# Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

## Collision Risk Modelling (CRM) Updates (EIA Context) Technical Note

**Revision A**
February 2023
Document Reference: 13.2

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| Title**:** | |
| **Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects Examination submission**<br>Collision Risk Modelling (CRM) Updates (EIA Context) Technical Note | |
| PINS document no.: 13.2 | |
| Document no.: C282-RH-Z-GA-00226 | |
| Date: | Classification |
| **February 2023** | **Final** |
| Prepared by:<br>**Royal HaskoningDHV** | |
| Approved by:<br>**Hannah Adams, Equinor** | Date:<br>**February 2023** |

## Table of Contents



## Table of Tables

## Glossary of Acronyms

| | |
|---|---|
| CIA | Cumulative Impact Assessment |
| DEP | Dudgeon Offshore Wind Farm Extension Project |
| DOW | Dudgeon Offshore Wind Farm |
| EC | European Commission |
| EIA | Environmental Impact Assessment |
| JNCC | Joint Nature Conservation Committee |
| OWF | Offshore Wind Farm |
| RB | Race Bank Offshore Wind Farm |
| RR | Relevant Representation |
| SEP | Sheringham Offshore Wind Farm Extension Project |
| SOW | Sheringham Shoal Offshore Wind Farm |
| TK | Triton Knoll Offshore Wind Farm |
| SEL | Scira Extension Limited |
| DEL | Dudgeon Extension Limited |
| ES | Environmental Statement |
| BDMPS | Biologically Defined Minimum Population Size |
| CI | Confidence interval |
| UCI | Upper Confidence interval |
| LCI | Lower Confidence Interval |

## Glossary of Terms

| | |
|---|---|
| Dudgeon Offshore Wind Farm Extension Project (DEP) | The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure. |
| Sheringham Shoal Offshore Wind Farm Extension Project (SEP) | The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure. |
| The Applicant | Equinor New Energy Limited. As the owners of SEP and DEP, Scira Extension Limited (SEL) and Dudgeon Extension Limited (DEL) are the named undertakers that have the benefit of the DCO. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of SEL and DEL as the undertakers of SEP and DEP. |

# 1 Introduction

1. This document presents an update to the Collision Risk Modelling (CRM) work undertaken as part of the assessment of the Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP) on offshore ornithology receptors. This update has been undertaken at the suggestion of Natural England, who in a Discretionary Advice Service (DAS) letter of 16/09/2022 (and subsequently in the Natural England Relevant Representation (RR) [RR-063]), indicated that potential collision estimates should be recalculated for the following species to account for Natural England's draft updated advice on CRM parameters, as provided in Appendix B1 of the Natural England RR [RR-063]:
   - Sandwich tern;
   - Gannet;
   - Kittiwake;
   - Great black-backed gull;
   - Lesser black-backed gull; and
   - Little gull.
2. The recalculated annual collision estimates for SEP, DEP, and SEP and DEP combined are considered in the context of appropriate background populations and published mortality rates (**Section 2.2**). The updated SEP and DEP CRM outputs by month are provided in **Appendix 1**. Whilst it was agreed with Natural England at a meeting on 22 November 2022 to use a correction factor to recalculate collision risk mortalities, the Applicant has instead taken the more comprehensive approach to re-run the CRM for the above species to enable full transparency of the revised assessments.
3. In addition to project-alone collision rates, cumulative collision rates have been recalculated and presented for the relevant species (i.e. all except little gull). The findings are put into context in a similar manner to the recalculated project-alone collision rates. The updated cumulative collision CRM outputs are provided in **Appendix 2** for all species except Sandwich tern. Sandwich tern cumulative collision rates are provided in **Section 3.1** with further details on the approach provided within **Section 2.3**.

## 1.1 Consultation on this document

4. Natural England was consulted on a draft of this document in December 2022. **Table 1-1** provides a summary of comments received from Natural England in February 2023. There has been insufficient time to address these comments prior to the submission of this document at Deadline 1. Information has therefore been included in **Table 1-1** to indicate how it is proposed these comments will be addressed in an update submitted at Deadline 2 or 3.

*Table 1-1: Natural England consultation summary*

| Section | Natural England comment | Natural England's advice | Applicant response |
|---|---|---|---|
| Section 1, point 2 | NE notes "the Applicant has instead taken the more comprehensive approach to re-run the CRM for the above species to enable full transparency of the revised assessments. | If possible, please supply the log files of these re-run models. | It should be noted that the CRM has been undertaken using the deterministic (Band) approach, which does not generate log files *per se*. However, the Applicant will provide the original Band CRM spreadsheets for Deadline 2 or 3, should these be required. |
| 2.3 Cumulative Impact Assessment - para 9 | NE note that the applicant has updated the collision totals for a number of species for the Cumulative Impact Assessment (CIA) as follows: 'A correction factor was applied for each CIA to update the avoidance rates from those previously used (SNCBs, 2014) to the latest avoidance rates (Ozsanlev-Harris et al., in prep).'<br><br>NE agree that in the case where Avoidance Rates (AR) have changed, it is technically possible to update collision totals that has been previously produced using Collison Risk Modelling (CRM), by applying a correction factor. However as the correction factor needs to be calculated using the original AR and the new AR, it is essential that the original AR is known for each project corrected. Ultimately, when the Cumulative Effects Framework (CEF) tool is released, it should enable full transparency and accessibility in terms of the input parameters for each consented windfarm, and the ability to apply 'wholesale' changes to impact modelling parameters (such as AR) when the evidence base changes. Until this tool is available, if there is a desire to apply correction factors to previous projects collision totals, Natural England considers it will be necessary to present sufficient | NE recognise that in the case of Sandwich tern in the Greater Wash the Applicant has run a new CRM for each wind farm. This means the cumulative totals are appropriate, and no action is required.<br><br>In the case of Kittiwake, Lesser Black-Backed Gull, Great Black-backed Gull, Little Gull and Gannet, NE recommend either reverting to the original cumulative totals (un-corrected for the updated ARs other than for SEP&DEP) or presenting significantly more detail on the application of the correction factors, including detail on the original modelling approach and AR applied to each project. There has, in previous OWF cases, been considerable work done on the cumulative totals for the North Sea wind farms. It may be that the totals being corrected have already been standardised to be the recommended ARs (as per 2014 guidance) and submitted into an OWF Examination. If this previous work is being relied on, it | Natural England's comment in respect of Sandwich tern is noted.<br><br>Further detail on the approach used and correction factors applied to the CIA will be provided for Deadline 2 or 3. |

| Section | Natural England comment | Natural England's advice | Applicant response |
|---|---|---|---|
| | details on the CRM for each project, and the correction factor applied to enable NE to assess whether this is appropriate.<br><br>It is worth noting that prior to 2014 there was no joint SNCB guidance on advised ARs and prior to 2012 (when guidance and spreadsheets were issued on use of the Band Model) there were a variety of interpretations of how to apply CRM. We highlight that Natural England's pre-application guidance to Round 4 and unsubmitted extension projects on this matter has been as follows:<br><br>*NE recognise that there is interest in using the avoidance rates in the interim advice to update cumulative/in-combination assessments as well as 'project alone' assessments. Our recommendation is that for the time being projects utilise the interim advice for their 'project alone' assessments, but refrain from updating existing cumulative/in-combination totals, instead simply adding their project alone values to the existing cumulative/in-combination totals presented in the latest relevant OWF examination. This reflects the fact that the SNCBs have not yet reached a position on how to go about updating such totals, and also the anticipated use of the CEF in the future, which will hopefully allow cumulative/in-combination assessments to take account of changes such as updated parameter information in an efficient and consistent way.* | would need to be clearly demonstrated and referenced within this report. | |
| 2.3 Cumulative Impact | Scenarios. At present the report presents 5 different scenarios reflecting different possible turbine numbers and sizes for the Greater Wash windfarms, which in turn dictates the total predicted mortality. | We consider a number of the scenarios are somewhat redundant and suggest simplifying by removing D. And provided that it can be satisfactorily demonstrated | The Applicant will present updated scenarios, as suggested by Natural England, at Deadline 2 or 3. The Applicant has provided further detail on modification of the |

| Section | Natural England comment | Natural England's advice | Applicant response |
|---|---|---|---|
| Assessment - Para 10 | However none of the scenarios reflect NEs requirements.<br><br>Our position is that we assess the legally secured worse case design (as per the Rochdale Envelope) for each windfarm. In the case of most of the Greater Wash windfarms this would be the consented design (as presented in scenario A). We understand that the applicant considers that they have legally secured the 'as built design' for Dudgeon Offshore windfarm<br><br>Article 45 of the DCO is clear in its intention of preventing DOW from building further (capacity and turbines), however Natural England queries whether this DCO can legally change an already granted Section 36 consent under the Electricity Act 1989. We recommend that Equinor seek legal advice on this matter and consider submitting a summary into the Examination, to demonstrate that this is a realistic scenario.<br><br>If it can be demonstrated that the DCO can effect such a change, a second scenario we would require to be presented is consented designs for all wind farms other than DOW, which should be the legally secured one. | that the DCO can indeed change an extant consent granted under another consenting regime, replacing E with a scenario that reflects consented designs unless legally secured (i.e. DOW). | DOW section 36 consent through Article 45 in its answers to Q1.5.11 and Q1.11.3.12 of **The Applicant's Responses to the Examining Authority's First Written Questions** [document reference 12.4]. |
| 3.1.2 (Cumulative) Table 3-5 | NE notes that Scenario C for DOW generates a greater impact than is consented (as per Scenario A). This level of impact would seemingly breach the predictions of the DOW ES and HRA and it is therefore doubtful whether that is actually a viable scenario to consider. | NE recommend SEP&DEP check that this value is accurate. | The Applicant understands that the CRM value for DOW under Scenario C (as built, with unbuilt capacity using consented designs) is greater than Scenario A (as consented) due to the different turbine parameters used for the as-built project. The consented CRM assumed a 63m radius rotor for the turbines, whereas the as-built |

| Section | Natural England comment | Natural England's advice | Applicant response |
|---|---|---|---|
| | | | used 77m radius rotors. This will be rechecked and confirmed for Deadline 2 or 3, assuming that this scenario is still presented. |

# 2 Methods

## 2.1 CRM Inputs

### 2.1.1 Seabird Densities

5. Updated CRM has been undertaken using both model-based and design-based density estimates for Sandwich tern, and design-based density estimates for all other species. The density estimates are unchanged from the original assessment and are presented in Environmental Statement (ES) **Appendix 11.1** of **Chapter 11 Offshore Ornithology** [APP-195]. CRMs have been presented that utilise the mean density and 95% lower and upper confidence intervals.

### 2.1.2 Flight Height

6. All updated CRMs use Option 2 of the Band Model (Band, 2012). For Sandwich tern, the flight height distribution was obtained from Harwood (Harwood, 2021). All other species used data from previously published flight height distributions ("Corrigendum," 2014; Johnston *et al.*, 2014).

### 2.1.3 Avoidance Rates

7. Avoidance rates for the updated CRMs were taken from Appendix B1 of the Natural England RR [RR-063]. The source of these avoidance rates is a JNCC report that is currently in preparation (Ozsanlev-Harris *et al.*, in prep). These are presented in **Table 2-1**.

### 2.1.4 Biometric and Other Parameters

8. The biometric and other parameters required for the updated CRM were taken from either Appendix B1 of the Natural England RR [RR-063] or **Appendix 11.1** of **Chapter 11 Offshore Ornithology** [APP-195]. They are presented in **Table 2-1**. With regard to the two flight speeds for Sandwich tern, these are discussed in detail in the original assessment (ES **Chapter 11 Offshore Ornithology** [APP-097]).

*Table 2-1: Avoidance rates and other input parameters used in updated CRM*

| Species | Avoidance rate[1] | Flight speed (m/s)[2] | Nocturnal activity[3] | Body length[1] | Wingspan[1] | Flight type[1] | % flights upwind[1] |
|---|---|---|---|---|---|---|---|
| Sandwich tern | 0.990 | 8.2 or 10.3 | 2% | 0.39 | 1.00 | Flapping | 50 |
| Gannet | 0.992[4] | 14.9 | 8% | 0.94 | 1.72 | Flapping | 50 |
| Kittiwake | 0.992 | 13.1 | 50% | 0.39 | 1.08 | Flapping | 50 |
| Great black-backed gull | 0.994 | 13.7 | 50% | 0.71 | 1.58 | Flapping | 50 |
| Lesser black-backed gull | 0.994 | 13.1 | 50% | 0.58 | 1.42 | Flapping | 50 |

| Species | Avoidance rate[1] | Flight speed (m/s)[2] | Nocturnal activity[3] | Body length[1] | Wingspan[1] | Flight type[1] | % flights upwind[1] |
|---|---|---|---|---|---|---|---|
| Little gull | 0.990 | 12.2 | 25% | 0.26 | 0.78 | Flapping | 50 |

**Notes**
1 From Appendix B1 of the Natural England RR [RR-063]
2 From Appendix B1 of the Natural England RR [RR-063], except 8.2m/s Sandwich tern flight speed, from Fijn and Collier (2020)
3 From Appendix B1 of the Natural England RR [RR-063], except 2% Sandwich tern nocturnal activity, from **Appendix 11.1** of **Chapter 11 Offshore Ornithology** [APP-195]
4 In addition to this avoidance rate, a macro-avoidance correction factor of 0.7 has been applied, as per Appendix B1 of the Natural England RR [RR-063]

## 2.2 Background Populations for Environmental Impact Assessment (EIA)

9. In terms of EIA, the key population and time period is an annual assessment of impact at the largest relevant population size. These are presented in **Table 2-2**.

*Table 2-2: Background populations and mortality rates used for year round EIA assessment*

| Species | Largest Biologically Defined Minimum Population Size (BDMPS) and season[1] | Biogeographic population[1] | Published all age mortality rate[2] |
|---|---|---|---|
| Sandwich tern | 38,051 (UK North Sea and Channel, non-breeding) | 148,000 | 0.240 |
| Gannet | 456,298 (UK North Sea and Channel, non-breeding) | 1,180,000 | 0.191 |
| Kittiwake | 839,456 (UK North Sea, breeding) | 5,100,000 | 0.156 |
| Great black-backed gull | 91,399 (UK North Sea, non-breeding) | 235,000 | 0.185 |
| Lesser black-backed gull | 209,007 (UK North Sea and Channel, non-breeding) | 864,000 | 0.126 |
| Little gull | N/A, not included in study | 75,000 | 0.200 |

**Notes**
1 From Appendix B1 of the Natural England RR [RR-063], except little gull, from ES **Chapter 11 Offshore Ornithology** [APP-097]
2 From Horswill and Robinson (2015)

## 2.3 Cumulative Impact Assessment

10. The information presented in the original assessment for the Cumulative Impact Assessment (CIA) was reviewed, and impacts from one offshore wind farm (OWF) that was not included in the original assessment (Rampion 2) was added for relevant species (GoBe Consultants and Wood Group UK, 2021a, 2021b). A correction factor was applied for each CIA to update the avoidance rates from those previously used (SNCBs, 2014) to the latest avoidance rates (Ozsanlev-Harris *et al.*, in prep). All other aspects of the CIA remain as per ES **Chapter 11 Offshore Ornithology** [APP-097].

11. For Sandwich tern, the CRMs for SEP, DEP and other OWFs included in the assessment (which were all produced from scratch for the SEP and DEP

assessment) were updated in light of the information presented in **Table 2-1**. The other OWFs included were DOW, Race Bank (RB), Sheringham Shoal (SOW) and Triton Knoll (TK). Five scenarios are presented, which incorporate different OWF designs as follows:

- Scenario A: Consented OWF designs
- Scenario B: As-built OWF designs
- Scenario C: As-built OWF designs, with unbuilt capacity built out using turbines of the same specification as the consented design
- Scenario D: As-built OWF designs, with unbuilt capacity built out using turbines of the same specification as the as-built design
- Scenario E: As per scenario D, but with the assumption that the as-built layout of DOW is legally secured through a mechanism within the DCO[1]

# 3 Results

12. Recalculated collision risk estimates are presented in the sections below. For Sandwich tern, gannet, kittiwake and little gull, predicted collision rates have reduced compared with those presented within ES **Chapter 11 Offshore Ornithology** [APP-097], whilst estimates for lesser black-backed gull and great black-backed gull have increased. These changes have been driven by the changes in the recommended avoidance rates. However, in all cases **the assessment conclusions as stated in the ES are not changed by these updated collision estimates**.

## 3.1 Sandwich tern

### 3.1.1 SEP and DEP

#### 3.1.1.1 Model-based density estimates

*Table 3-1: Estimated annual collision risk based on model-based density for Sandwich tern at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size, using the flight speed of Fijn and Collier (2020) as a model input*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 7.77 | 0.09 | 0.02 |
| | Mean | 4.46 | 0.05 | 0.01 |
| | 95% LCI | 2.45 | 0.03 | 0.01 |
| SEP | 95% UCI | 2.63 | 0.03 | 0.01 |

[1] See Article 45 (Modification of DOW section 36 consent) of the **Draft DCO** (AS-009)

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| | Mean | 1.41 | 0.02 | 0.00 |
| | 95% LCI | 0.78 | 0.01 | 0.00 |
| SEP and DEP | 95% UCI | 10.41 | 0.11 | 0.03 |
| | Mean | 5.87 | 0.06 | 0.02 |
| | 95% LCI | 3.23 | 0.04 | 0.01 |

*Table 3-2: Estimated annual collision risk based on model-based density for Sandwich tern at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size, using the flight speed of Fijn and Gyimesi (2018) as a model input*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 9.22 | 0.10 | 0.03 |
| | Mean | 5.35 | 0.06 | 0.02 |
| | 95% LCI | 2.94 | 0.03 | 0.01 |
| SEP | 95% UCI | 3.16 | 0.03 | 0.01 |
| | Mean | 1.69 | 0.02 | 0.00 |
| | 95% LCI | 0.93 | 0.01 | 0.00 |
| SEP and DEP | 95% UCI | 12.38 | 0.14 | 0.03 |
| | Mean | 7.04 | 0.08 | 0.02 |
| | 95% LCI | 3.88 | 0.04 | 0.01 |

#### 3.1.1.2 Design-based density estimates

*Table 3-3: Estimated annual collision risk based on design-based density for Sandwich tern at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size, using the flight speed of Fijn and Collier (2020) as a model input*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 11.33 | 0.12 | 0.03 |
| | Mean | 3.79 | 0.04 | 0.01 |
| | 95% LCI | 0.45 | 0.00 | 0.00 |
| SEP | 95% UCI | 3.13 | 0.03 | 0.01 |

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| | Mean | 0.94 | 0.01 | 0.00 |
| | 95% LCI | 0.05 | 0.00 | 0.00 |
| SEP and DEP | 95% UCI | 14.46 | 0.19 | 0.05 |
| | Mean | 4.73 | 0.06 | 0.02 |
| | 95% LCI | 0.50 | 0.01 | 0.00 |

*Table 3-4: Estimated annual collision risk based on design-based density for Sandwich tern at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size, using the flight speed of Fijn and Gyimesi (2018) as a model input*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 13.59 | 0.15 | 0.04 |
| | Mean | 4.55 | 0.05 | 0.01 |
| | 95% LCI | 0.54 | 0.01 | 0.00 |
| SEP | 95% UCI | 3.75 | 0.04 | 0.01 |
| | Mean | 1.13 | 0.01 | 0.00 |
| | 95% LCI | 0.06 | 0.00 | 0.00 |
| SEP and DEP | 95% UCI | 17.34 | 0.19 | 0.05 |
| | Mean | 5.67 | 0.06 | 0.02 |
| | 95% LCI | 0.60 | 0.01 | 0.00 |

### 3.1.2 Cumulative

*Table 3-5: Estimated annual collision risk for Sandwich tern at OWFs in the wider Wash area, under five different consented/as-built scenarios, using model-based density estimates and the flight speed of Fijn and Collier (2020) as a model input*

| OWF | Scenario A | Scenario B | Scenario C | Scenario D | Scenario E |
|---|---|---|---|---|---|
| DOW | 20.05 | 16.65 | 22.26 | 21.31 | 16.65 |
| RB | 45.73 | 15.47 | 15.93 | 15.63 | 15.63 |
| SOW | 8.67 | 8.67 | 8.67 | 8.67 | 8.67 |
| TK | 8.92 | 3.03 | 5.61 | 3.91 | 3.91 |
| DEP | 4.46 | 4.46 | 4.46 | 4.46 | 4.46 |
| SEP | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 |

| OWF | Scenario A | Scenario B | Scenario C | Scenario D | Scenario E |
|---|---|---|---|---|---|
| Total | 89.24 | 49.69 | 58.34 | 55.39 | 50.73 |
| % increase to annual mortality of largest BDMPS population | 0.98 | 0.54 | 0.64 | 0.61 | 0.56 |
| % increase to annual mortality of biogeographic population | 0.25 | 0.14 | 0.16 | 0.16 | 0.14 |

*Table 3-6: Estimated annual collision risk for Sandwich tern at OWFs in the wider Wash area, under five different consented/as-built scenarios, using model-based density estimates and the flight speed of Fijn and Gyimesi (2018) as a model input*

| OWF | Scenario A | Scenario B | Scenario C | Scenario D | Scenario E |
|---|---|---|---|---|---|
| DOW | 23.25 | 18.68 | 25.19 | 23.92 | 18.68 |
| RB | 51.62 | 19.44 | 19.95 | 19.63 | 19.63 |
| SOW | 10.10 | 10.10 | 10.10 | 10.10 | 10.10 |
| TK | 10.54 | 3.48 | 6.54 | 4.49 | 4.49 |
| DEP | 4.46 | 4.46 | 4.46 | 4.46 | 4.46 |
| SEP | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 |
| Total | 101.38 | 57.57 | 67.65 | 64.01 | 58.77 |
| % increase to annual mortality of largest BDMPS population | 1.11 | 0.63 | 0.74 | 0.70 | 0.64 |
| % increase to annual mortality of biogeographic population | 0.29 | 0.16 | 0.19 | 0.18 | 0.17 |

*Table 3-7: Estimated annual collision risk for Sandwich tern at OWFs in the wider Wash area, under five different consented/as-built scenarios, using design-based density estimates and the flight speed of Fijn and Collier (2020) as a model input*

| OWF | Scenario A | Scenario B | Scenario C | Scenario D | Scenario E |
|---|---|---|---|---|---|
| DOW | 20.05 | 16.65 | 22.26 | 21.31 | 16.65 |
| RB | 45.73 | 15.47 | 15.93 | 15.63 | 15.63 |
| SOW | 8.67 | 8.67 | 8.67 | 8.67 | 8.67 |
| TK | 8.92 | 3.03 | 5.61 | 3.91 | 3.91 |
| DEP | 3.79 | 3.79 | 3.79 | 3.79 | 3.79 |
| SEP | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Total | 88.1 | 48.55 | 57.2 | 54.25 | 49.59 |
| % increase to annual mortality of largest BDMPS population | 0.96 | 0.53 | 0.63 | 0.59 | 0.54 |
| % increase to annual mortality of biogeographic population | 0.25 | 0.14 | 0.16 | 0.15 | 0.14 |

*Table 3-8: Estimated annual collision risk for Sandwich tern at OWFs in the wider Wash area, under five different consented/as-built scenarios, using design-based density estimates and the flight speed of Fijn and Gyimesi (2018) as a model input*

| OWF | Scenario A | Scenario B | Scenario C | Scenario D | Scenario E |
|---|---|---|---|---|---|
| DOW | 23.25 | 18.68 | 25.19 | 23.92 | 18.68 |
| RB | 51.62 | 19.44 | 19.95 | 19.63 | 19.63 |
| SOW | 10.10 | 10.10 | 10.10 | 10.10 | 10.10 |
| TK | 10.54 | 3.48 | 6.54 | 4.49 | 4.49 |
| DEP | 4.55 | 4.55 | 4.55 | 4.55 | 4.55 |
| SEP | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 |
| Total | 101.19 | 57.38 | 67.46 | 63.82 | 58.58 |
| % increase to annual mortality of largest BDMPS population | 1.11 | 0.63 | 0.74 | 0.70 | 0.64 |
| % increase to annual mortality of biogeographic population | 0.28 | 0.16 | 0.19 | 0.18 | 0.16 |

## 3.2 Gannet

### 3.2.1 SEP and DEP

*Table 3-9: Estimated annual collision risk for gannet at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 2.63 | 0.00 | 0.00 |
| | Mean | 0.90 | 0.00 | 0.00 |
| | 95% LCI | 0.02 | 0.00 | 0.00 |
| SEP | 95% UCI | 0.60 | 0.00 | 0.00 |
| | Mean | 0.16 | 0.00 | 0.00 |
| | 95% LCI | 0.00 | 0.00 | 0.00 |
| SEP and DEP | 95% UCI | 3.23 | 0.00 | 0.00 |
| | Mean | 1.06 | 0.00 | 0.00 |
| | 95% LCI | 0.02 | 0.00 | 0.00 |

### 3.2.2 Cumulative

*Table 3-10: Estimated annual cumulative collision risk for gannet*

| Tier/OWF | Spring migration | Breeding | Autumn migration | Annual |
|---|---|---|---|---|
| 1 to 3 | 70.9 | 391.0 | 179.5 | 641.4 |
| Hornsea Project Four (Tier 4) | 0.3 | 3.4 | 1.1 | 4.8 |
| SEP and DEP (Tier 4) | 0.0 | 0.4 | 0.6 | 1.1 |
| Rampion 2 (Tier 5) | 0.2 | 2.6 | 0.6 | 3.3 |
| Total | 71.4 | 397.4 | 181.9 | 650.6 |
| % increase to annual mortality of largest BDMPS population | - | - | - | 0.7 |
| % increase to annual mortality of biogeographic population | - | - | - | 0.3 |

## 3.3 Kittiwake

### 3.3.1 SEP and DEP

*Table 3-11: Estimated annual collision risk for kittiwake at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 27.82 | 0.02 | 0.00 |
| | Mean | 10.94 | 0.01 | 0.00 |
| | 95% LCI | 1.25 | 0.00 | 0.00 |
| SEP | 95% UCI | 6.66 | 0.01 | 0.00 |
| | Mean | 1.47 | 0.00 | 0.00 |
| | 95% LCI | 0.00 | 0.00 | 0.00 |
| SEP and DEP | 95% UCI | 34.48 | 0.03 | 0.00 |
| | Mean | 12.41 | 0.01 | 0.00 |
| | 95% LCI | 1.25 | 0.00 | 0.00 |

### 3.3.2 Cumulative

*Table 3-12: Estimated annual cumulative collision risk for kittiwake*

| Tier/OWF | Spring migration | Breeding | Autumn migration | Annual |
|---|---|---|---|---|
| 1 to 3 | 867.7 | 927.5 | 1124.6 | 2919.9 |
| Hornsea Project Four (Tier 4) | 3.3 | 54.2 | 10.1 | 67.6 |
| SEP and DEP (Tier 4) | 0.9 | 7.2 | 4.3 | 12.4 |

| Tier/OWF | Spring migration | Breeding | Autumn migration | Annual |
|---|---|---|---|---|
| Rampion 2 (Tier 5) | 4.9 | 1.6 | 1.2 | 7.7 |
| Total | 877.3 | 990.1 | 1140.1 | 3007.5 |
| % increase to annual mortality of largest BDMPS population | - | - | - | 2.3 |
| % increase to annual mortality of biogeographic population | - | - | - | 0.4 |

## 3.4 Great black-backed gull

### 3.4.1 SEP and DEP

*Table 3-13: Estimated annual collision risk for great black-backed gull at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 7.31 | 0.04 | 0.02 |
| | Mean | 1.57 | 0.01 | 0.00 |
| | 95% LCI | 0.00 | 0.00 | 0.00 |
| SEP | 95% UCI | 23.35 | 0.14 | 0.05 |
| | Mean | 4.41 | 0.03 | 0.01 |
| | 95% LCI | 0.00 | 0.00 | 0.00 |
| SEP and DEP | 95% UCI | 30.67 | 0.18 | 0.07 |
| | Mean | 5.97 | 0.04 | 0.01 |
| | 95% LCI | 0.00 | 0.00 | 0.00 |

### 3.4.2 Cumulative

*Table 3-14: Estimated annual cumulative collision risk for great black-backed gull*

| Tier/OWF | Breeding | Non-breeding | Annual |
|---|---|---|---|
| 1 to 3 | 220.7 | 954.5 | 1175.3 |
| Hornsea Project Four (Tier 4) | 1.0 | 10.6 | 11.5 |
| SEP and DEP (Tier 4) | 5.7 | 0.3 | 6.0 |
| Rampion 2 (Tier 5) | 1.1 | 3.7 | 4.8 |
| Total | 228.4 | 969.0 | 1197.6 |
| % increase to annual mortality of largest BDMPS population | - | - | 7.1 |

| Tier/OWF | Breeding | Non-breeding | Annual |
|---|---|---|---|
| % increase to annual mortality of biogeographic population | - | - | 2.8 |

## 3.5 Lesser black-backed gull

### 3.5.1 SEP and DEP

*Table 3-15: Estimated annual collision risk for lesser black-backed gull at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 8.04 | 0.03 | 0.01 |
| | Mean | 1.57 | 0.01 | 0.00 |
| | 95% LCI | 0.00 | 0.00 | 0.00 |
| SEP | 95% UCI | 2.93 | 0.01 | 0.00 |
| | Mean | 0.64 | 0.00 | 0.00 |
| | 95% LCI | 0.00 | 0.00 | 0.00 |
| SEP and DEP | 95% UCI | 10.97 | 0.04 | 0.01 |
| | Mean | 2.21 | 0.01 | 0.00 |
| | 95% LCI | 0.00 | 0.00 | 0.00 |

### 3.5.2 Cumulative

*Table 3-16: Estimated annual cumulative collision risk for lesser black-backed gull*

| Tier/OWF | Breeding | Non-breeding | Annual |
|---|---|---|---|
| 1 to 3 | 189.7 | 445.9 | 635.6 |
| Hornsea Project Four (Tier 4) | 1.0 | 0.0 | 1.0 |
| SEP and DEP (Tier 4) | 1.9 | 0.3 | 2.2 |
| Rampion 2 (Tier 5) | 0.7 | 1.4 | 2.2 |
| Total | 193.3 | 447.7 | 641.0 |
| % increase to annual mortality of largest BDMPS population | - | - | 2.4 |
| % increase to annual mortality of biogeographic population | - | - | 0.6 |

## 3.6 Little gull

### 3.6.1 SEP and DEP

*Table 3-17: Estimated annual collision risk for little gull at DEP, SEP, and SEP and DEP combined, along with associated increases in mortality within largest population size*

| OWF | Output | Annual collision rate | % increase to annual mortality of largest BDMPS population | % increase to annual mortality of biogeographic population |
|---|---|---|---|---|
| DEP | 95% UCI | 8.08 | - | 0.05 |
| | Mean | 2.36 | - | 0.02 |
| | 95% LCI | 0.00 | - | 0.00 |
| SEP | 95% UCI | 1.80 | - | 0.01 |
| | Mean | 0.53 | - | 0.00 |
| | 95% LCI | 0.00 | - | 0.00 |
| SEP and DEP | 95% UCI | 9.88 | - | 0.07 |
| | Mean | 2.89 | - | 0.02 |
| | 95% LCI | 0.00 | - | 0.00 |

# Appendix 1: SEP and DEP Updated CRM Outputs by Month

## Sandwich tern

*Estimated monthly collision risk for Sandwich tern at DEP, using the flight speed of Fijn and Collier (2020)*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 2.01 | 2.01 | 1.08 | 1.62 | 0.30 | 0.75 | 0.00 | 0.00 | 0.00 | 7.77 |
| Mean | 0.00 | 0.00 | 0.00 | 1.02 | 1.31 | 0.59 | 1.10 | 0.13 | 0.31 | 0.00 | 0.00 | 0.00 | 4.46 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.45 | 0.81 | 0.29 | 0.74 | 0.05 | 0.11 | 0.00 | 0.00 | 0.00 | 2.45 |

*Estimated monthly collision risk for Sandwich tern at SEP, using the flight speed of Fijn and Collier (2020)*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.09 | 0.58 | 0.80 | 0.86 | 0.16 | 0.15 | 0.00 | 0.00 | 0.00 | 2.63 |
| Mean | 0.00 | 0.00 | 0.00 | 0.02 | 0.33 | 0.36 | 0.59 | 0.05 | 0.05 | 0.00 | 0.00 | 0.00 | 1.41 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.14 | 0.42 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.78 |

*Estimated monthly collision risk for Sandwich tern at SEP and DEP combined, using the flight speed of Fijn and Collier (2020)*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 2.10 | 2.59 | 1.88 | 2.49 | 0.46 | 0.90 | 0.00 | 0.00 | 0.00 | 10.41 |
| Mean | 0.00 | 0.00 | 0.00 | 1.04 | 1.64 | 0.95 | 1.69 | 0.18 | 0.37 | 0.00 | 0.00 | 0.00 | 5.87 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.45 | 1.00 | 0.43 | 1.16 | 0.06 | 0.12 | 0.00 | 0.00 | 0.00 | 3.23 |

*Estimated monthly collision risk for Sandwich tern at DEP, using the flight speed of Fijn and Gyimesi (2018)*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 2.37 | 2.39 | 1.29 | 1.93 | 0.36 | 0.89 | 0.00 | 0.00 | 0.00 | 9.22 |
| Mean | 0.00 | 0.00 | 0.00 | 1.22 | 1.57 | 0.71 | 1.32 | 0.16 | 0.38 | 0.00 | 0.00 | 0.00 | 5.35 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.54 | 0.98 | 0.35 | 0.88 | 0.06 | 0.13 | 0.00 | 0.00 | 0.00 | 2.94 |

*Estimated monthly collision risk for Sandwich tern at SEP, using the flight speed of Fijn and Gyimesi (2018)*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.11 | 0.69 | 0.96 | 1.04 | 0.19 | 0.17 | 0.00 | 0.00 | 0.00 | 3.16 |
| Mean | 0.00 | 0.00 | 0.00 | 0.03 | 0.40 | 0.43 | 0.71 | 0.06 | 0.06 | 0.00 | 0.00 | 0.00 | 1.69 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.22 | 0.17 | 0.50 | 0.02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.93 |

*Estimated monthly collision risk for Sandwich tern at SEP and DEP combined, using the flight speed of Fijn and Gyimesi (2018)*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 2.48 | 3.08 | 2.25 | 2.96 | 0.55 | 1.06 | 0.00 | 0.00 | 0.00 | 12.38 |
| Mean | 0.00 | 0.00 | 0.00 | 1.25 | 1.97 | 1.14 | 2.02 | 0.22 | 0.44 | 0.00 | 0.00 | 0.00 | 7.04 |

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.54 | 1.20 | 0.52 | 1.39 | 0.08 | 0.15 | 0.00 | 0.00 | 0.00 | 3.88 |

## Gannet

*Estimated monthly collision risk for gannet at DEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.21 | 0.38 | 0.09 | 0.12 | 0.09 | 0.08 | 0.18 | 0.83 | 0.52 | 0.13 | 2.63 |
| Mean | 0.00 | 0.00 | 0.04 | 0.16 | 0.02 | 0.02 | 0.02 | 0.02 | 0.07 | 0.24 | 0.26 | 0.03 | 0.90 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |

*Estimated monthly collision risk for gannet at SEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.06 | 0.05 | 0.07 | 0.00 | 0.32 | 0.00 | 0.60 |
| Mean | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.11 | 0.00 | 0.16 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Estimated monthly collision risk for gannet at SEP and DEP combined*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.21 | 0.48 | 0.09 | 0.12 | 0.14 | 0.13 | 0.25 | 0.83 | 0.84 | 0.13 | 3.23 |
| Mean | 0.00 | 0.00 | 0.04 | 0.19 | 0.02 | 0.02 | 0.03 | 0.03 | 0.08 | 0.24 | 0.38 | 0.03 | 1.06 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 |

## Kittiwake

*Estimated monthly collision risk for kittiwake at DEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 1.39 | 0.92 | 0.81 | 7.18 | 3.79 | 0.59 | 0.95 | 3.00 | 5.73 | 1.96 | 0.54 | 0.97 | 27.82 |
| Mean | 0.57 | 0.38 | 0.21 | 3.94 | 1.15 | 0.11 | 0.36 | 0.85 | 1.93 | 0.86 | 0.10 | 0.49 | 10.94 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 1.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.00 | 0.00 | 0.00 | 1.25 |

*Estimated monthly collision risk for kittiwake at SEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 2.59 | 0.00 | 0.36 | 0.00 | 0.00 | 1.60 | 0.00 | 0.77 | 1.35 | 6.66 |
| Mean | 0.00 | 0.00 | 0.00 | 0.54 | 0.00 | 0.06 | 0.00 | 0.00 | 0.41 | 0.00 | 0.20 | 0.26 | 1.47 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Estimated monthly collision risk for kittiwake at SEP and DEP combined*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 1.39 | 0.92 | 0.81 | 9.76 | 3.79 | 0.95 | 0.95 | 3.00 | 7.33 | 1.96 | 1.31 | 2.32 | 34.48 |
| Mean | 0.57 | 0.38 | 0.21 | 4.48 | 1.15 | 0.17 | 0.36 | 0.85 | 2.34 | 0.86 | 0.30 | 0.75 | 12.41 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 1.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 | 0.00 | 0.00 | 0.00 | 1.25 |

### Great black-backed gull

*Estimated monthly collision risk for great black-backed gull at DEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 1.60 | 0.00 | 0.00 | 1.01 | 0.00 | 0.00 | 1.00 | 0.00 | 1.92 | 0.00 | 1.78 | 7.31 |
| Mean | 0.00 | 0.30 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.16 | 0.00 | 0.68 | 0.00 | 0.31 | 1.57 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Estimated monthly collision risk for great black-backed gull at SEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 1.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.81 | 1.60 | 18.34 | 23.35 |
| Mean | 0.29 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 | 0.84 | 2.99 | 4.41 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Estimated monthly collision risk for great black-backed gull at SEP and DEP combined*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 1.60 | 1.60 | 0.00 | 0.00 | 1.01 | 0.00 | 0.00 | 1.00 | 0.00 | 3.73 | 1.60 | 20.12 | 30.67 |
| Mean | 0.29 | 0.30 | 0.00 | 0.00 | 0.11 | 0.00 | 0.00 | 0.16 | 0.00 | 0.96 | 0.84 | 3.31 | 5.97 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

### Lesser black-backed gull

*Estimated monthly collision risk for lesser black-backed gull at DEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.49 | 0.00 | 2.60 | 2.91 | 0.18 | 0.63 | 0.00 | 0.00 | 1.23 | 8.04 |
| Mean | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.49 | 0.63 | 0.04 | 0.11 | 0.00 | 0.00 | 0.22 | 1.57 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Estimated monthly collision risk for lesser black-backed gull at SEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 1.54 | 0.81 | 0.00 | 0.00 | 0.00 | 0.00 | 2.93 |
| Mean | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.32 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Estimated monthly collision risk for lesser black-backed gull at SEP and DEP combined*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.49 | 0.00 | 3.18 | 4.45 | 0.99 | 0.63 | 0.00 | 0.00 | 1.23 | 10.97 |
| Mean | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.57 | 0.95 | 0.29 | 0.11 | 0.00 | 0.00 | 0.22 | 2.21 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

### Little gull

*Estimated monthly collision risk for little gull at DEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.08 | 0.00 | 0.00 | 8.08 |

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.36 | 0.00 | 0.00 | 2.36 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Estimated monthly collision risk for little gull at SEP*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 0.42 | 1.19 | 0.00 | 1.80 |
| Mean | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 0.08 | 0.41 | 0.00 | 0.53 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

*Estimated monthly collision risk for little gull at SEP and DEP combined*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95% UCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 8.50 | 1.19 | 0.00 | 9.88 |
| Mean | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 2.44 | 0.41 | 0.00 | 2.89 |
| 95% LCI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

## Appendix 2: Updated Cumulative Collision Outputs

### Gannet

*Cumulative collision risk for gannet, consented OWF parameters*

| Tier | OWF | Estimated gannet collisions (0.992 avoidance rate, with 0.7 macro-avoidance correction factor) | | | |
|---|---|---|---|---|---|
| | | Spring | Breeding | Autumn | Annual |
| 1 | Beatrice | 2.1 | 8.2 | 10.6 | 20.9 |
| 1 | Beatrice (demonstrator) | 0.2 | 0.1 | 0.2 | 0.5 |
| 1 | Blyth Demonstration | 0.6 | 0.8 | 0.5 | 1.8 |
| 1 | Dudgeon | 4.2 | 4.9 | 8.5 | 17.5 |
| 1 | East Anglia ONE | 1.4 | 0.7 | 28.6 | 30.8 |
| 1 | EOWDC (Aberdeen OWF) | 0.0 | 0.9 | 1.1 | 2.0 |
| 1 | Galloper | 2.7 | 3.9 | 6.7 | 13.4 |
| 1 | Greater Gabbard | 1.0 | 3.1 | 1.9 | 6.0 |
| 1 | Gunfleet Sands | - | - | - | - |
| 1 | Hornsea Project One | 4.9 | 2.5 | 7.0 | 14.4 |
| 1 | Humber Gateway | 0.3 | 0.4 | 0.2 | 1.0 |
| 1 | Hywind | 0.2 | 1.2 | 0.2 | 1.6 |
| 1 | Kentish Flats | 0.2 | 0.3 | 0.2 | 0.7 |
| 1 | Kentish Flats Extension | - | - | - | - |
| 1 | Kincardine | 0.0 | 0.7 | 0.0 | 0.7 |
| 1 | Lincs | 0.4 | 0.5 | 0.3 | 1.1 |
| 1 | London Array | 0.4 | 0.5 | 0.3 | 1.2 |

| Tier | OWF | Estimated gannet collisions (0.992 avoidance rate, with 0.7 macro-avoidance correction factor) | | | |
|---|---|---|---|---|---|
| | | Spring | Breeding | Autumn | Annual |
| 1 | Lynn and Inner Dowsing | 0.0 | 0.0 | 0.0 | 0.1 |
| 1 | Methil | 0.0 | 1.3 | 0.0 | 1.3 |
| 1 | Moray Firth (EDA) | 1.9 | 17.6 | 7.7 | 27.3 |
| 1 | Race Bank | 0.9 | 7.4 | 2.6 | 10.8 |
| 1 | Rampion | 0.5 | 7.9 | 13.9 | 22.2 |
| 1 | Scroby Sands | - | - | - | - |
| 1 | Sheringham Shoal | 0.0 | 3.1 | 0.8 | 3.8 |
| 1 | Teesside | 0.0 | 1.1 | 0.4 | 1.5 |
| 1 | Thanet | 0.0 | 0.2 | 0.0 | 0.2 |
| 1 | Triton Knoll | 6.6 | 5.8 | 14.0 | 26.4 |
| 1 | Westermost Rough | 0.0 | 0.0 | 0.0 | 0.1 |
| 2 | Dogger Bank A and B | 11.9 | 17.7 | 18.2 | 47.8 |
| 2 | Dogger Bank C and Sofia | 2.4 | 3.2 | 2.2 | 7.8 |
| 2 | Forth (Seagreen) Alpha and Bravo | 14.4 | 174.7 | 10.8 | 199.8 |
| 2 | Hornsea Project Two | 1.3 | 1.5 | 3.1 | 5.9 |
| 2 | Moray West | 0.2 | 2.2 | 0.4 | 2.8 |
| 2 | Neart na Gaoithe | 5.0 | 31.2 | 10.3 | 46.5 |
| 3 | East Anglia ONE North | 0.2 | 2.7 | 2.4 | 5.3 |
| 3 | East Anglia THREE | 2.1 | 1.3 | 7.3 | 10.7 |
| 3 | East Anglia TWO | 0.9 | 2.7 | 5.0 | 8.6 |
| 3 | Hornsea Project Three | 0.9 | 2.2 | 1.1 | 4.1 |

| Tier | OWF | Estimated gannet collisions (0.992 avoidance rate, with 0.7 macro-avoidance correction factor) | | | |
|---|---|---|---|---|---|
| | | Spring | Breeding | Autumn | Annual |
| 3 | Inch Cape | 1.1 | 73.5 | 6.4 | 81.0 |
| 3 | Norfolk Boreas | 0.9 | 3.1 | 2.8 | 6.7 |
| 3 | Norfolk Vanguard | 1.2 | 1.8 | 4.1 | 7.0 |
| 4 | Hornsea Project Four | 0.3 | 3.4 | 1.1 | 4.8 |
| 4 | Sheringham and Dudgeon Extension Projects | 0.0 | 0.4 | 0.6 | 1.1 |
| 5 | Rampion 2 | 0.2 | 2.6 | 0.6 | 3.3 |
| **TOTAL** | | **71.4** | **397.4** | **181.9** | **650.6** |

### Kittiwake

*Cumulative collision risk for kittiwake, consented OWF parameters*

| Tier | OWF | Estimated kittiwake collisions (0.992 avoidance rate) | | | |
|---|---|---|---|---|---|
| | | Spring | Breeding | Autumn | Annual |
| 1 | Beatrice | 28.9 | 68.9 | 7.8 | 105.6 |
| 1 | Beatrice (demonstrator) | 1.2 | 0.0 | 1.5 | 2.8 |
| 1 | Blyth Demonstration | 1.0 | 1.2 | 1.7 | 3.9 |
| 1 | Dudgeon | - | - | - | - |
| 1 | East Anglia ONE | 34.0 | 1.3 | 116.7 | 152.0 |
| 1 | EOWDC (Aberdeen OWF) | 0.8 | 8.6 | 4.2 | 13.6 |
| 1 | Galloper | 23.1 | 4.6 | 20.2 | 47.9 |
| 1 | Greater Gabbard | 8.3 | 0.8 | 10.9 | 20.0 |
| 1 | Gunfleet Sands | - | - | - | - |

| Tier | OWF | Estimated kittiwake collisions (0.992 avoidance rate) | | | |
|---|---|---|---|---|---|
| | | Spring | Breeding | Autumn | Annual |
| 1 | Hornsea Project One | 15.2 | 32.0 | 40.7 | 87.9 |
| 1 | Humber Gateway | 1.4 | 1.4 | 2.3 | 5.1 |
| 1 | Hywind | 0.7 | 12.1 | 0.7 | 13.3 |
| 1 | Kentish Flats | 0.5 | 0.0 | 0.7 | 1.2 |
| 1 | Kentish Flats Extension | 2.0 | 0.0 | 0.0 | 2.0 |
| 1 | Kincardine | 0.7 | 16.0 | 6.5 | 23.3 |
| 1 | Lincs | 0.5 | 0.5 | 0.9 | 1.9 |
| 1 | London Array | 1.3 | 1.0 | 1.7 | 4.0 |
| 1 | Lynn and Inner Dowsing | - | - | - | - |
| 1 | Methil | 0.0 | 0.3 | 0.0 | 0.3 |
| 1 | Moray East | 14.0 | 31.7 | 1.5 | 47.2 |
| 1 | Race Bank | 4.1 | 1.4 | 17.4 | 22.8 |
| 1 | Rampion | 21.6 | 39.6 | 27.2 | 88.4 |
| 1 | Scroby Sands | - | - | - | - |
| 1 | Sheringham Shoal | - | - | - | - |
| 1 | Teesside | 1.8 | 27.9 | 17.5 | 47.2 |
| 1 | Thanet | 0.3 | 0.1 | 0.4 | 0.8 |
| 1 | Triton Knoll | 33.0 | 17.9 | 101.1 | 152.0 |
| 1 | Westermost Rough | 0.1 | 0.1 | 0.1 | 0.4 |
| 2 | Dogger Bank A and B | 214.8 | 209.9 | 98.2 | 522.9 |
| 2 | Dogger Bank C and Sofia | 157.7 | 99.6 | 66.0 | 323.3 |

| Tier | OWF | Estimated kittiwake collisions (0.992 avoidance rate) | | | |
|---|---|---|---|---|---|
| | | Spring | Breeding | Autumn | Annual |
| 2 | Forth (Seagreen) Alpha and Bravo | 180.1 | 111.3 | 227.7 | 519.1 |
| 2 | Hornsea Project Two | 2.2 | 11.6 | 6.5 | 20.4 |
| 2 | Moray West | 5.1 | 57.5 | 17.5 | 80.0 |
| 2 | Neart na Gaoithe | 3.2 | 23.9 | 40.8 | 67.9 |
| 3 | East Anglia ONE North | 2.5 | 29.4 | 5.9 | 37.8 |
| 3 | East Anglia THREE | 27.3 | 4.4 | 50.2 | 82.0 |
| 3 | East Anglia TWO | 5.4 | 21.5 | 3.9 | 30.8 |
| 3 | Hornsea Project Three | 5.8 | 56.0 | 27.6 | 89.5 |
| 3 | Inch Cape | 46.2 | 9.5 | 163.5 | 219.2 |
| 3 | Norfolk Boreas | 8.7 | 9.7 | 23.4 | 41.8 |
| 3 | Norfolk Vanguard | 14.0 | 15.9 | 11.9 | 41.8 |
| 4 | Hornsea Project Four | 3.3 | 54.2 | 10.1 | 67.6 |
| 4 | Sheringham and Dudgeon Extension Projects | 0.9 | 7.2 | 4.3 | 12.4 |
| 5 | Rampion 2 | 4.9 | 1.6 | 1.2 | 7.7 |
| **TOTAL** | | **876.9** | **990.5** | **1140.1** | **3007.6** |

### Great black-backed gull

*Cumulative collision risk for great black-backed gull, consented OWF parameters*

| Tier | OWF | Estimated great black-backed gull collisions (0.994 avoidance rate) | | |
|---|---|---|---|---|
| | | Breeding | Non-breeding | Annual |
| 1 | Beatrice | 36.2 | 145.0 | 181.2 |
| 1 | Beatrice (demonstrator) | 0.0 | 0.0 | 0.0 |
| 1 | Blyth Demonstration | 1.6 | 6.1 | 7.6 |
| 1 | Dudgeon | 0.0 | 0.0 | 0.0 |
| 1 | East Anglia ONE | 0.0 | 55.2 | 55.2 |
| 1 | EOWDC (Aberdeen OWF) | 0.7 | 2.9 | 3.6 |
| 1 | Galloper | 5.4 | 21.6 | 27.0 |
| 1 | Greater Gabbard | 18.0 | 72.0 | 90.0 |
| 1 | Gunfleet Sands | - | - | - |
| 1 | Hornsea Project One | 20.6 | 82.3 | 103.0 |
| 1 | Humber Gateway | 1.6 | 6.1 | 7.6 |
| 1 | Hywind | 0.4 | 5.4 | 5.8 |
| 1 | Kentish Flats | - | - | - |
| 1 | Kentish Flats Extension | 0.1 | 0.2 | 0.4 |
| 1 | Kincardine | 0.0 | 0.0 | 0.0 |
| 1 | Lincs | 0.0 | 0.0 | 0.0 |
| 1 | London Array | - | - | - |
| 1 | Lynn and Inner Dowsing | 0.0 | 0.0 | 0.0 |
| 1 | Methil | 1.0 | 1.0 | 1.9 |

| Tier | OWF | Estimated great black-backed gull collisions (0.994 avoidance rate) | | |
|---|---|---|---|---|
| | | Breeding | Non-breeding | Annual |
| 1 | Moray Firth (EDA) | 11.4 | 30.6 | 42.0 |
| 1 | Race Bank | 0.0 | 0.0 | 0.0 |
| 1 | Rampion | 6.2 | 25.0 | 31.2 |
| 1 | Scroby Sands | - | - | - |
| 1 | Sheringham Shoal | 0.0 | 0.0 | 0.0 |
| 1 | Teesside | 10.4 | 41.8 | 52.3 |
| 1 | Thanet | 0.1 | 0.5 | 0.6 |
| 1 | Triton Knoll | 29.3 | 117.1 | 146.4 |
| 1 | Westermost Rough | 0.0 | 0.0 | 0.1 |
| 2 | Dogger Bank A and B | 7.0 | 28.0 | 34.9 |
| 2 | Dogger Bank C and Sofia | 7.7 | 30.6 | 38.3 |
| 2 | Forth (Seagreen) Alpha and Bravo | 16.1 | 64.1 | 80.2 |
| 2 | Hornsea Project Two | 3.6 | 24.0 | 27.6 |
| 2 | Moray West | 4.8 | 6.0 | 10.8 |
| 2 | Neart na Gaoithe | 1.1 | 4.3 | 5.4 |
| 3 | East Anglia ONE North | 4.4 | 1.4 | 6.0 |
| 3 | East Anglia THREE | 5.5 | 41.3 | 46.8 |
| 3 | East Anglia TWO | 4.2 | 4.1 | 8.3 |
| 3 | Hornsea Project Three | 9.6 | 33.6 | 43.2 |
| 3 | Inch Cape | 0.0 | 44.2 | 44.2 |
| 3 | Norfolk Boreas | 8.3 | 34.4 | 42.7 |

| Tier | OWF | Estimated great black-backed gull collisions (0.994 avoidance rate) | | |
|---|---|---|---|---|
| | | Breeding | Non-breeding | Annual |
| 3 | Norfolk Vanguard | 5.4 | 25.8 | 31.2 |
| 4 | Hornsea Project Four | 1.0 | 10.6 | 11.5 |
| 4 | Sheringham and Dudgeon Extension Projects | 5.7 | 0.3 | 6.0 |
| 5 | Rampion 2 | 1.1 | 3.7 | 4.8 |
| **TOTAL** | | **228.4** | **969.0** | **1197.6** |

### Lesser black-backed gull

*Cumulative collision risk for lesser black-backed gull, consented OWF parameters*

| Tier | OWF | Estimated lesser black-backed gull collisions (0.994 avoidance rate) | | |
|---|---|---|---|---|
| | | Breeding | Non-breeding | Annual |
| 1 | Beatrice | 0.0 | 0.0 | 0.0 |
| 1 | Beatrice (demonstrator) | - | - | - |
| 1 | Blyth Demonstration | 0.0 | 0.0 | 0.0 |
| 1 | Dudgeon | 9.2 | 36.7 | 46.0 |
| 1 | East Anglia ONE | 7.1 | 40.6 | 47.6 |
| 1 | EOWDC (Aberdeen OWF) | 0.0 | 0.0 | 0.0 |
| 1 | Galloper | 33.4 | 133.2 | 166.6 |
| 1 | Greater Gabbard | 14.9 | 59.5 | 74.4 |
| 1 | Gunfleet Sands | 1.2 | 0.0 | 1.2 |
| 1 | Hornsea Project One | 5.3 | 20.9 | 26.2 |
| 1 | Humber Gateway | 0.4 | 1.3 | 1.7 |

| Tier | OWF | Estimated lesser black-backed gull collisions (0.994 avoidance rate) | | |
|---|---|---|---|---|
| | | Breeding | Non-breeding | Annual |
| 1 | Hywind | 0.0 | 0.0 | 0.0 |
| 1 | Kentish Flats | - | - | - |
| 1 | Kentish Flats Extension | 0.4 | 1.6 | 1.9 |
| 1 | Kincardine | 0.0 | 0.0 | 0.0 |
| 1 | Lincs | 2.0 | 8.2 | 10.2 |
| 1 | London Array | - | - | - |
| 1 | Lynn and Inner Dowsing | - | - | - |
| 1 | Methil | 0.6 | 0.0 | 0.6 |
| 1 | Moray East | 0.0 | 0.0 | 0.0 |
| 1 | Race Bank | 51.8 | 13.0 | 64.8 |
| 1 | Rampion | 1.9 | 7.6 | 9.5 |
| 1 | Scroby Sands | - | - | - |
| 1 | Sheringham Shoal | 2.0 | 7.9 | 10.0 |
| 1 | Teesside | 0.0 | 0.0 | 0.0 |
| 1 | Thanet | 3.8 | 15.4 | 19.2 |
| 1 | Triton Knoll | 8.9 | 35.5 | 44.4 |
| 1 | Westermost Rough | 0.1 | 0.4 | 0.5 |
| 2 | Dogger Bank A and B | 3.1 | 12.5 | 15.6 |
| 2 | Dogger Bank C and Sofia | 2.9 | 11.5 | 14.4 |
| 2 | Forth (Seagreen) Alpha and Bravo | 2.5 | 10.1 | 12.6 |
| 2 | Hornsea Project Two | 2.4 | 2.4 | 4.8 |

| Tier | OWF | Estimated lesser black-backed gull collisions (0.994 avoidance rate) | | |
|---|---|---|---|---|
| | | Breeding | Non-breeding | Annual |
| 2 | Moray West | 0.0 | 0.0 | 0.0 |
| 2 | Neart na Gaoithe | 0.4 | 1.4 | 1.8 |
| 3 | East Anglia ONE North | 1.1 | 0.7 | 1.8 |
| 3 | East Anglia THREE | 2.2 | 9.8 | 12.0 |
| 3 | East Anglia TWO | 5.0 | 0.6 | 5.6 |
| 3 | Hornsea Project Three | 9.6 | 1.2 | 10.8 |
| 3 | Inch Cape | 0.0 | 0.0 | 0.0 |
| 3 | Norfolk Boreas | 7.4 | 9.7 | 17.2 |
| 3 | Norfolk Vanguard | 10.1 | 4.3 | 14.4 |
| 4 | Hornsea Project Four | 1.0 | 0.0 | 1.0 |
| 4 | Sheringham and Dudgeon Extension Projects | 1.9 | 0.3 | 2.2 |
| 5 | North Falls | 16.3 | 6.2 | 22.6 |
| 5 | Rampion 2 | 0.7 | 1.4 | 2.2 |
| **TOTAL** | | **193.3** | **447.7** | **641.0** |

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