population and baseline mortality rate		Estimated number of razorbills subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults)*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*	*30 Disp; 1-10% Mort*	*70 Disp; 1-10% Mort*
winter (Nov-Dec)	H4 plus all consented projects only	664	40,506	4,253	2.0-19.9	4.6-46.5	0.05-0.47%	0.11-1.09%
	All projects	700			2.1-21.0	4.9-49.0	0.05-0.49%	0.12-1.15%
Annual	**H4 plus all consented projects only**	**9,994**	**21,140**	**2,220**	**30.0-299.8**	**70.0-699.6**	**1.35-13.51%**	**3.15-31.52%**
	All projects	**10,264**			**30.8-207.9**	**71.8-718.5**	**1.39-13.87%**	**3.24-32.37%**
	H4 plus all consented projects only	**9,994**	**40,506**	**4,253**	**30.0-299.8**	**70.00-699.6**	**0.70-7.05%**	**1.64-16.45%**
	All projects	**10,264**			**30.8-307.9**	**71.8-718.5**	**0.72-7.24%**	**1.69-16.89%**

Table 132: FFC SPA razorbill in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects (Applicant's/ Standard approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	1	2	3	4	7	15	22	30	37	44	52	59	67	74
10	7	15	22	30	37	74	148	222	296	370	444	518	592	665	739
20	15	30	44	59	74	148	296	444	592	739	887	1,035	1,183	1,331	1,479
30	22	44	67	89	111	222	444	665	887	1,109	1,331	1,553	1,775	1,996	2,218
40	30	59	89	118	148	296	592	887	1,183	1,479	1,775	2,070	2,366	2,662	2,958
50	37	74	111	148	185	370	739	1,109	1,479	1,849	2,218	2,588	2,958	3,327	3,697
60	44	89	133	177	222	444	887	1,331	1,775	2,218	2,662	3,105	3,549	3,993	4,436
70	52	104	155	207	259	518	1,035	1,553	2,070	2,588	3,105	3,623	4,141	4,658	5,176
80	59	118	177	237	296	592	1,183	1,775	2,366	2,958	3,549	4,141	4,732	5,324	5,915
90	67	133	200	266	333	665	1,331	1,996	2,662	3,327	3,993	4,658	5,324	5,989	6,655
100	74	148	222	296	370	739	1,479	2,218	2,958	3,697	4,436	5,176	5,915	6,655	7,394

Table 133: FFC SPA razorbill in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 (Natural England's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	2	3	4	5	10	21	31	41	51	62	72	82	92	103
10	10	21	31	41	51	103	205	308	411	513	616	718	821	924	1,026
20	21	41	62	82	103	205	411	616	821	1,026	1,232	1,437	1,642	1,848	2,053
30	31	62	92	123	154	308	616	924	1,232	1,540	1,848	2,155	2,463	2,771	3,079
40	41	82	123	164	205	411	821	1,232	1,642	2,053	2,463	2,874	3,284	3,695	4,106
50	51	103	154	205	257	513	1,026	1,540	2,053	2,566	3,079	3,592	4,106	4,619	5,132
60	62	123	185	246	308	616	1,232	1,848	2,463	3,079	3,695	4,311	4,927	5,543	6,158
70	72	144	216	287	359	718	1,437	2,155	2,874	3,592	4,311	5,029	5,748	6,466	7,185
80	82	164	246	328	411	821	1,642	2,463	3,284	4,106	4,927	5,748	6,569	7,390	8,211
90	92	185	277	370	462	924	1,848	2,771	3,695	4,619	5,543	6,466	7,390	8,314	9,238
100	103	205	308	411	513	1,026	2,053	3,079	4,106	5,132	6,158	7,185	8,211	9,238	10,264

6.5 Puffin

Table 134: FFC SPA puffin in-combination bio-season and total abundance estimates form all Tier 1 & 2 projects.

Project	Breeding	Non-breeding	Annual	Tier
Beatrice	0	10	10	1a
Blyth Demonstration Site	0	1	1	1a
Dudgeon	0	0	0	1a
EOWDC	0	0	0	1a
Galloper	0	0	0	1a
Greater Gabbard	0	0	0	1a
Gunfleet Sands	-	-	0	1a
Humber Gateway	15	0	15	1a
Hywind 2 Demonstration	0	0	0	1a
Kentish Flats	-	-	0	1a
Kentish Flats Extension	0	0	0	1a
Lincs, Lynn and Inner Dowsing	0	0	0	1a
London Array	0	0	0	1a
Methil	0	0	0	1a
Race Bank	0	0	0	1a
Rampion	0	0	0	1a
Scroby Sands	-	-	0	1a
Sheringham Shoal	0	0	0	1a
Teesside	35	0	35	1a
Thanet	0	0	0	1a
Westermost Rough	61	0	61	1a
East Anglia One	0	0	0	1b
Hornsea Project One	407	5	412	1b
Hornsea Project Two	178	8	186	1b
Moray East	0	3	3	1b
Triton Knoll	23	0	23	1b
Kincardine	0	0	0	1b
Dogger Bank Creyke Beck A	11	1	12	1c
Dogger Bank Creyke Beck B	31	3	34	1c
Dogger Bank Teesside A	10	1	11	1c
East Anglia Three	0	1	1	1c
Inch Cape	0	11	11	1c
Moray West	0	16	16	1c
Neart na Gaoithe	0	9	9	1c
Seagreen Alpha	0	6	6	1c

Seagreen Bravo	0	16	16	1c
Sofia	11	1	12	1c
Hornsea Three Applicant's approach	20	1	21	1c
Hornsea Three NE's approach	127	0	127	1c
Norfolk Boreas	0	1	1	1c
Norfolk Vanguard	0	0	0	1c
East Anglia One North	-	-	0	1c
East Anglia Two	0	0	0	1c
Hornsea Four Applicant's Approach	181	2	183	1d
Hornsea Four NE Approach	203	2	205	1d
Total Applicant's Approach (consented projects only)	**1,109**	**98**	**1,207**	
Total Natural England's Approach (consented projects only)	**1,131**	**98**	**1,229**	
Dudgeon Extension Project	0	0	0	2
Sheringham Shoal Extension Project	0	0	0	2
Rampion 2	0	0	0	2
North Falls	-	-	-	2
Five Estuaries	-	-	-	2
Total Applicant's Approach (All Projects)	**1,109**	**98**	**1,207**	
Total Natural England's Approach (All Projects)	**1,131**	**98**	**1,229**	

Table 135: FFC SPA puffin in-combination operation and maintenance phase bio-season displacement estimates all from Tier 1 & 2 projects (Applicant's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA latest colony (2017/2018) population and baseline mortality rate		Estimated number of puffins subject to mortality (breeding adults per annum)	Increase in baseline mortality (%)
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*50% Disp; 1% Mort*	*50% Disp; 1% Mort*
Breeding (Apr-Jul)	H4 plus all consented projects only	1,109	3,579	336	5.5	1.65%
	All projects	1,109			5.5	1.65%
Non-breeding (Aug-Mar)	H4 plus all consented projects only	98	3,579	336	0.5	0.15%
	All projects	98			0.5	0.15%
Annual	H4 plus all consented projects only	1,207	3,579	336	6.0	1.79%
	All projects	1,207			6.0	1.79%

Table 136: FFC SPA puffin in-combination operation and maintenance phase bio-season displacement estimates all from Tier 1 & 2 projects (Natural England's approach).

Bio-season (months)	Projects included within seasonal totals	Seasonal abundance (array area & 2 km buffer)	FFC SPA latest colony (2017/2018) population and baseline mortality rate		Estimated number of puffins subject to mortality (breeding adults per annum)		Increase in baseline mortality (%)	
			Population (breeding adults)	*Baseline mortality (breeding adults per annum)*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*	*30% Disp; 1-10% Mort*	*70% Disp; 1-10% Mort*
Breeding (Apr-Jul)	H4 plus all consented projects only	1,131	3,579	336	3.4-33.9	7.9-79.1	1.0-10.1%	2.4-23.5%
	All projects	1,131			3.4-33.9	7.9-79.1	1.0-10.1%	2.4-23.5%
Non-breeding (Aug-Mar)	H4 plus all consented projects only	98	3,579	336	0.3-2.9	0.7-6.9	0.1-0.9%	0.2-2.0%
	All projects	98			0.3-3.0	0.7-6.9	0.1-0.9%	0.2-2.0%
Annual	H4 plus all consented projects only	1,229	3,579	336	3.7-36.9	8.6-86.0	1.1-11.0%	2.6-25.6%
	All projects	1,229			3.7-36.9	8.6-86.0	1.1-11.0%	2.6-25.6%

Table 137: FFC SPA puffin in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 projects (Applicant's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	1	1	2	4	5	6	7	8	10	11	12
10	1	2	4	5	6	12	24	36	48	60	72	85	97	109	121
20	2	5	7	10	12	24	48	72	97	121	145	169	193	217	241
30	4	7	11	14	18	36	72	109	145	181	217	254	290	326	362
40	5	10	14	19	24	48	97	145	193	241	290	338	386	435	483
50	6	12	18	24	30	60	121	181	241	302	362	423	483	543	604
60	7	14	22	29	36	72	145	217	290	362	435	507	579	652	724
70	8	17	25	34	42	85	169	254	338	423	507	592	676	761	845
80	10	19	29	39	48	97	193	290	386	483	579	676	773	869	966
90	11	22	33	43	54	109	217	326	435	543	652	761	869	978	1,086
100	12	24	36	48	60	121	241	362	483	604	724	845	966	1,086	1,207

Table 138: FFC SPA puffin in-combination operation and maintenance phase annual displacement matrix for all Tier 1 & 2 (Natural England's approach).

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	1	1	2	4	5	6	7	9	10	11	12
10	1	2	4	5	6	12	25	37	49	61	74	86	98	111	123
20	2	5	7	10	12	25	49	74	98	123	147	172	197	221	246
30	4	7	11	15	18	37	74	111	147	184	221	258	295	332	369
40	5	10	15	20	25	49	98	147	197	246	295	344	393	442	492
50	6	12	18	25	31	61	123	184	246	307	369	430	492	553	614
60	7	15	22	29	37	74	147	221	295	369	442	516	590	664	737
70	9	17	26	34	43	86	172	258	344	430	516	602	688	774	860
80	10	20	29	39	49	98	197	295	393	492	590	688	787	885	983
90	11	22	33	44	55	111	221	332	442	553	664	774	885	995	1,106
100	12	25	37	49	61	123	246	369	492	614	737	860	983	1,106	1,229

7 References

Cleasby IR, Owen E, Wilson LJ, Bolton M (2018) Combining habitat modelling and hotspot analysis to reveal the location of high density seabird areas across the UK: Technical Report. RSPB Research Report no. 63. RSPB Centre for Conservation Science, RSPB, The Lodge, Sandy, Bedfordshire, SG19 2DL.

Donovan, C. (2018) Stochastic Band CRM – GUI User Manual, Draft V1.0, 31/03/2017.

Dunn, R.E., Wanless, S., Daunt, F., Harris, M.P. and Green, J.A., (2020). A year in the life of a North Atlantic seabird: behavioural and energetic adjustments during the annual cycle. Scientific reports, 10(1), pp.1-11.

Furness, R.W. (2015) Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

Langston, R.H.W., Teuten, E. & Butler, A. (2013). Foraging ranges of northern gannets Morus bassanus in relation to proposed offshore wind farms in the North Sea: 2010-2012. RSPB Report to DECC. RSPB, Sandy.

Marine Scotland (2017). Marine Scotland Licensing Operations Team: Scoping Opinion for Seagreen Phase 1 Offshore Project. Available: http://marine.gov.scot/sites/default/files/00524860_1.pdf

Scott-Hayward et al. (2017) Vignette for the MRSea Package v1.3: Statistical Modelling of bird and cetacean distributions in offshore renewables development areas. Centre for Research into Ecological and Environmental Modelling, University of St Andrews

SNH. (2018). Interim Guidance on Apportioning Impacts from Marine Renewable Developments to Breeding Seabird Populations in Special Protection Areas. [Version: Updated November 2018]. SNH, Inverness.

Statutory Nature Conservation Bodies (2022). Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments.

Appendix A Collision Risk Input Parameters

Table 139: Input parameters for the collision risk scenarios modelled (Applicant's Approach).

Species	Scenario	Nocturnal Activity	Basic Avoidance Rate (BO3)	Extended Avoidance Rate (BO3)	Flight Height Data	Density Data
Gannet	Scenario 1 (mean/central)	0	0.989	N/A	Maximum Likelihood	Central
	Scenario 2 (minimum)	0	0.991	N/A	Maximum Likelihood	Central - SD
	Scenario 3 (maximum	25	0.987	N/A	Maximum Likelihood	Central + SD
	Scenario 4 (mean/ central incl. macro avoidance)	0	0.989	N/A	Maximum Likelihood	Central - 70%
	Scenario 5 (mean/ central incl. macro avoidance)	0	0.989	N/A	Maximum Likelihood	Central - 60%
	Scenario 6 (mean/ central incl. macro avoidance)	0	0.989	N/A	Maximum Likelihood	Central - 65%
	Scenario 7 (mean/ central incl. macro avoidance)	0	0.989	N/A	Maximum Likelihood	Central - 75%
	Scenario 8 (mean/central incl. macro avoidance)	0	0.989	N/A	Maximum Likelihood	Central - 80%
Kittiwake	Scenario 1 (mean/central)	25	0.989	N/A	Maximum Likelihood	Central
	Scenario 2 (minimum)	25	0.991	N/A	Maximum Likelihood	Central - SD
	Scenario 3 (maximum	50	0.987	N/A	Maximum Likelihood	Central + SD
Great black-backed gull	Scenario 1 (mean/central)	25	0.995	0.989	Maximum Likelihood	Central
	Scenario 2 (minimum)	25	0.994	0.991	Maximum Likelihood	Central - SD
	Scenario 3 (maximum	50	0.996	0.987	Maximum Likelihood	Central + SD

Table 140: Input parameters for the collision risk scenarios modelled (Natural England's Approach).

Species	Scenario	Nocturnal Activity	Basic Avoidance Rate (BO3)	Extended Avoidance Rate (BO3)	Flight Height Data	Density Data
Gannet	Scenario 1 (mean/central)	25	0.989	N/A	Maximum Likelihood	Central
	Scenario 2 (minimum)	25	0.991	N/A	95% Lower CI	Central - SD
	Scenario 3 (maximum	25	0.987	N/A	95% Upper CI	Central + SD
	Scenario 4 (mean/ central incl. macro avoidance)	25	0.989	N/A	Maximum Likelihood	Central - 70%
	Scenario 5 (mean/ central incl. macro avoidance)	25	0.989	N/A	Maximum Likelihood	Central - 60%
	Scenario 6 (mean/ central incl. macro avoidance)	25	0.989	N/A	Maximum Likelihood	Central - 65%
	Scenario 7 (mean/ central incl. macro avoidance)	25	0.989	N/A	Maximum Likelihood	Central - 75%
	Scenario 8 (mean/central incl. macro avoidance)	25	0.989	N/A	Maximum Likelihood	Central - 80%
Kittiwake	Scenario 1 (mean/central)	50	0.989	N/A	Maximum Likelihood	Central
	Scenario 2 (minimum)	25	0.991	N/A	95% Lower CI	Central - SD
	Scenario 3 (maximum	50	0.987	N/A	95% Upper CI	Central + SD
Great black-backed gull	Scenario 1 (mean/central)	50	0.995	0.989	Maximum Likelihood	Central
	Scenario 2 (minimum)	25	0.994	0.991	95% Lower CI	Central - SD
	Scenario 3 (maximum	50	0.996	0.987	95% Upper CI	Central + SD

Appendix B Monthly Densities of birds in flight

Table 141 Gannet densities (birds per km^2).

Month	Mean Density (Birds/km^2)	Minimum Density (mean – SD; Birds/km^2)	Maximum Density (mean + SD; Birds/km^2)
Jan	0.03	0.00	1.91
Feb	0.03	0.00	0.06
Mar	0.18	0.13	0.23
Apr	0.06	0.04	0.09
May	0.10	0.00	0.26
Jun	0.45	0.38	0.53
Jul	0.45	0.34	0.56
Aug	0.39	0.31	0.48
Sep	0.16	0.12	0.19
Oct	0.17	0.13	0.20
Nov	0.64	0.52	0.76
Dec	0.16	0.11	0.20

Table 142 Kittiwake densities (birds per km^2).

Month	Mean Density (Birds/km^2)	Minimum Density (mean – SD; Birds/km^2)	Maximum Density (mean + SD; Birds/km^2)
Jan	0.29	0.21	0.38
Feb	0.31	0.21	0.41
Mar	0.38	0.32	0.43
Apr	0.94	0.41	1.47
May	1.64	1.04	2.24
Jun	1.67	1.35	2.00
Jul	0.77	0.63	0.91
Aug	2.56	1.76	3.35
Sep	0.30	0.00	0.62
Oct	0.13	0.10	0.16
Nov	0.38	0.28	0.48
Dec	0.96	0.41	1.50

Table 143 Great black-backed gull densities (birds per km^2).

Month	Mean Density (Birds/km^2)	Minimum Density (mean – SD; Birds/km^2)	Maximum Density (mean + SD; Birds/km^2)
Jan	0.13	0.00	0.58
Feb	0.02	0.02	0.02
Mar	0.04	0.04	0.04
Apr	0.00	0.00	0.00
May	0.01	0.01	0.01
Jun	0.02	0.02	0.02
Jul	0.00	0.00	0.00
Aug	0.00	0.00	0.00
Sep	0.00	0.00	0.00
Oct	0.01	0.01	0.01
Nov	0.10	0.10	0.10
Dec	0.12	0.01	0.20

Appendix C Applicant's Approach Predicted Monthly Collision Risk Modelling Results

Table 144: Monthly predicted collision rates for gannet (Applicant's approach).

	Band Option 2							
Month	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8
Jan	0.10	0.00	13.30	0.03	0.04	0.03	0.02	0.02
Feb	0.14	0.01	0.45	0.04	0.06	0.05	0.04	0.03
Mar	1.03	0.59	2.01	0.31	0.4	0.36	0.26	0.21
Apr	0.41	0.21	0.79	0.1	0.17	0.14	0.10	0.08
May	0.74	0.00	2.66	0.22	0.29	0.26	0.18	0.15
Jun	3.55	2.41	5.43	1.06	1.42	1.24	0.89	0.71
Jul	3.52	2.15	5.82	1.06	1.41	1.23	0.88	0.70
Aug	2.79	1.76	4.70	0.84	1.12	0.98	0.70	0.56
Sep	0.93	0.57	1.70	0.28	0.37	0.33	0.23	0.19
Oct	0.87	0.54	1.67	0.26	0.35	0.30	0.22	0.17
Nov	2.61	1.72	5.37	0.78	1.05	0.92	0.65	0.52
Dec	0.57	0.32	1.37	0.17	0.23	0.20	0.14	0.11
Annual	**17.26**	**10.28**	**45.26**	**5.18**	**6.90**	**6.04**	**4.31**	**3.45**

Table 145: Monthly predicted collision rates for kittiwake (Applicant's approach).

	Band Option 2		
Month	Scenario 1	Scenario 2	Scenario 3
Jan	1.71	0.99	3.49
Feb	1.81	1.00	3.59
Mar	2.72	1.87	4.51
Apr	7.26	2.55	15.58
May	14.20	7.31	25.67
Jun	14.49	9.49	22.48
Jul	6.75	4.52	10.40
Aug	20.99	11.73	37.11
Sep	2.16	0.00	6.33
Oct	0.89	0.55	1.63
Nov	2.24	1.35	4.38
Dec	5.42	1.91	13.71
Annual	**80.62**	**43.26**	**148.88**

Table 146 Monthly predicted collision rates for great black-backed gull (Applicant's approach).

Band Option 2			
Month	Scenario 1	Scenario 2	Scenario 3
Jan	2.07	0.00	15.29
Feb	0.36	0.28	0.54
Mar	0.86	0.68	1.26
Apr	0.00	0.00	0.00
May	0.26	0.20	0.35
Jun	0.46	0.37	0.61
Jul	0.00	0.00	0.00
Aug	0.00	0.00	0.00
Sep	0.00	0.00	0.00
Oct	0.21	0.16	0.30
Nov	1.57	1.24	2.49
Dec	1.65	0.10	5.23
Annual	**7.44**	**3.03**	**26.07**
Band Option 3			
Month	Scenario 1	Scenario 2	Scenario 3
Jan	1.22	0.00	9.00
Feb	0.21	0.17	0.32
Mar	0.51	0.41	0.74
Apr	0.00	0.00	0.00
May	0.16	0.12	0.20
Jun	0.27	0.22	0.36
Jul	0.00	0.00	0.00
Aug	0.00	0.00	0.00
Sep	0.00	0.00	0.00
Oct	0.12	0.10	0.18
Nov	0.93	0.74	1.47
Dec	0.97	0.06	3.08
Annual	**4.40**	**1.81**	**15.35**

Appendix D Natural England's Approach Predicted Monthly Collision Risk Modelling Results

Table 147: Monthly predicted collision rates for gannet (Natural England's approach).

	Band Option 2							
Month	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8
Jan	0.16	0.00	36.59	0.05	0.06	0.05	0.04	0.03
Feb	0.21	0.00	1.25	0.06	0.08	0.07	0.05	0.04
Mar	1.39	0.19	5.53	0.42	0.55	0.49	0.35	0.28
Apr	0.52	0.07	2.18	0.16	0.21	0.18	0.13	0.10
May	0.88	0.00	7.31	0.26	0.35	0.31	0.22	0.18
Jun	4.16	0.69	14.92	1.25	1.67	1.46	1.04	0.83
Jul	4.16	0.62	16.01	1.25	1.67	1.46	1.04	0.83
Aug	3.43	0.53	12.94	1.03	1.37	1.20	0.86	0.69
Sep	1.21	0.18	4.67	0.36	0.48	0.42	0.30	0.24
Oct	1.21	0.19	4.59	0.36	0.49	0.42	0.30	0.24
Nov	4.03	0.65	14.77	1.21	1.61	1.41	1.01	0.81
Dec	0.94	0.129	3.76	0.28	0.37	0.33	0.23	0.19
Annual	**22.29**	**3.25**	**124.51**	**6.69**	**8.92**	**7.80**	**5.57**	**4.46**

Table 148 Monthly predicted collision rates for kittiwake (Natural England's approach).

	Band Option 2		
Month	Scenario 1	Scenario 2	Scenario 3
Jan	2.28	0.60	4.81
Feb	2.29	0.60	4.95
Mar	3.28	1.13	6.23
Apr	8.36	1.54	21.49
May	15.79	4.41	35.40
Jun	15.83	5.73	31.01
Jul	7.43	2.73	14.34
Aug	23.77	7.08	51.18
Sep	2.55	0.00	8.73
Oct	1.10	0.33	2.24
Nov	2.93	0.81	6.04
Dec	7.35	1.15	18.90
Annual	**92.95**	**26.12**	**205.33**

Table 149 Monthly predicted collision rates for great black-backed gull (Natural England's approach).

Band Option 2			
Month	**Scenario 1**	**Scenario 2**	**Scenario 3**
Jan	2.76	0.00	29.43
Feb	0.45	0.21	1.05
Mar	1.04	0.51	2.42
Apr	0.00	0.00	0.00
May	0.29	0.15	0.67
Jun	0.50	0.28	1.18
Jul	0.00	0.00	0.00
Aug	0.00	0.00	0.00
Sep	0.00	0.00	0.00
Oct	0.26	0.12	0.59
Nov	2.05	0.93	4.80
Dec	2.24	0.08	10.07
Annual	**9.59**	**2.27**	**50.19**
Band Option 3			
Month	**Scenario 1**	**Scenario 2**	**Scenario 3**
Jan	1.63	0.00	26.52
Feb	0.27	0.11	0.94
Mar	0.62	0.27	2.18
Apr	0.00	0.00	0.00
May	0.17	0.08	0.60
Jun	0.29	0.15	1.07
Jul	0.00	0.00	0.00
Aug	0.00	0.00	0.00
Sep	0.00	0.00	0.00
Oct	0.15	0.06	0.53
Nov	1.21	0.50	4.32
Dec	1.32	0.04	9.07
Annual	**5.67**	**1.21**	**45.23**