Offshore Wind

RWE Renewables UK Dogger Bank South (West) Limited

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Dogger Bank South Offshore Wind Farms

Precaution in the Ornithology Assessment and Implications for Compensation Quantum

Document Date:	March 2025
Application Reference:	13.5
Revision Number:	01
Classification:	Unrestricted

Company:	**RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited**	Asset:	**Development**
Project:	**Dogger Bank South Offshore Wind Farms**	Sub Project/Package	**Consents**
Document Title or Description:	Precaution in the Ornithology Assessment and Implications for Compensation Quantum		
Document Number:	005648313-01	Contractor Reference Number:	PC2340-RHD-OF-ZZ-RP-Z-0203

Rev No.	Date	Status/Reason for Issue	Author	Checked by	Approved by
01	March 2025	Submission for Deadline 3	RHDHV	RWE	RWE

Contents

Tables

Glossary

Term	Definition
Array Areas	The DBS East and DBS West offshore Array Areas, where the wind turbines, offshore platforms and array cables would be located. The Array Areas do not include the Offshore Export Cable Corridor or the Inter-Platform Cable Corridor within which no wind turbines are proposed. Each area is referred to separately as an Array Area.
Collision Risk Model (CRM)	Quantitative means to estimate the number of predicted collisions between seabirds recorded in the Array Areas and rotating wind turbines.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
Environmental Statement (ES)	A document reporting the findings of the EIA and produced in accordance with the EIA Directive as transposed into UK law by the EIA Regulations.
Habitats Regulations	Conservation of Habitats and Species Regulations 2017 and Conservation of Offshore Marine Habitats and Species Regulations 2017.
Habitats Regulations Assessment (HRA)	The process that determines whether or not a plan or project may have an adverse effect on the integrity of a European Site or European Offshore Marine Site.
Offshore Development Area	The Offshore Development Area for ES encompasses both the DBS East and West Array Areas, the Inter-Platform Cable Corridor, the Offshore Export Cable Corridor, plus the associated Construction Buffer Zones.
Offshore Export Cable Corridor	This is the area which will contain the offshore export cables between the Offshore Converter Platforms and Transition Joint Bays at the landfall.
Special Protection Area (SPA)	Strictly protected sites designated pursuant to Article 4 of the Birds Directive (via the Habitats Regulations) for species listed on Annex I of the Directive and for regularly occurring migratory species

Term	Definition
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).

Acronyms

Acronym	Definition
ANS	Artificial Nesting Structure
BDMPS	Biologically Defined Minimum Population Scales
BTO	British Trust for Ornithology
CI	Confidence Interval
CRM	Collision Risk Modelling
DBS	Dogger Bank South
EIA	Environmental Impact Assessment
ES	Environmental Statement
FFC	Flamborough and Filey Coast
GRCP	Guillemot and Razorbill Compensation Plan
HRA	Habitats Regulations Assessment
KCP	Kittiwake Compensation Plan
RIAA	Report to Inform Appropriate Assessment
SPA	Special Protection Area
UCI	Upper Confidence Intervals

1 Precaution in the Ornithology Assessment and Implications for Compensation Quantum

1.1 Introduction

1. Within the ExQ1 on **Offshore and intertidal ornithology and relevant Habitats Regulations Assessment (HRA)** [PD-016] several of the questions relate to aspects of the assessment, such as rates of displacement, mortality, apportionment, and whether mean values or confidence intervals around the means are the more appropriate representative outputs from the impact assessment and how these relate to the methodologies and ratios then applied for any required compensation.

2. The Applicants acknowledge that within aspects of the ornithology assessment and implementation of compensation there can be a great deal of uncertainty. However, it is clear that precaution applied at multiple levels throughout the process leads to inflated levels of impact and disproportionate requirements for compensation.

3. Given that this is a complex topic and there are varied opinions and a great deal of room for misunderstanding or misinterpretation, this document aims to provide a step-by-step breakdown of what each of the above parameters refers to and how changes in them can materially affect the assessment and the resultant quantum of compensation.

4. This document is focused upon the HRA aspects and includes apportionment to Special Protection Area (SPA) populations which is not relevant to Environmental Impact Assessment (EIA).

1.2 Determining the scale of compensation

5. Determining the scale of compensation requires a stepwise approach as outlined in the **Round 4 Kittiwake Strategic Compensation Plan** [APP-053] these steps are:

- Step 1 - calculate the project level impact;
- Step 2 - determine the size of compensation population required; and
- Step 3 - application of a precautionary compensation ratio to account for uncertainties.

6. **Step 1** is undertaken in the **Report to Inform Appropriate Assessment (RIAA) HRA Part 4 of 4 – Marine Ornithological Features (Revision 3)** [AS-085]. The methodology for Step 2 was discussed (for kittiwake) as part of The Crown Estate's Strategic Compensation process (see Section 8 of the **Round 4 Kittiwake Strategic Compensation Plan** [APP-053] and presented in each of the species specific compensation plans (**Project Level Kittiwake Compensation Plan (Revision 4)** [REP2-010] and **Guillemot [and Razorbill] Compensation Plan** [AS-089]). Section 1.3.1 and Section 1.4.1 discuss the assessments of and elements of precaution within the displacement and collision risk assessments respectively.

7. In simple terms, and with respect to measures that seek to deliver seabird compensation through increased or enhanced productivity, **Step 2** provides an estimate of how many breeding pairs are required to produce enough fledglings to replace the adults lost from the population as a result of a given project's predicted impacts (Step 1). The approach should be the same for any species, the only species-specific information being the demographic information for each species (i.e. productivity (number of chicks produced) and their survival rates) which are fed into the method. These demographic data are obtained from accepted literature.

8. There is no standardised methodology for **Step 2**. As stated in the Section 8.2 of the **Round 4 Kittiwake Strategic Compensation Plan** [APP-053]:

"Compensation in respect of the mortality risk to seabirds as a result of offshore wind farm impacts is still in its relative infancy when compared to port developments or other similar projects requiring derogation. The current lack of developed and functioning compensatory measures for seabirds, in particular kittiwake, creates a level of uncertainty surrounding the suitable scale of compensation. As more offshore wind projects and associated compensation proposals are consented, the amount of evidence to support decision making will increase via detailed monitoring procedures stipulated for each project within the DCOs."

9. The Applicants proposed the methods presented in the species-specific compensation plans ([REP2-010] and [AS-089]) based upon a review of existing methods which had been applied for consented projects, and analysis of their merits and flaws. The Applicants' preferred methods are those presented for the Hornsea 4 project for both kittiwake, and guillemot and razorbill.

10. The Applicants consider the Hornsea 3 method to be unsuitable for a number of reasons (stated in ([REP2-010]) namely, that it is unnecessarily complicated, and includes double-counting of the effects of mortality and thus overestimates the compensation quantum. In addition, the full method is not publicly available in a format that allows it to be readily replicated or quality assured. Natural England have acknowledged this in **Appendix H2 - Natural England's Advice on Offshore Ornithology Compensation Deadline 2** [As-160], stating that '*identifying a robust and proportionate approach to quantifying the compensation requirements for offshore windfarms impacting seabird SPAs has proved challenging. Multiple methods have been used but there is no clear consensus on the most appropriate method to use*'. As a result, Natural England has commissioned the British Trust for Ornithology (BTO) to carry out a review of existing approaches to compensation calculations regarding the most appropriate method to use for black legged kittiwake and potentially other relevant seabird species. A definite publication date is not provided by Natural England, however assuming the BTO review is published in a timely manner, prior to the end of the Examination, the Applicants will review the methodology and apply it to their data, amending the relevant documents as required.

11. **Step 3** is intended to account for uncertainty (in the impact assessment and compensation calculations, and ability of the measure to deliver) and is scaled accordingly to ensure that the compensation delivery is adequate.

12. Section 1.3.2 and section 1.4.2 discuss the elements of precaution within **Step 2** and **Step 3**.

13. This document is accompanied by a spreadsheet (**Appendix A**) which is provided so that all parties can follow the calculations through themselves if required and confirm the derivation of the values presented in the tables hereafter. This includes all three species for which the Applicants have developed project level compensation plans: kittiwake, guillemot and razorbill (without prejudice).

1.3 Displacement

14. Displacement relates to the activities of the Projects during construction, operation and decommissioning that disturb birds from the Offshore Development Area. There are a number of different measures used to assess bird disturbance and displacement from areas of sea in response to activities associated with an offshore windfarm. Garthe and Hüppop (2004) developed a scoring system for such disturbance factors which they applied to seabird species in German sectors of the North Sea. This was refined by Furness and Wade (2012) and Furness *et al.* (2013) with a focus on seabirds using Scottish offshore waters. These measures were used to screen in species to the assessment, with the species screened in for the Projects including guillemot and razorbill.

15. For displacement the Applicants will use the example of guillemot and the Flamborough and Filey Coast (FFC) SPA and the project-alone impacts of Dogger Bank South (DBS) East and DBS West (hereafter referred to as the 'Projects') together. The methodology for razorbill is largely identical as for guillemot therefore the considerations are the same for both species.

1.3.1 Impact assessment

1.3.1.1 Number of birds at risk of displacement

1.3.1.1.1 Abundance

16. A worst case assumption has been made that birds will be at risk of displacement from the complete extent of the Array Areas plus species specific buffers (2km in the case of guillemot). This will over-estimate impacts since it is highly unlikely that the entire area within the Array Areas will contain wind turbines, and even if it did then the inter-turbine separation distance would be such that birds would be very likely to use areas between wind turbines.

17. This is the first assumption in the assessment that embeds precaution and is not contested by the Applicants.

18. The abundance estimate for the number of birds within the Array Areas and buffer is presented on a seasonal basis based upon the site-specific survey results presented in **Technical Appendix 12-5a-c - Seasonal Peak Abundance (All, Sitting, Flying)** [AS-060]. For the assessment, the Applicant considers that the use of the mean peak abundance in each season is appropriate, and this is historically how assessments have been presented. Natural England requested additional matrices using the upper and lower 95% confidence intervals. These have been provided **in Appendix 12-12 Seasonal Displacement Matrices Upper Lower C.I. Abundance** [APP-115]. For displacement, the mortality is presented in the form of a matrix showing the displacement rate and mortality rates (with each between 0 – 100%), with 100 cells, if this was presented with the upper and lower Confidence Intervals (CIs) there would be 300 mortalities presented in a single matrix. This would be impossible to navigate, hence the upper and lower values are presented separately.

19. In **Appendix H2 - Natural England's Advice on Offshore Ornithology Compensation Deadline 2** [As-160] they state:

"We also highlight that in contrast to the KCP [Kittiwake Compensation Plan], predicted impacts and compensation quantum in the GRCP [Guillemot and Razorbill Plan] have only been provided for the central impact estimates. The upper Confidence Intervals have not been presented, and it is therefore unclear whether these sites would still have capacity were the upper Confidence Interval values to be considered."

20. Presentation of the mean is considered by the Applicants to be appropriate to use as it is, by definition, the most likely value for bird abundance between the upper and lower confidence intervals. Furthermore, the upper 95% confidence interval is no more appropriate than the lower 95% confidence interval – both represent the ends of the probability distribution and the likelihood that the 'true' mean value is as high (or as low) as these is only 2.5%.

21. Use of the mean or upper 95% confidence interval can create considerable difference in the primary input into the assessment. This is the difference between a starting point of **62,730 birds** (using upper 95% CI, see **Appendix A**) to **32,562 birds** (using the mean) at risk.

1.3.1.1.2 Apportionment

22. Once the number of adult birds at risk is established, for HRA purposes these birds are then apportioned to the relevant SPA(s). This is based on connectivity from the SPA to the Projects and relates to the foraging range, coastal position and relative population sizes of the species during the different biological seasons of the year.

23. For guillemot, three seasons have been assumed, breeding, post-breeding and non-breeding.

1.3.1.1.2.1 Breeding season

24. The Applicants consider that a large proportion of the birds on the wind farm will not be breeding birds from FFC SPA, since the Projects are over 100km from the SPA (although within mean maximum plus 1 S.D. of 153km, the mean range which is a more representative figure is 33km; Woodward *et al.* 2019). Furthermore, guillemot do not begin breeding until they 6 years old, meaning that sub-adult birds will be present in the North Sea and likely foraging in areas with lower colony attendance (i.e. those areas further away from colonies) such as where the Projects are located. It is quite likely that in the breeding season, these sub-adult, nonbreeding individuals form the majority of those recorded in locations away from breeding colonies. However, as it is not possible to reliably age guillemots from digital aerial imagery (their plumage is not sufficiently distinct from adults) and the presence of adult birds cannot be ruled out, the Applicants consider that the proportions of each age class in the population obtained from demographic studies provides a reasonable and precautionary estimate of the proportion of individuals likely to be adults (55.2%, Furness 2015).

25. However, due to the limited direct evidence from the surveys to inform this estimate, Natural England advocates a much more precautionary approach of assuming 100% of the birds recorded in the surveys in the breeding season months are adults breeding at the FFC SPA.

1.3.1.1.2.2 Post-breeding season

26. The Applicants consider that Natural England's advised FFC SPA proportions of auks from FFC SPA are also very likely to be on the high side (~70%) but acknowledge that Natural England has presented the rationale for their estimation. However, the Applicants consider that Natural England's guidance on post-breeding auk movements from which these rates were derived (see **Natural England's Relevant Representation Annex G** [RR-039]) does not make sufficient allowance for the year round presence of immature auks in the southern North Sea, the presence of which is evidenced in ring recovery data (Wernham *et al.*, 2002). Thus, just as the breeding season proportion (100% FFC SPA adults) fails to allow for immature birds, so does the post-breeding one.

27. Whilst the Applicants accept there is likely some precaution within the apportionment of the post-breeding adults, the percentage used here is not disputed.

1.3.1.1.2.3 Non-breeding season

28. The Applicants consider the non-breeding season auk FFC SPA proportions, calculated as the SPA's proportion of the North Sea Biologically Defined Minimum Population Scales (BDMPS) populations, to be reasonable and appropriate and was calculated using Furness (2015). This apportionment (4.4%) is not disputed.

1.3.1.1.2.4 Summary of abundance and apportioning

29. The choice of mean or upper 95% CI determines the key input into the assessment from which birds are then apportioned. Apportionment of adults in the breeding season is the largest contributor to differences in outcome for this part of the assessment.

30. **Table 1-1** illustrates how the differences of approach for just this part of the assessment can result in great variation in the numbers taken forward. The upper 95% CI doubles the number of birds at risk, from the mean which already incorporates some measure of precaution.

Table 1-1 Birds at risk of displacement dependent on abundance estimate and breeding season (the Applicants accepted values presented in the RIAA [AS-085] are in bold)

Abundance estimate	Breeding Season % Adults	Annual Apportionment to FFC SPA (individuals)	% of FFC SPA Population
Mean	55.2	24,581	16.4
	100	**32,562**	**21.7**
Upper 95% CI	55.2	50,703	33.8
	100	62,730	41.8

31. The Applicants acknowledge the use of the values presented in bold in **Table 1-1** as the worst case for the assessment (i.e. 100% adults in the breeding season and using the mean), noting that this incorporates the precaution described above. It is worth noting that based on the most recent estimate of 149,978 breeding adults at the FFC SPA, the Projects would, in this case, suggest that approximately 22% of that population is present at the Array Areas during the breeding season. This seems unrealistic given the size of the Array Areas and buffer, approximately 2-3%, in relation to the wider area available for foraging.

1.3.1.2 Displacement and mortality

32. Once the number of birds at risk of displacement is estimated, the ecological consequence is considered through applying rates for displacement and mortality.

33. There is limited consistent evidence that seabirds are displaced or suffer from consequent mortality, therefore a range of displacement and mortality rates are provided within a matrix covering a wide range of combinations of these rates as per standard practice. This allows any potential impact values to be considered.

34. The Applicants maintain that suitably precautionary rates for auks of 50% displacement and 1% mortality are appropriate. These values were derived from a review of studies conducted by Professor Bob Furness on behalf of the Norfolk Vanguard application[1].

35. This review recommended a 50% displacement rate within the wind farm, 30% in a 1km buffer and 1% mortality rate, but importantly still considered these to be precautionary. The Applicants consider that there has been no robust evidence presented since to suggest that these rates (i.e. 50% displacement and 1% mortality) are not precautionary, and indeed some studies have found no compelling evidence that auks respond negatively to turbines in the breeding season (Trinder et al., 2024).

36. To illustrate the effect this can have **Table 1-2** takes the birds at risk of displacement from Table 1-1 and applies the Applicants preferred displacement and mortality rates against those suggested by Natural England (noting that the most relevant recently consented project, Hornsea 4, was consented on the basis of 70% / 2%).

[1] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-002249-Womble%20Bond%20Dickinson%20on%20Behalf%20of%20Norfolk%20Vanguard%20-%20Appendices%20to%20written%20Questions-%20Email%204.pdf

37. Applying the Applicants accepted annual mortality (using 50% / 1%) or the most recently consented values (i.e. 70% / 2% from Hornsea 4) gives considerable difference in mortality. The Applicants consider that given that lack of evidence for displacement, even the use of the 50% and 1% rates greatly inflate the potential impact at **162.6 birds** (notwithstanding any precaution already incorporated via the derivation of the birds at risk of displacement described in section 1.2.1.1). If the 95% Upper Confidence Intervals (UCI) values are used as the starting point for this assessment, instead of the mean, and combined with the 70% / 2% rates the impact is five times higher at **878.2 birds**.

Table 1-2 Application of displacement and mortality rates to birds at risk of displacement from the Projects (the Applicants accepted values presented in the RIAA [AS-085] are in bold, greyed values show the 55.2% apportioning to FFC SPA to show the full range with the minimal accepted precaution).

Annual apportionment to SPA (metric/adult %)	Displacement Rate (%)/ Mortality Rate (%)	Annual Mortality at FFC SPA (individuals)
24,581 (mean/55.2%)	50 / 1	122.9
	70 / 2	344.1
	70 / 10	1720.7
32,562 (mean/100%)	**50 / 1**	**162.8**
	70 / 2	455.9
	70 / 10	2279.3
50,703 (95UCI/55.2%)	50 / 1	253.5
	70 / 2	709.8
	70 / 10	3549.2
62,730 (95UCI/100%)	50 / 1	313.6
	70 / 2	878.2
	70 / 10	4391.1

1.3.1.3 Summary of the Impact Assessment

38. As illustrated in **Table 1-2**, the choice of inputs into the assessment lead to an order of magnitude difference in the potential mortality derived. Whilst it is important to recognise uncertainty and build in some contingency, it can already be seen that just up to this stage of the process we have four potential contributors of precaution:

- Mean abundance versus 95% UCI in determining birds at risk
- Apportionment percentage to the SPA in the different seasons
- Displacement rate
- Mortality rate

39. The Applicants consider that it is important to recognise that although numbers are shown because this has been requested, the upper range shown does not depict the 'worst case' and should not be considered to accurately reflect a realistic value for the upper range of impact. As described elsewhere, the 70% / 10% values are not supported by any evidence. Indeed a mortality rate as high as 10%, which is equivalent to all sources of existing adult mortality (i.e. this would represent an effective doubling of the natural mortality rate), would almost certainly have produced clear evidence of impacts through sharp declines in auk populations and possibly even elevated numbers of carcasses being recovered along coastlines, neither of which have been reported at colonies and locations in proximity to operational wind farms.

1.3.2 Compensation

1.3.2.1 Methodology

40. The Hornsea 4 compensation calculation for auks has two steps to estimate how many pairs are required to produce the same number of impact mortalities:

1. Calculate the number of fledglings required to obtain recruitment age adults (i.e. accounting for survival to maturity), and
2. Calculate how many pairs are required to produce the number of fledglings at step 1

41. The calculation is as follows:

$$Compensation = Impact\ mortality \times \frac{1}{survival\ to\ maturity} \times \frac{1}{productivity}$$

42. Within this part of the process there should be no element of precaution (besides that embedded in the mortality estimate, as detailed above). The demographic rates (i.e. survival and productivity) are taken from the literature and no other factors are applied.

43. The above calculation does not take account of any requirement to 'export' birds outside of the colony (by adding consideration of philopatry or its reciprocal, natal dispersal). The requirement for this is questionable. As acknowledged by Natural England, the case for connectivity was established in **Guillemot [and Razorbill] Compensation Plan** [AS-089] for each of the colonies identified since they are all located within reported recruitment distances. While the probability of recruitment from a natal (hatched) colony to any other particular breeding colony is likely to decline with increasing distance, all additional birds hatched within the regional population will ultimately be contributing to the overall coherence of the National Site Network, including individuals that recruit to non-SPA colonies. This is because growth at those colonies will also contribute to growth in the regional populations (i.e. the inter-connected nature of seabird breeding populations means that they are all linked to a greater or lesser extent, whether designated as SPAs or not). Thus, the Applicants consider that the emphasis Natural England places on the need to account for philopatry for auk species (guillemots and razorbills) within the compensation calculation is overstated.

44. If philopatry were included, then rates for this would be taken from the literature. It is also worth noting that philopatry rates for most seabirds are not well known, since it can only be estimated through long-term ringing and re-sighting programmes conducted across multiple colonies, and the expense and logistic effort required mean such studies are rare.

45. The values in **Table 1-3** differ from those presented in the **Guillemot [and Razorbill] Compensation Plan** [AS-089] due to a previous error in the interpretation of the demographics leading to an incorrect lower survival rate for razorbill, resulting in an overestimation of compensation requirement . The updated values for razorbill will be included in the next revision of the **Guillemot [and Razorbill] Compensation Plan** [AS-089].

1.3.2.2 Ratios

46. As stated in the section 8.3 of the **Round 4 Kittiwake Strategic Compensation Plan** [APP-053]:

"A compensation ratio is typically applied to ensure that the compensatory measures fully off-set the predicted impact on a site/feature. Ratios close to 1:1 are appropriate in circumstances where the compensatory measure is very similar in character and scale to the feature being compensated (i.e. it is like for like). Where the measure is less like for like and/or there is uncertainty about its delivery then higher ratios may be applied."

47. The Applicants propose that compensation ratios should only be applied to address uncertainty that the proposed measure (e.g. rat eradication) will deliver its projected outcomes (increased population and productivity) and not on the basis of any other part of the assessment or consideration (since those should already have been appropriately accounted for).

48. **Table 1-3** illustrates the compounding effects of precaution at different stages of the assessment using the examples presented so far. The values in bold with red border represent those which the Applicant propose are used, while those with the purple border represent a case where multiple levels of precaution have been applied and then a ratio added. In this case the precaution added in the assessment stage results in impacts five times those estimated by the Applicants, which results in compensation requirements five times those estimated by the Applicants (as the compensation method is the same in both cases). Adding any ratio at this stage simply adds an arbitrary uplift to the compensation required.

Table 1-3 Application of compensation ratios to different assessment inputs using the Hornsea 4 methodology for guillemot.

Annual apportionment to SPA (individuals) (metric/adult %)	Displacement (%)/ mortality rate (%)	Annual Mortality	Compensation required (breeding pairs) and Ratio		
			1:1	2:1	3:1
24,581 (mean/55.2%)	50 / 1	122.9	543	1086	1629
	70 / 2	344.1	1521	3042	4562
	70 / 10	1720.7	7604	15208	22812
32,562 (mean/100%)	**50 / 1**	**162.8**	719	1439	2158
	70 / 2	455.9	2015	4029	6044
	70 / 10	2279.3	10073	20146	30219
50,703 (95UCI/55.2%)	50 / 1	253.5	1120	2241	3361
	70 / 2	709.8	3137	6274	9411
	70 / 10	3549.2	15685	31370	47055
	50 / 1	313.6	1386	2772	4158
62,730 (95UCI/100%)	**70 / 2**	**878.2**	3881	7762	11643
	70 / 10	4391.1	19405	38811	58216

1.3.3 Displacement Summary

49. Throughout the impact assessment and compensation calculation process there are many opportunities to apply precaution. The main reason for applying precaution is to deal with uncertainty given the lack of definitive evidence on the scale of impact (due to the relative novelty of offshore wind and understanding of potential issues). However, this should be undertaken in a proportionate manner that captures the overall level of uncertainty, rather than the individual elements.

50. For avoidance of doubt, the Applicants consider that the following assumptions are robust and provide an element of precaution

- Abundance estimate – mean peak for each season
- Displacement rate – 50%
- Mortality rate – 1%
- Adult proportion from FFC SPA in the breeding season - 55.2% (*but accept the use of 100% as per Natural England*),
- Adult proportion from FFC SPA in the post-breeding season – 70, and
- Adult proportions in the non-breeding seasons – 4.4%.

51. In the examples presented above it can be seen that as precaution is added at each stage the required compensation quantum increases massively. The intention of this review is to clearly set out how this approach manifests to allow the results of such compounding actions to be appreciated and sense-checked.

52. If we take the example from **Table 1-3** (with the purple border) we have assumed the upper case for birds at risk (through selection of 95% UCI from the survey data and then applying 100% adult apportionment), we have then applied a 70% displacement rate (up to double the 30% that has been recommended from some reviews), 2% mortality (again double the percentage recommended from reviews) and finally added an arbitrary ratio for compensation. For an impact which the Applicants consider to be highly precautionary at **162.8 individuals** we are potentially required to compensate by increasing a breeding population by **7,762 breeding pairs** (over 15,000 individuals). In the most extreme example where all the largest values are used (95% UCI ; 70% displacement / 10% mortality with a 3:1 ratio) the compensation requirement is 58,000 pairs (116,000 individuals, a 700-fold multiplier and equivalent to 77% of the FFC SPA breeding adult population).

53. The Applicants consider that this approach is clearly wrong. If precaution is applied, it should be applied once not multiple times. In the following examples in **Table 1-4** precaution is applied at a single, but different stage of the process in each scenario, but results in similar requirements for compensation (between 1,100 and 2,000 breeding pairs) without compounding errors through each stage of the process. Note that if the Applicants' preferred assumptions are used (see paragraph 49) the compensation requirement would be **719 pairs**.

54. This example should provide comfort to stakeholders and the Secretary of State that even allowing for uncertainty, the level of compensation being proposed by the Applicants is within the limits of what is required and practically deliverable.

Table 1-4 Illustration of the application of precaution at different parts of the assessment for guillemot (red denotes where precaution is included)

Annual apportion to SPA (individuals) (metric/adult %)	Displacement (%)/ mortality rate (%)	Annual mortality	Compensation required (breeding pairs) and ratio		
			1:1	2:1	3:1
24,581 (mean/55.2%)	*50 / 1*	*122.9*	*543*	*1086*	*1629*
	Precaution applied at this stage only				
	70 / 2	344.1	**1,5201**	3042	4562
	70 / 10	*1720.7*	*7604*	*15208*	*22812*
32,562 (mean/**100%**)				Precaution applied at this stage only	
	50 / 1	**162.8**	**719**	**1,439**	2158
	Precaution applied at this stage only				
	70 / 2	455.9	**2,015**	4029	6044
	70 / 10	*2279.3*	*10073*	*20146*	*30219*
Precaution applied at this stage only					
50,703 (95UCI/55.2%)	50 / 1	253.5	**1,120**	2241	3361
	70 / 2	*709.8*	*3137*	*6274*	*9411*
	70 / 10	*3549.2*	*15685.0*	*31370.0*	*47055.0*
Precaution applied at this stage only	50 / 1	313.6	**1,386**	2772	4158
62,730 (95UCI/100%)	*70 / 2*	*878.2*	*3881*	*7762*	*11643*

Annual apportion to SPA (individuals) (metric/adult %)	Displacement (%)/ mortality rate (%)	Annual mortality	Compensation required (breeding pairs) and ratio		
			1:1	2:1	3:1
	70 / 10	4391.1	19405	38811	58216

1.4 Collision

55. There is a potential risk of collision with the wind turbine rotors and associated infrastructure resulting in injury or fatality to birds which fly through the Array Areas whilst foraging for food or commuting between breeding sites and foraging areas. The key factor in determining susceptibility to collision is the flight height for each species based on the percentage of birds flying at Potential Collision Height derived from data from a number of offshore wind farms, presented in Johnston et al. (2014a, 2014b).

56. For collision we consider kittiwake from FFC SPA and the project-alone impacts of the Projects.

1.4.1 Impact Assessment

1.4.1.1 Collision risk

57. There are clearly different considerations within the assessment of collision from those of displacement discussed above, not only with the necessarily different methodology for calculating mortality but also with the presentation of the impact.

58. The assessment of collisions is based upon collision risk modelling (CRM). Within this model there are a number of conservative assumptions included, however, given that the Applicants have undertaken the CRM using Natural England's advice and are not contesting this element, this point is not developed further.

59. As per the displacement example above, the key site-specific input into the CRM model is the data on bird abundance within the Array Areas (which ultimately determines the number of birds at risk). The abundance data generates figures with confidence intervals, all values are fed into the CRM and mortalities presented in the assessment using the full range of values (i.e. lower and upper CI and the mean). The reason for the difference in presentation from displacement (i.e. why displacement is not shown with the confidence intervals) is simply convention. The CRM produces a single number, the mortality (with the upper and lower numbers around it). In both collision and displacement assessments, the actual assessment is based upon the mean and the Applicants maintain that the mean is the appropriate number to use as it is, by definition, the most likely value for bird abundance between the upper and lower confidence intervals. Furthermore, the upper 95% confidence interval is no more appropriate than the lower 95% confidence interval – both represent the ends of the probability distribution and the likelihood that the 'true' mean value is as high (or as low) as these is only 2.5%.

1.4.1.2 Apportionment

60. For the HRA, the number of mortalities from the CRM are then apportioned to relevant SPAs in the same way as for displacement, considering connectivity from the SPA to the Projects and relates to the foraging range, coastal position and relative population sizes of the species during the different biological seasons of the year.

61. Given the proximity of the Projects to FFC SPA, it is considered that during the breeding season, 100% of the kittiwakes are likely to come from the SPA, notwithstanding that there may be many birds from non-SPA colonies (such as colonised offshore oil and gas infrastructure) which are nearer to the Projects and are not accounted for given the limited data on these colonies and their birds' distribution. The Applicants have agreed this apportioning of 100% of the birds and are not contesting this point, however as for the auks, we highlight that this is a source of precaution.

62. In addition to this, the proportion of kittiwakes present in the breeding season that are breeding adults is debateable. As per guillemot, the Applicants have presented the assessment based on both demographic studies (assuming 53% of the birds apportioned to the SPA are breeding adults) and advice from Natural England that, in the absence of definitive data, 100% of the birds are adults. There is a twofold difference in breeding season mortality between these two adult percentages, with the 100% case being an extreme worst case assumption.

1.4.1.3 Summary of collision mortality and apportioning

63. **Table 1-5** illustrates how the differences of approach for just this part of the assessment can result in a four-fold variation in the numbers taken forward. From the mean to the upper 95% CI doubles the number of birds at risk, from the best case which already incorporates some measure of precaution.

Table 1-5 Kittiwake collision risk mortality dependent on abundance estimate and breeding season (the Applicants accepted values presented in the RIAA [AS-085] are in bold)

Abundance estimate metric	Breeding Season % Adults	Annual Mortality Apportioned to FFC SPA (individuals)
Mean	53	104
	100	**191**
Upper 95% CI	53	205
	100	377

1.4.2 Compensation

64. Unlike for guillemot, two methodologies for calculation of the compensation quantum have been presented in the **Project Level Kittiwake Compensation Plan (Revision 4)** [REP2-010] and as discussed in section 1.2 above the Applicants do not consider the Hornsea 3 method fit for purpose. However, for the purposes of this document examples are provided below of how, as with guillemot, use of multiple levels of precaution with the assessment and compensation calculation can lead to inflated requirements for compensation.

1.4.2.1 Methodology

65. The Applicants do not propose to provide a detailed critique of the Hornsea 3 method given that Natural England has commissioned the BTO to carry out a review of methodologies (see section 1.2 above). The Applicants will comment on any method recommended by this process but for the purposes of this document simply reiterate that the Hornsea 3 method is unnecessarily complicated, and includes double-counting of the effects of mortality and thus overestimates the compensation quantum.

66. It should be noted that the Applicants used the Hornsea 4 methodology based on demographic rates used for that project. This incorporates an element of precaution as the 'Survival to maturity' rate used was low, which increases the compensation required (by approximately 7%).

67. Survival to maturity (i.e. from fledging to breeding age) is typically calculated as the product of the annual survival rates involved. In the case of kittiwake, using annual values in Horswill and Robinson (2015) for each age from 0-4 this calculation is 0.79 x 0.854 x 0.854 x 0.854 = 0.492. In other words, just less than half of all hatched birds (49.2%) are expected to survive to breeding age.

68. Hornsea 4 combined the above survival rates with estimates of the age at recruitment rates obtained from a detailed study conducted at North Shields during the 1950s-1970s (Wooler and Coulson 1977), which Horswill and Robinson (2015) note should be used with 'caution' since kittiwake populations (and hence demographic rates) have changed very considerably in the 50 years since then. Thus, while the Hornsea 4 approach has applied detailed age specific information and arrived at a survival to maturity rate of 0.457, this is based on observations which are very likely to no longer be representative. Nonetheless, given that this methodology was the basis of the Hornsea 4 consent and pending the BTO review which may provide guidance on this point, the Applicants do not amend the calculations to use the 0.492 rate at this stage.

1.4.2.2 Ratios

69. The Applicants propose that compensation ratios should only be applied to address uncertainty that the proposed measure (e.g. offshore artificial nesting structures (ANS)) will deliver its projected outcomes (increased population and productivity) and not on the basis of any other part of the assessment or consideration (since those should already have been appropriately accounted for). The Applicants therefore consider that in light of the uncertainties around ANS and in line with the **Round 4 Kittiwake Strategic Compensation Plan** [APP-053] a 2:1 ratio is appropriate in this case.

70. **Table 1-6** illustrates the differences of compensation quantum obtained from the different abundance estimates (mean and upper 95% CI) and the two compensation methods, reiterating that the Applicants consider the Hornsea 3 values should be disregarded.

Table 1-6 Application of compensation ratios to different assessment inputs using the Hornsea 3 and Hornsea 4 methodology for kittiwake. The Applicants' preferred values are in bold

Abundance estimate metric	Breeding Season % Adults	Annual Mortality	Compensation method	Compensation required (breeding pairs) and Ratio		
				1:1	2:1	3:1
Mean	53	104	Hornsea 3	575	1151	1726
			Hornsea 4	278	556	834
Mean	**100**	**191**	Hornsea 3	1057	2114	3170
			Hornsea 4	510	1021	1531
95UCI	53	205	Hornsea 3	1134	2269	3403
			Hornsea 4	548	1095	1643

Abundance estimate metric	Breeding Season % Adults	Annual Mortality	Compensation method	Compensation required (breeding pairs) and Ratio		
				1:1	2:1	3:1
95UCI	100	377	Hornsea 3	2086	4172	6258
			Hornsea 4	1007	2015	3022

1.4.2.3 Collision Summary

71. The collision example is somewhat more straightforward than for displacement as there are fewer sources of additional precaution in the process, however there is still potential for compounding precaution when deriving the compensation quantum.

72. If precaution is applied to deal with uncertainty, it should be applied once, not multiple times. In the following examples in **Table 1-7** precaution is applied at a single[2], but different stage of the process in each scenario, but results in similar requirements for compensation (approximately 1,000 breeding pairs) without compounding errors through each stage of the process.

73. This example should provide comfort to stakeholders and the Secretary of State that even allowing for uncertainty, the level of compensation being proposed by the Applicants is within the limits of what is required and practically deliverable.

[2] Arguably the Applicants' preferred case includes additional precaution through the assumption of 100% breeding adults

Table 1-7 Illustration of the application of precaution at different parts of the assessment / compensation process for kittiwake (Applicants' preferred values in bold, red denotes where precaution is included)

Abundance estimate metric	Breeding Season % Adults	Annual Mortality	Compensation method	Compensation required (breeding pairs) and Ratio		
				1:1	2:1	3:1
Mean	53	104	Hornsea 4	278	556	834
					Precaution applied at this stage only	
Mean	**100**	**191**	**Hornsea 4**	510	**1021**	1531
95UCI	53	205	Hornsea 4	548	1095	1643
Precaution applied at this stage only						
95UCI	100	377	Hornsea 4	**1007**	2015	3022

1.5 Conclusions

74. There are many uncertainties with ornithological assessments and in the derivation of compensation quantum. The temptation can be to apply precaution at every stage of the process, ignoring the fact that previous stages of the process have already accounted for uncertainty. This may seem like a pragmatic approach to dealing with uncertainty, but in reality, it simply inflates the compensation requirement massively and arbitrarily. This can be seen in the examples illustrated above where in the most extreme examples (see **Table 1-4**) the compensation quantum is 700 times the likely impact and equivalent to 77% of the affected population.

75. This is an issue because:

- In the case of predator eradication, it potentially rules out good locations which cannot accommodate the inflated quantum;
- In the case of predator eradication, it increases the impacts upon other users (e.g. recreational user - in the event that predator proof fencing is required)

- In the case of ANS, it increases the environmental footprint of the measures (e.g. fabrication, transport, seabed footprint, carbon footprint) and impacts upon other sea users (e.g. sterilisation of seabed for aggregates, fisheries, increasing steaming times etc)
- It is adding unjustified additional lifetime financial burden to the Projects through over-compensation (e.g. fabrication and installation, operation and maintenance, monitoring and biosecurity, decommissioning);
- It increases the chances of 'failure' of the measures by imposing unrealistic targets / success measures and potential implementation of adaptive management ; and
- It 'uses up' capacity for compensation for future projects and therefore potentially undermines the deliverability of future projects. This is particularly important given that there are limited opportunities for some of the measures (i.e. suitable locations for predator eradication schemes) .

76. The Applicants advocate that the compensation quantum should be justified by robust assumptions at all stages of the process and that the precautionary positions already incorporated into the assessments based on Natural England advice incorporate sufficient assumptions on uncertainty that large ratios are unjustified.

1.6 References

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Appendix A: Spreadsheet of Calculations

Notes:
This spreadsheet contains the calculations that support document **"Precaution in the Ornithology Assessment & Implications for Compensation Quantum" (REF)**

Compensation requirement formula

$$Compensation = Impact\ mortality \times \frac{1}{survival\ to\ maturity} \times \frac{1}{productivity}$$

Guillemot (using Hornsea 4 Methdology)

Abundance estimate	SPA Adult apportion (breeding season)	Annual no. Appn to SPA (see Sheet GU RIAA No.)	Displacement Rate (%)	Mortality Rate (%)	Annual Mortality Appn to SPA (individuals)	Compensation Demographic Values		Compensation Required (breeding pairs) Ratio		
						Survival to Maturity	Productivity	1:1	2:1	3:1
Mean	55.2	24581	50	1	122.9	0.337	0.672	543	1086	1629
Mean	100	32562	**50**	**1**	**162.8**	0.337	0.672	**719**	1439	2158
Mean	55.2	24581	70	2	344.1	0.337	0.672	1521	3042	4562
Mean	100	32562	70	2	455.9	0.337	0.672	2015	4029	6044
Mean	55.2	24581	70	10	1720.7	0.337	0.672	7604	15208	22812
Mean	100	32562	70	10	2279.3	0.337	0.672	10073	20146	30219
U95 CI	55.2	50703	50	1	253.5	0.337	0.672	1120	2241	3361
U95 CI	100	62730	50	1	313.6	0.337	0.672	1386	2772	4158
U95 CI	55.2	50703	70	2	709.8	0.337	0.672	3137	6274	9411
U95 CI	100	62730	70	2	878.2	0.337	0.672	3881	7762	11643
U95 CI	55.2	50703	70	10	3549.2	0.337	0.672	15685	31370	47055
U95 CI	100	62730	70	10	4391.1	0.337	0.672	19405	38811	58216

Razorbill (using Hornsea 4 Methdology)

Abundance estimate	SPA Adult apportion (breeding season)	Annual no. Appn to SPA (see Sheet RA RIAA No.)	Displacement Rate (%)	Mortality Rate (%)	Annual Mortality Appn to SPA (individuals)	Compensation Demographic Values		Compensation Required (breeding pairs) Ratio		
						Survival to Maturity	Productivity	1:1	2:1	3:1
Mean	61.3	8933.4	50	1	44.7	0.452	0.57	174	347	521
Mean	**100**	10030.8	**50**	**1**	**50.2**	0.452	0.57	**195**	390	584
Mean	61.3	8933.4	70	2	125.1	0.452	0.57	486	972	1457
Mean	100	10030.8	70	2	140.4	0.452	0.57	545	1091	1636
Mean	61.3	8933.4	70	10	625.3	0.452	0.57	2429	4858	7287
Mean	100	10030.8	70	10	702.2	0.452	0.57	2727	5455	8182
U95 CI	61.3	28703.6	50	1	143.5	0.452	0.57	557	1115	1672
U95 CI	100	30683.5	50	1	153.4	0.452	0.57	596	1192	1788
U95 CI	61.3	28703.6	70	2	401.9	0.452	0.57	1561	3122	4683
U95 CI	100	30683.5	70	2	429.6	0.452	0.57	1669	3337	5006
U95 CI	61.3	28703.6	70	10	2009.3	0.452	0.57	7805	15609	23414
U95 CI	100	30683.5	70	10	2147.8	0.452	0.57	8343	16686	25029

Kittiwake

Abundance estimate	SPA Adult apportion (breeding season)	Annual no. Appn to SPA	Method	Compensation Demographic Values		Compensation Required (breeding pairs) Ratio		
				Survival to Maturity	Productivity	1:1	2:1	3:1
Mean	53	104	H4	0.457	0.819	278	556	834
Mean	**100**	**191**	H4	0.457	0.819	510	**1021**	1531
U95 CI	53	205	H4	0.457	0.819	548	1095	1643
U95 CI	100	377	H4	0.457	0.819	1007	2015	3022
Mean	53	104	H3	*Using H3 method (formula not provided)*		575	1151	1726
Mean	100	191	H3			1057	2114	3170
U95 CI	53	205	H3			1134	2269	3403
U95 CI	100	377	H3			2086	4172	6258

Notes: This sheet provides the abundance of guillemot at risk of displacement (i.e. those within the array areas + 2km buffer) which is used in column "Annual no. Appn to SPA (see Sheet GU RIAA No.)" of the "All Species" sheet

Mean					
Project		Total Abundance (WF+2km)	% Apportioned to SPA	% Adults	No. Appn to SPA
DBS E	Breeding	9030.5	1	0.552	4984.8
			1	1	9030.5
	Post-breed	7678	1	0.682	5236.4
	Non-breed	12551.8	0.044	1	552.3
	Annual			0.552	10773.5
				1	14819.2
DBS W	Breeding	8783.5	1	0.552	4848.5
			1	1	8783.5
	Post-breed	12498	1	0.682	8523.6
	Non-breed	9895	0.044	1	435.4
	Annual			0.552	13807.5
				1	17742.5
DBS E+W	Breeding	17814	1	0.552	9833.3
			1	1	17814.0
	Post-breed	20176	1	0.682	13760.0
	Non-breed	22446.8	0.044	1	987.7
	Annual			0.552	24581.0
				1	32561.7

Upper 95 CI					
	Season	Total Abundance (WF+2km)	% Apportioned to SPA	% Adults	No. Appn to SPA
DBS E	Breeding	14575.2	1	0.552	8045.5
			1	1	14575.2
	Post-breed	19141.4	1	0.682	13054.4
	Non-breed	14834.4	0.044	1	652.7
	Annual			0.552	21752.7
				1	28282.3
DBS W	Breeding	12269.4	1	0.552	6772.7
			1	1	12269.4
	Post-breed	31199.2	1	0.682	21277.9
	Non-breed	20452.9	0.044	1	899.9
	Annual			0.552	28950.5
				1	34447.2
DBS E+W	Breeding	26844.6	1	0.552	14818.2
			1	1	26844.6
	Post-breed	50340.6	1	0.682	34332.3
	Non-breed	35287.3	0.044	1	1552.6
	Annual			0.552	50703.1
				1	62729.5

Notes: This sheet provides the abundance of guillemot at risk of displacement (i.e. those within the array areas + 2km buffer) which is used in column "Annual no. Appn to SPA (see Sheet RA RIAA No.)" of the "All Species" sheet

Mean					
Project		Total Abundance (WF+2km)	% Apportioned to SPA	% Adults	No. Appn to SPA
DBS E	Breeding	555.1	1	0.613	340.3
			1	1	555.1
	Post-breed	4685.6	1	0.699	3276.6
	Non-breed	3376.7	0.027	1	91.2
	Spring	3578.5	0.034	1	121.7
	Annual			0.613	3708.1
				1	3922.9
DBS W	Breeding	2280.6	1	0.613	1398.0
			1	1	2280.6
	Post-breed	4886.9	1	0.699	3417.4
	Non-breed	5066.2	0.027	1	136.8
	Spring	4454.6	0.034	1	151.5
	Annual			0.613	4952.2
				1	5834.8
DBS E+W	Breeding	2835.7	1	0.613	1738.3
			1	1	2835.7
	Post-breed	9572.5	1	0.699	6694.0
	Non-breed	8442.9	0.027	1	228.0
	Spring	8033.1	0.034	1	273.1
	Annual			0.613	8933.4
				1	10030.8

Upper 95 CI					
	Season	Total Abundance (WF+2km)	% Apportioned to SPA	% Adults	No. Appn to SPA
DBS E	Breeding	1006.8	1	0.613	617.2
			1	1	1006.8
	Post-breed	14569.6	1	0.699	10188.5
	Non-breed	4324.3	0.027	1	116.8
	Spring	7055.8	0.034	1	239.9
	Annual			0.613	10922.4
				1	11312.1
DBS W	Breeding	4109.3	1	0.613	2519.0
			1	1	4109.3
	Post-breed	20574.5	1	0.699	14387.7
	Non-breed	11485.5	0.027	1	310.1
	Spring	9540.6	0.034	1	324.4
	Annual			0.613	17216.9
				1	18807.2
DBS E+W	Breeding	5116.1	1	0.613	3136.2
			1	1	5116.1
	Post-breed	35144.1	1	0.699	24576.3
	Non-breed	15809.8	0.027	1	426.9
	Spring	16596.4	0.034	1	564.3
	Annual			0.613	28703.6
				1	30683.5

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