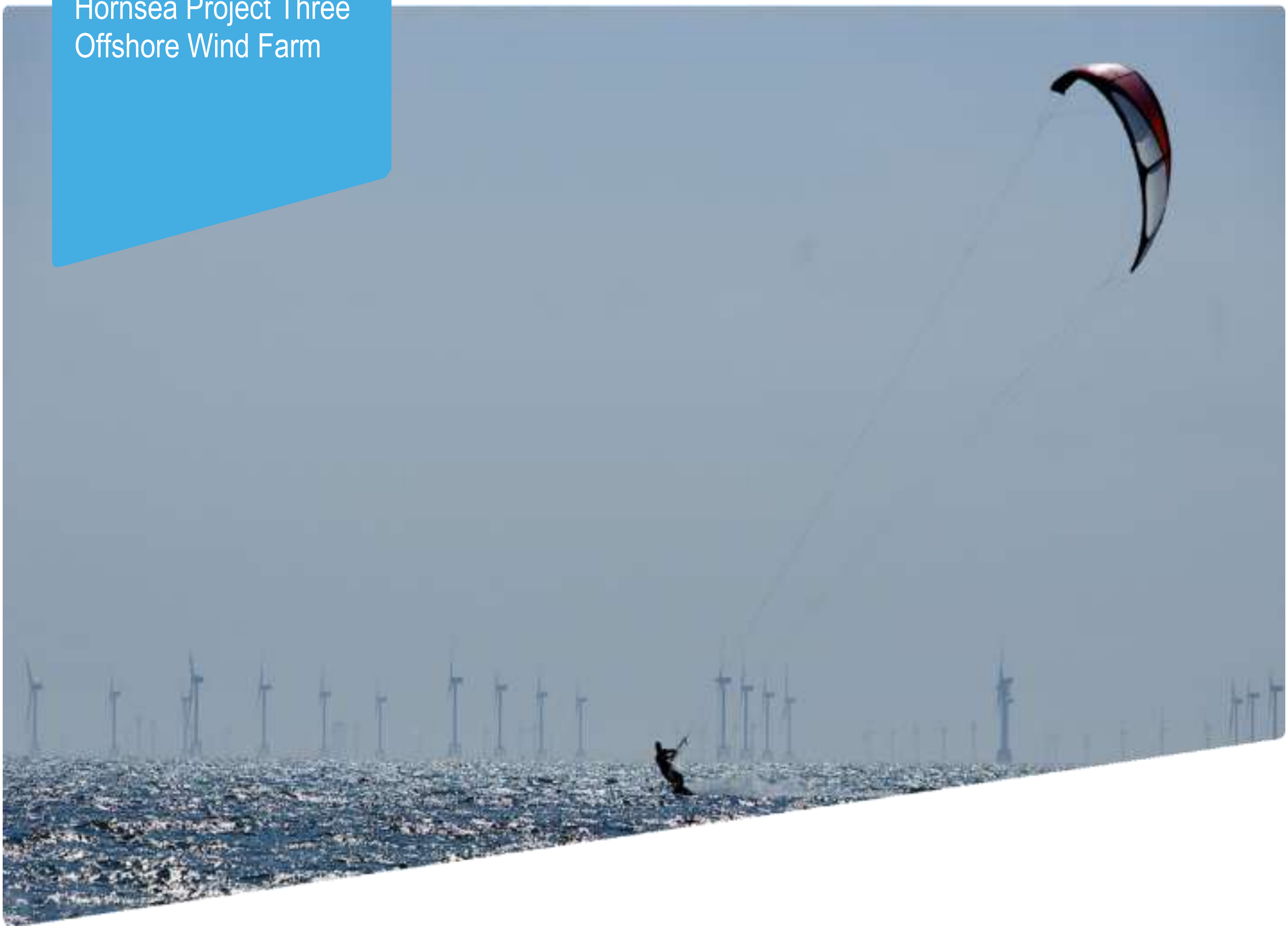
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Appendix 12 to Deadline I submission – Collision risk modelling – herring gull – Clarification Note

Date: 7th November 2018

Hornsea 3
Offshore Wind Farm

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Table of Contents

List of Tables

1. Collision risk modelling – herring gull

Introduction

1.1 Herring gull was not identified as a Valued Ornithological Receptor (VOR) using the criteria defined in Volume 5, Annex 5.1: Baseline Characterisation Report. This conclusion was based on the abundance of herring gull recorded during site-specific surveys which was considered unlikely to surpass population importance thresholds (e.g. 1% of the reference breeding population).

1.2 The Royal Society for the Protection of Birds (RSPB) do not agree with the decision to exclude herring gull from the assessments undertaken for herring gull, stating in their Relevant Representation that: *"While Hornsea 3 lies outwith the mean maximum foraging range presented in Thaxter et al., (2012), the species is currently red listed in Birds of Conservation Concern and considered to be at a high risk of collision. Numbers in the Hornsea 3 survey area can be relatively high in the breeding season (221 in June 2017), therefore further consideration should be made in the assessment."*.

1.3 It has been agreed with the RSPB, as part of a consultation meeting undertaken on 8th August 2018 that the Applicant would conduct collision risk modelling for herring gull to support the conclusions in Volume 5, Annex 5.1: Baseline Characterisation Report. This report presents the collision risk modelling process for herring gull and considers the resulting collision risk estimates against relevant reference populations.

1.4 No Likely Significant Effects were identified for herring gull at any UK SPA as part of the screening process undertaken for Hornsea Three. This was due either to the location of Hornsea Three, which is far beyond the foraging range of herring gull from any UK breeding colony or there being no predicted impacts in the non-breeding season. As such no consideration is given here to potential effects on UK SPAs.

Methodology

Overview

1.5 The collision risk modelling methodology used for herring gull is consistent with that presented in Volume 5, Annex 5.3 - Collision Risk Modelling (Document 6.5.5.3). The parameters used for modelling are presented in the following sections

Species parameters

Bird biometric and behavioural data

1.6 Table 1.1 presents the species-specific parameters for herring gull used in collision risk modelling. All parameters are informed by the use of best available evidence with sources for all parameters provided in Table 1.1.

1.7 The avoidance rates used for herring gull are taken from Cook *et al.* (2014). Cook *et al.* (2014) recommends avoidance rates for use with both the Basic and Extended models for herring gull with this advocated for use by JNCC *et al.* (2014). Skov *et al.* (2018) recommends an avoidance rate of 0.999 (± 0.005 SD) for herring gull. However, the avoidance rates derived by Skov *et al.* (2018) have not yet been assessed for use in the Band (2012) CRM and are therefore not considered here.

1.8 Collision risk modelling conducted in Volume 5, Annex 5.3 - Collision Risk Modelling (Document 6.5.5.3) utilised flight speed data from Alerstam *et al.* (2007) or Pennycuick (1987). Since the submission of the application flight speed data that is more representative of seabird flight behaviour has been published (Skov *et al.,* 2018).

1.9 The flight speed value for herring gull from Alerstam *et al.* (2007) (13.1 m/s) is based on a very small sample size (18 tracks). The laser rangefinder track data recorded by Skov *et al*. (2018) at Thanet Offshore Wind Farm off the Kent coast, offers empirical data on flight speeds for herring gull from large numbers of individuals (n = 790 large gulls), albeit in non-adverse weather conditions and provides a flight speed of 9.8 m/s. As such, those data are a valuable source of information on more realistic mean flight speeds and associated variability in offshore wind farms.

i. The birds observed by Alerstam *et al*. (2007) were located either in southern Sweden or within the Arctic circle and no determination is given between migratory or foraging birds from colonies. Indeed, the large range of species included in Alerstam *et al.* (2007) suggests that non-breeding and/or migratory flights comprised a significant component of the data set.

1.10 The total track time for the radar recordings of herring gull used in Alerstam *et al.* (2007) was 7,210 seconds and was restricted to radar recordings from migration flight which are expected to be birds flying at an airspeed close to that associated with maximum lift-drag ratio (Alerstam *et al*., 2007). This would imply that the very small sample sizes of flight speed data from Alerstam *et al.* (2007) are not necessarily behaviourally representative of bird flight at sea. Indeed the flight speeds recorded by Skov *et al*. (2018) were markedly lower than the generic speeds typically used (Alerstam *et al*., 2007).

1.11 There is no reason to consider the Thanet data to be any less representative for birds at Hornsea Three than those of Alerstam *et al*., (2007). The flight speed data presented by Skov *et al.* (2018) is therefore considered to represent the best available evidence on flight speed for use in collision risk modelling and therefore the flight speed value for herring gull is used for the collision risk modelling presented in this report.

Table 1.1: Species-specific parameters used for collision risk modelling

Parameter	Source	Value
Bird length (m)	Robinson (2017)	0.6

Parameter	Source	Value
Wingspan (m)	Robinson (2017)	1.44
Flight speed (m/s)	Skov *et al.* (2018)	9.8
Nocturnal activity factor [1]	Garthe and Hüppop (2004)	3
Flight type	N/A[2]	Flapping
Proportion of flights upwind (%)	N/A[3]	50
Avoidance rate (Basic model) (%)[4]	Cook *et al*. (2014) JNCC *et al.* (2014)	99.5 (± 0.1) 99.5 (± 0.1)
Avoidance rate (Extended model) (%)	Cook *et al*. (2014) JNCC *et al.* (2014)	99.0 (± 0.2) 99.0 (± 0.2)

Density data

1.12 Project-specific data for Hornsea Three has been collected by twenty digital aerial surveys carried out between April 2016 and November 2017 encompassing the wind farm array area plus a 4 km buffer. From these data, and to inform collision risk assessment, monthly densities of birds in flight (including upper and lower 95% confidence limits) in the Hornsea Three array area have been derived.

1.13 Further information on the aerial surveys undertaken for Hornsea Three and the methodologies used to derive population estimates is provided in the Annex 5.1: Offshore Ornithology Baseline Characterisation Report.

1.14 Herring gull is not an abundant species at Hornsea Three or across the former Hornsea Zone (SmartWind, 2015) and it is therefore considered that the project-specific aerial surveys provide sufficient information to describe the abundance and associated variability of herring gull at Hornsea Three.

Hornsea Three design and turbine parameters

1.15 The wind farm design and turbine parameters used for collision risk modelling for herring gull are consistent with those used for collision risk modelling in Volume 5, Annex 5.3 - Collision Risk Modelling (Document 6.5.5.3). These are presented in Table 1.2 and Table 1.3.

Table 1.2: Wind farm and turbine parameters used for collision risk modelling.

[1] A 1-5 scale is used for nocturnal activity with 1 representing limited nocturnal activity and 5 large amounts of nocturnal activity
[2] Based on expert opinion - the input parameters for flight type are either 'flapping' or 'gliding' with flapping representing the worst case scenario
[3] Assumed that there is a 50:50 split in flights upwind and downwind
[4] A range of avoidance rates are presented in the following sections, with those in Table 1.1 the rates reported in Cook *et al.* (2014)

Parameter	Value
Wind farm	
Latitude (degrees)	53.87
Number of turbines	300
Tidal offset (m)	1.8
Turbine	
Average rotation speed (rpm)	8.1
Rotor radius (m)	97.5
Hub height (m)	128.87 (HAT)
Max blade width (m)	6
Average pitch (°)	4.3

Table 1.3: Monthly proportion of time turbines at Hornsea Three will be operational.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Proportion of time operational (%)	92.50	92.61	92.14	90.96	90.71	89.36	89.18	89.86	91.29	92.57	92.59	92.61

Band model Options

1.16 Volume 5, Annex 5.3: Collision Risk Modelling (Document 6.5.5.3) presented collision risk estimates calculated using Options 1, 2 and 3 of Band (2012). Options 1 and 2 use the Basic Band (2012) Band model with Option 3 using the Extended Band (2012) model. The difference between the two Options under each model is linked to the use of flight height data. Options 2 and 3 use generic data from Johnston *et al*. (2014) whereas Option 1 uses site-specific data derived from site-specific surveys.

1.17 Due to limitations with the flight height data obtained from site-specific aerial surveys (see paragraphs 1.3.4.4 and 1.3.4.5 in Volume 5, Annex 5.3: Collision Risk Modelling (Document 6.5.5.3)), flight height data from boat-based surveys conducted to support the application process for the Hornsea Project One and Hornsea Project Two offshore wind farms were used to calculate the proportion of birds at collision height (PCH) for use with Option 1. The data used overlapped with Hornsea Three plus a 4 km buffer. This subset of the dataset, however does not provide an adequate sample size to calculate a representative PCH value for use in collision risk modelling.

1.18 For herring gull, the full boat-based dataset covering the full extent of the former Hornsea Zone has been used to derive a PCH value. It should be noted that there may exist differences in the flight behaviour of birds across such a large area due to, for example, proximity to breeding colonies. However, as no other site-specific data are available it is considered appropriate to utilise the whole boat-based dataset collected to support the application process for the Hornsea Project One and Hornsea Project Two offshore wind farms as this represents the best available evidence for herring gull.

1.19 Using all boat-based data collected across the Hornsea Zone provides a sample size of 257 herring gulls. Of these birds, 10.51% (upper confidence metric = 19.46%) were recorded flying at PCH. This PCH value has therefore been used to calculate collision risk estimates using Option 1 of Band (2012). The use of these data is still considered to provide a more representative PCH value than that derived from generic flight height data from Johnston *et al.* (2014).

Expressing uncertainty

1.20 In order to express the uncertainty associated with the collision risk estimates presented in this Annex, modelling has been conducted incorporating confidence metrics associated with species densities and flight height distributions. The upper and lower 95% confidence limits associated with density values are used within collision risk modelling to provide a range of collision risk estimates describing the variability around density estimates. In addition this process has also been undertaken for flight height distribution with the upper and lower 95% confidence intervals associated with the flight height distributions presented in Johnston *et al*. (2014) used in collision risk modelling for each species. The results obtained are presented on an annual basis in the results section and on a monthly basis in Annex A.

Results

1.21 The annual collision risk estimates (Options 1, 2 and 3) calculated for herring gull using Band (2012) are shown in Table 1.4 and Table 1.5 incorporating variability associated with density data and flight height distribution. Monthly collision risk estimates are presented in 0.

Table 1.4: Annual collision risk estimates for herring gull calculated using Options 1, 2 and 3 of the Band (2012) collision risk model using mean estimate and upper and lower 95% confidence interval density values.

Avoidance rate (%)	Collision risk estimates (no. of collisions/annum)		
	Lower CL	***Mean estimate***	***Upper CL***
Option 1			
99.4	1	7	14
99.5	1	6	12
99.6	1	4	9
Option 2			
99.4	1	9	20
99.5	1	8	16

Avoidance rate (%)	Collision risk estimates (no. of collisions/annum)		
99.6	1	6	13
Option 3			
98.8	1	7	14
99.0	1	6	12
99.2	1	4	9

Table 1.5: Annual collision risk estimates for herring gull calculated using Options 1, 2 and 3 of the Band (2012) collision risk model using maximum likelihood and upper and lower 95% confidence interval flight height distributions.

Avoidance rate (%)	Collision risk estimates (no. of collisions/annum)		
	Lower CL	***Maximum likelihood***	***Upper CL***
Option 1			
99.4		7	12
99.5		6	10
99.6		4	8
Option 2			
99.4	6	9	16
99.5	5	8	13
99.6	4	6	10
Option 3			
98.8	4	7	16
99.0	3	6	13
99.2	3	4	10

Conclusion

1.22 Table 1.6 presents seasonal collision risk estimates for herring gull based on the seasonal definitions defined in Volume 5, Annex 5.1: Baseline Characterisation Report (Document 6.5.5.1). The proportion these collision risk estimates represent of the relevant reference population is also calculated alongside the increase in baseline mortality of the relevant reference population.

Table 1.6: Herring gull seasonal collision risk results expressed as change in regional population baseline mortality based on collision risk estimates calculated using the mean estimate of relevant parameters.

CRM Option (Avoidance rate)	Season [a]	Collision mortality	Reference population (no. of birds)	Baseline mortality of reference mortality (no. of birds)	Increase in baseline mortality (%)
Option 1 (99.5%)	Breeding	1	280,000	46,480	0.00
	Non-breeding	5	466,511	77,441	0.01
Option 2 (99.5%)	Breeding	1	280,000	46,480	0.00
	Non-breeding	7	466,511	77,441	0.01
Option 3 (99.0%)	Breeding	1	280,000	46,480	0.00
	Non-breeding	5	466,511	77,441	0.01

a The seasons defined for herring gull are presented in Volume 5, Annex 5.1: Baseline Characterisation Report (Document 6.5.5.1). Breeding season = May to July; Non-breeding season = August to April.

1.23 Collisions in the breeding season defined for herring gull (May to July) account for approximately 11% of the annual total. One collision is predicted in the breeding season when using any of the three Band model Options. This represents a negligible increase (<0.01%) in the baseline mortality of the national breeding population of herring gull (280,000 birds). It should be noted that the reference breeding population does not include immature and non-breeding birds which are likely to comprise the majority (if not all) of the birds present at Hornsea Three during the breeding season due to the distance between Hornsea Three and breeding colonies.

1.24 The degree of variability associated with the density data, flight height data and avoidance rates used in collision risk modelling for herring gull is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the reference breeding population (no more than a 0.01% increase in the baseline mortality of the reference breeding population).

1.25 Collisions in the non-breeding season defined for herring gull (August to April) account for approximately 8% of the annual total. Between five and seven collisions are predicted in the non-breeding season representing a negligible increase (0.01%) in the baseline mortality of the regional non-breeding population (466,511 birds).

1.26 The degree of variability associated with the density data, flight height data and avoidance rates used in collision risk modelling for herring gull is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional non-breeding population (no more than a 0.02% increase in the baseline mortality of the reference breeding population).

1.27 The number of collisions for herring gull as a proportion of the relevant reference population using either of the three Band model Options is considered to be negligible. There would therefore be no significant effects on the status of herring gull as a result of the operation of Hornsea Three. This supports the conclusion to discount herring gull as a VOR in Volume 5, Annex 5.1: Baseline Characterisation Report (Document 6.5.5.1).

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Annex A - Additional collision risk modelling outputs

Table 1.7: Monthly collision risk estimates for herring gull calculated using Option 1 of Band (2012) using confidence intervals associated with density.

Avoidance rate (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density = Mean estimate												
99.4	0.00	1.15	0.00	0.00	0.00	0.36	0.37	0.00	1.82	0.00	0.00	2.97
99.5	0.00	0.96	0.00	0.00	0.00	0.30	0.31	0.00	1.51	0.00	0.00	2.47
99.6	0.00	0.77	0.00	0.00	0.00	0.24	0.25	0.00	1.21	0.00	0.00	1.98
Density = UCL												
99.4	0.00	2.30	0.00	0.00	0.00	1.26	1.10	0.00	3.96	0.00	0.00	5.34
99.5	0.00	1.91	0.00	0.00	0.00	1.05	0.92	0.00	3.30	0.00	0.00	4.45
99.6	0.00	1.53	0.00	0.00	0.00	0.84	0.74	0.00	2.64	0.00	0.00	3.56
Density = LCL												
99.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.89
99.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74
99.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59

Table 1.8: Monthly collision risk estimates for herring gull calculated using Option 2 of Band (2012) using confidence metrics associated with flight height distribution.

Avoidance rate (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PCH = Mean estimate												
99.4	0.00	1.15	0.00	0.00	0.00	0.36	0.37	0.00	1.82	0.00	0.00	2.97
99.5	0.00	0.96	0.00	0.00	0.00	0.30	0.31	0.00	1.51	0.00	0.00	2.47
99.6	0.00	0.77	0.00	0.00	0.00	0.24	0.25	0.00	1.21	0.00	0.00	1.98
PCH = Upper confidence metric												
99.4	0.00	2.13	0.00	0.00	0.00	0.67	0.68	0.00	3.37	0.00	0.00	5.50
99.5	0.00	1.77	0.00	0.00	0.00	0.56	0.57	0.00	2.80	0.00	0.00	4.58
99.6	0.00	1.42	0.00	0.00	0.00	0.45	0.45	0.00	2.24	0.00	0.00	3.67

Table 1.9: Monthly collision risk estimates for herring gull calculated using Option 2 of Band (2012) using confidence intervals associated with density.

Avoidance rate (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density = Mean estimate												
99.4	0.00	1.60	0.00	0.00	0.00	0.50	0.51	0.00	2.54	0.00	0.00	4.14
99.5	0.00	1.34	0.00	0.00	0.00	0.42	0.43	0.00	2.11	0.00	0.00	3.45
99.6	0.00	1.07	0.00	0.00	0.00	0.34	0.34	0.00	1.69	0.00	0.00	2.76
Density = UCL												
99.4	0.00	3.21	0.00	0.00	0.00	1.76	1.54	0.00	5.53	0.00	0.00	7.46
99.5	0.00	2.67	0.00	0.00	0.00	1.47	1.28	0.00	4.61	0.00	0.00	6.22
99.6	0.00	2.14	0.00	0.00	0.00	1.18	1.03	0.00	3.69	0.00	0.00	4.97
Density = LCL												
99.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24
99.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.04
99.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83

Table 1.10: Monthly collision risk estimates for herring gull calculated using Option 2 of Band (2012) using confidence intervals associated with flight height distribution.

Avoidance rate (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flight height distribution = Maximum Likelihood												
99.4	0.00	1.60	0.00	0.00	0.00	0.50	0.51	0.00	2.54	0.00	0.00	4.14
99.5	0.00	1.34	0.00	0.00	0.00	0.42	0.43	0.00	2.11	0.00	0.00	3.45
99.6	0.00	1.07	0.00	0.00	0.00	0.34	0.34	0.00	1.69	0.00	0.00	2.76
Flight height distribution = UCL												
99.4	0.00	2.69	0.00	0.00	0.00	0.85	0.86	0.00	4.26	0.00	0.00	6.96
99.5	0.00	2.24	0.00	0.00	0.00	0.70	0.72	0.00	3.55	0.00	0.00	5.80
99.6	0.00	1.79	0.00	0.00	0.00	0.56	0.57	0.00	2.84	0.00	0.00	4.64
Flight height distribution = LCL												
99.4	0.00	1.07	0.00	0.00	0.00	0.34	0.34	0.00	1.70	0.00	0.00	2.78
99.5	0.00	0.90	0.00	0.00	0.00	0.28	0.29	0.00	1.42	0.00	0.00	2.32
99.6	0.00	0.72	0.00	0.00	0.00	0.23	0.23	0.00	1.13	0.00	0.00	1.85

Table 1.11: Monthly collision risk estimates for herring gull calculated using Option 3 of Band (2012) using confidence intervals associated with density.

Avoidance rate (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density = Mean estimate												
98.8	0.00	1.16	0.00	0.00	0.00	0.36	0.37	0.00	1.84	0.00	0.00	3.00
99.0	0.00	0.97	0.00	0.00	0.00	0.30	0.31	0.00	1.53	0.00	0.00	2.50
99.2	0.00	0.77	0.00	0.00	0.00	0.24	0.25	0.00	1.22	0.00	0.00	2.00
Density = UCL												
98.8	0.00	2.32	0.00	0.00	0.00	1.28	1.12	0.00	4.01	0.00	0.00	5.40
99.0	0.00	1.93	0.00	0.00	0.00	1.06	0.93	0.00	3.34	0.00	0.00	4.50
99.2	0.00	1.55	0.00	0.00	0.00	0.85	0.74	0.00	2.67	0.00	0.00	3.60
Density = LCL												
98.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90
99.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75
99.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60

Table 1.12: Monthly collision risk estimates for herring gull calculated using Option 3 of Band (2012) using confidence intervals associated with flight height distribution.

Avoidance rate (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flight height distribution = Maximum Likelihood												
98.8	0.00	1.16	0.00	0.00	0.00	0.36	0.37	0.00	1.84	0.00	0.00	3.00
99.0	0.00	0.97	0.00	0.00	0.00	0.30	0.31	0.00	1.53	0.00	0.00	2.50
99.2	0.00	0.77	0.00	0.00	0.00	0.24	0.25	0.00	1.22	0.00	0.00	2.00
Flight height distribution = UCL												
98.8	0.00	2.69	0.00	0.00	0.00	0.85	0.86	0.00	4.26	0.00	0.00	6.97
99.0	0.00	2.24	0.00	0.00	0.00	0.71	0.72	0.00	3.55	0.00	0.00	5.80
99.2	0.00	1.80	0.00	0.00	0.00	0.56	0.58	0.00	2.84	0.00	0.00	4.64
Flight height distribution = LCL												
98.8	0.00	0.68	0.00	0.00	0.00	0.22	0.22	0.00	1.08	0.00	0.00	1.77
99.0	0.00	0.57	0.00	0.00	0.00	0.18	0.18	0.00	0.90	0.00	0.00	1.48
99.2	0.00	0.46	0.00	0.00	0.00	0.14	0.15	0.00	0.72	0.00	0.00	1.18