Hornsea Project Four: Environmental Statement (ES)

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Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling

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Glossary

Term	Definition
Collision	An instance of one moving object or individual striking violently against another.
Collision Risk Model (CRM)	General term to describe the method of estimating the collision risk of seabirds (estimated mortality) to operational turbines, which could be either deterministic or stochastic.
Commitment	A term used interchangeably with mitigation. Commitments are Embedded Mitigation Measures. Commitments are either Primary (Design) or Tertiary (Inherent) and embedded within the assessment at the relevant point in the EIA (e.g. at Scoping, Preliminary Environmental Information Report (PEIR) or ES). The purpose of Commitments is to reduce and/or eliminate Likely Significant Effects (LSEs), in EIA terms.
Deterministic Collision Risk Model	A program used to assess the collision risk (estimated mortality) of seabirds to operational turbines of offshore wind farms. A deterministic CRM is run without any uncertainty provided around the inputs.
Hornsea Four array area	The proposed area for Hornsea Four within which the Wind Turbine Generators (WTGs) would be installed
Hornsea Project Four Offshore Wind Farm	The term covers all elements of the project (i.e. both the offshore and onshore). Hornsea Four infrastructure will include offshore generating stations (wind turbines), electrical export cables to landfall, and connection to the electricity transmission network. Hereafter referred to as Hornsea Four.
Highest Astronomical Tide (HAT)	The highest tide level which can be predicted to occur under average meteorological conditions and any combination of astronomical conditions.
Lowest Astronomical Tide (LAT)	The lowest tide level which can be predicted to occur under average meteorological conditions and any combination of astronomical conditions.
Mean Sea Level (MSL)	The average level of the surface of sea from which heights such as elevation may be measured.
Orsted Hornsea Project Four Ltd	The Applicant for the proposed Hornsea Project Four Offshore Wind Farm Development Consent Order (DCO).
Shiny App	User-friendly graphical user interface accessible via a standard web-browser that uses underlying R code.
Statutory Nature Conservation Bodies (SNCBs)	Comprised of the Joint Nature Conservation Committee (JNCC), Natural Resources Wales, Department of Agriculture, Environment and Rural Affairs/Northern Ireland Environment Agency, Natural England and Scottish Natural Heritage. These agencies provide advice in relation to nature conservation to government.
Stochastic Collision Risk Model (sCRM)	A program used to assess the collision risk (estimated mortality) of seabirds to operational turbines of offshore wind farms. A stochastic CRM is used to account for uncertainty around input variables.

Acronyms

Acronym	Definition
AfL	Agreement for Lease
COWRIE	Collaborative Offshore Wind Research Into The Environment
CRM	Collision Risk Modelling
DCO	Development Consent Order
EIA	Environmental Impact Assessment
EP	Evidence Plan
ES	Environmental Statement
ESAS	European Seabirds at Sea
HAT	Highest Astronomical Tide
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
MDS	Maximum Design Scenario
MSL	Mean Sea Level
PCH	Potential Collision Height
PEIR	Preliminary Environmental Information Report
RSPB	Royal Society for the Protection of Birds
sCRM	Stochastic Collision Risk Modelling
SD	Standard Deviation
SNCB	Statutory Nature Conservation Bodies

Units

Unit	Definition
m	Metre (distance)
km	Kilometre (distance)
km^2	Kilometre squared (area)
ms^{-1}	Metres per second (speed)
rpm	Revolutions per minute (speed)
°	Degrees (angle)
%	Percentage (proportion)

1 Introduction

1.1 Project Background

1.1.1.1 Orsted Hornsea Project Four Ltd., (hereafter 'the Applicant') is proposing to develop the Hornsea Project Four Offshore Wind Farm (hereafter 'Hornsea Four'). Hornsea Four is located approximately 69 km offshore from coastline of the East Riding of Yorkshire in the Southern North Sea with the array area covering an area of approximately 468 km^2 and will be the fourth project to be developed in the former Hornsea Zone. Hornsea Four will include both offshore and onshore infrastructure including an offshore generating station (wind farm), export cables to landfall, and connection to the electricity transmission network (please see **Volume A1, Chapter 4: Project Description** for full details on the Project Design).

1.1.1.2 The Hornsea Four Agreement for Lease (AfL) area was 846 km^2 at the Scoping phase of project development. In the spirit of keeping with Hornsea Four's approach to Proportionate Environmental Impact Assessment (EIA), the project has given due consideration to the size and location (within the existing AfL area) of the final project that is being taken forward to Development Consent Order (DCO) application. This consideration is captured internally as the "Developable Area Process", which includes Physical, Biological and Human constraints in refining the developable area, balancing consenting and commercial considerations with technical feasibility for construction. It has also involved further consideration of project design so as to reduce the risk to birds from collision with wind turbines through engineering solutions. One such measure has been to increase the air gap between the sea surface and the lowest swept area of the turbines (from a minimum of 35 m to 42.43 m measured against the Lowest Astronomical Tide (LAT) (see Co138 (**Volume A4, Annex 5.2: Commitment Register**) and **Table 9** for detailed parameters) in order to provide an increased space for birds to fly without the risk of colliding with wind turbines.

1.1.1.3 The combination of Hornsea Four's Proportionality in EIA and Developable Area Process has resulted in a marked reduction in the AfL taken forward at the point of DCO application. Hornsea Four adopted a major site reduction from the AfL presented at Scoping (846 km^2) to the Preliminary Environmental Information Report (PEIR) boundary (600 km^2), with a further reduction adopted for the Environmental Statement (ES) and DCO application (468 km^2) due to the results of the PEIR, technical considerations and stakeholder feedback. The evolution of the AfL is detailed in **Volume A1, Chapter 3: Site Selection and Consideration of Alternatives** and **Volume A4, Annex 3.2: Selection and Refinement of the Offshore Infrastructure**.

1.1.1.4 APEM Ltd (hereafter APEM) was commissioned by the Applicant to undertake a study of offshore and intertidal ornithology that characterise the area that may be influenced by Hornsea Four. A separate report (**Annex 5.1: Offshore and Intertidal Ornithology Baseline Characterisation Report**) provides the findings from offshore and intertidal ornithology data to determine the receptors that characterise the baseline and are of relevance to the assessment of potential impacts from Hornsea Four. This technical annex has been produced to support **Volume A2, Chapter 5: Offshore and Intertidal Ornithology**.

1.1.1.5 The consideration of offshore and intertidal ornithology for Hornsea Four has been discussed with consultees through the Hornsea Four Evidence Plan (EP) process; specifically with the Offshore and Intertidal Ornithology Evidence Plan Technical Panel (hereafter EP Technical Panel) of which Natural England and the Royal Society for the Protection of Birds (RSPB) are members. Agreements made with consultees within the EP process are set out in the topic specific EP Logs which are appendices to the Hornsea Four Evidence Plan (**B1.1.1: Evidence Plan**), an annex of the Hornsea Four Consultation Report (**B1.1: Consultation Report**). All agreements within the EP Logs have unique identifier codes which have been used throughout this document to signpost to the specific agreements made (e.g. OFF-ORN-2.1).

1.2 Collision Risk Modelling

1.2.1.1 There is potential risk to birds from offshore wind farms through collision with wind turbines and associated infrastructure. There is an increase in potential risk of collision with wind turbines if they are located in areas of high bird densities in which there is a high level of flight activity. That high level of flight activity can be associated with locations where food supplies are concentrated or with areas where there is a high turnover of individuals (possibly commuting daily between nesting and feeding areas or passing through the area on seasonal migrations). The potential collision risk can be estimated using collision risk modelling (CRM).

1.2.1.2 CRM has been carried out for Hornsea Four to provide information for five seabird species of interest identified as potentially at risk and of interest for impact assessment through the EP process (OFF-ORN-2.11);

- Gannet;
- Kittiwake;
- Lesser black-backed gull;
- Herring gull; and
- Great black-backed gull.

1.2.1.3 CRM was undertaken using the stochastic Collision Risk Model (sCRM), developed by Marine Scotland (Donovan 2018), run deterministically for each seabird species, to determine the risk of collision for these five seabird species when in flight. The sCRM was accessed via the 'Shiny App' interface, which is a user-friendly graphical user interface accessible via a standard web-browser that uses an R code to estimate collision risk. The advantages of using the 'Shiny App' are that users are not required to use any R code, are not required to install or maintain R, updates to the model are made directly to the server, so are immediately programmed to users and it is publicly available and free to access (Donovan 2018). Unlike the Band 2012 CRM model the sCRM also provides a clear and transparent audit trail for all modelling run, which enables regulators to easily assess and reproduce the results of any modelling scenario. A full report on the sCRM was published by Marine Scotland in 2018 to accompany the User Guide (McGregor et al. 2018).

1.3 Updates to CRM Post-PEIR

1.3.1.1 The most significant change to the CRM, since the PEIR, is a commitment (**Co138** from **Volume A4, Annex 5.2: Commitments Register**) from the Applicant to revise the project design (**Volume A1, Chapter 4: Project Description**) in order to further reduce any risk to seabirds. This is through a significant increase in the air gap between the sea surface and the lowest tip height of the turbine blades. The commitment described in the PEIR (committing to a minimum height of the lowest blade tip of 35 m measured against LAT) has been increased to 42.43 m LAT or 40 m measured against Mean Sea Level (MSL) for the DCO Application.

1.3.1.2 Through the EP process, APEM conducted rigorous testing of the newly updated Donovan (2018) sCRM in consultation with Natural England, with guidance from the developers of the sCRM during a specific meeting held on 12 March 2020 (see **B1.1.1: Evidence Plan**). Natural England's concern stemmed from whether the sCRM could be run deterministically to provide comparable results to the Band (2012) CRM. The results of these tests provided evidence that the Donovan (2018) sCRM could be run deterministically to reach results that were comparable to that from Band (2012) CRM outputs to within under 0.01% in most instances. Following further consultation on these results, it was agreed with Natural England and the RSPB (OFF-ORN-2.38) that the sCRM is suitable for assessing collision risk to seabirds deterministically for Hornsea Four and other offshore wind farm assessments.

2 Methodology

2.1 Guidance and Models

2.1.1.1 The User Guide for the sCRM Shiny App provided by Marine Scotland (Donovan 2018) has been followed for the modelling and assessment of impacts predicted for Hornsea Four.

2.1.1.2 The parameters used in the CRM are presented in **Section 2.2**. It was agreed that the five species which would be subject to CRM were gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull (OFF-ORN-2.11). Fulmar was excluded because there were no individuals recorded at the height with highest potential risk, using the site-specific boat flight height data (HiDef BioConsult 2018a). Further consideration for migratory non-seabirds and migratory seabird species is provided in a separate report (**Annex 5.5: Offshore Ornithology Migratory Birds Report**).

2.1.1.3 Within this report, the Shiny App audit trail for three different Band Options are presented, Band Options 1, 2 and 3, as described in the following sections.

2.1.2 Basic Band CRM Option 1 with site-specific flight heights

2.1.2.1 The Basic Band model applies a uniform distribution of bird flights between the lowest and the highest levels of the rotors. Using Band Option 1 (BO1), the percentage of bird flights passing between the lowest and the highest levels of the rotors (i.e. the proportion of birds at potential collision height (PCH)) is determined from the observations of bird flight heights made during the boat-based site-specific surveys. This Band Option has been considered for all five CRM seabird species.

2.1.3 Basic Band CRM Option 2 with generic flight heights

2.1.3.1 The Basic Band model applies a uniform distribution of bird flights between the lowest and the highest levels of the rotors. Using Band Option 2 (BO2), the proportion at PCH was determined from the results of the Strategic Ornithological Support Services (SOSS) SOSS-02 project (Cook et al. 2012) that analysed the flight height measurements taken from boat surveys conducted around the UK. The project was updated following Johnston et al. (2014), and the revised published spreadsheet[1] is used to determine the 'generic' percentage of flights at PCH for each species based on the Hornsea Four wind turbine parameters. This Band Option has been considered for all five CRM seabird species.

2.1.4 Extended Band CRM Option 3 with generic flight heights

2.1.4.1 The Extended Band model (BO3) accounts for the skewed vertical distribution of bird flight heights between the lowest and the highest levels of the rotors. Most seabird species are observed flying more frequently at the lower level of the rotor swept height, which presents a lower risk of collision than at heights equivalent to the rotor hub height where collision risk is greater. By understanding the variation of bird flight through the rotor swept area, the Extended Band model considers and applies different probabilities of being struck by the moving rotor blades through the rotor swept area vertically. The Extended Band model,

[1] Final_Report_SOSS02_FlightHeights2014.xls

using Band Option 3, relies on the data spreadsheet that accompanies Johnston et al., (2014), which is the result of a statistical analysis of a large number of offshore surveys across multiple study sites. These data are fed into the model in order to allow for the flight distribution to be calculated based upon the wind farm parameters of the proposed project. This Band Option has been considered for all three large gull species as per Statutory Nature Conservation Body (SNCB) advice (JNCC et al. 2014). Band Option 3 has also been run for all gull species using the more recent advocated avoidance rates from Bowgen & Cook (2018).

2.2 CRM Input Parameters

2.2.1.1 This report provides the CRM results using the input parameters presented to the EP Technical Panel (OFF-ORN-2.32 to 2.36) and additional parameters such as Bowgen and Cook (2018) avoidance rates and Band Option 3 input parameters due to the delay in Natural England's updated collision risk guidance report (OFF-ORN-2.44). As the sCRM has been run deterministically only, an evidence-led approach determined the most likely central parameters used to determine collision risk for each species. The evidence-led approach describes the Applicant's advocated position, which forms the basis of the impact assessments described in **Volume A2, Chapter 5: Offshore and Intertidal Ornithology**. However, in order to provide a range of values to capture variability for each species, the key input parameters were reviewed in order to provide 'minimum' and 'maximum' estimates of collision rates, which are presented in **Table 11** to **Table 15**. The parameters used in calculating the mean, minimum and maximum estimates of collision are presented in **Appendix B** to **Appendix F**.

2.2.1.2 An overview of all input parameters used for the Applicant's evidence led approach and Natural England's / RSPB's SNCB approach to CRM modelling is provided in **Table 1**; cells colour coded in green indicate both Applicant and SNCB agree on the input value, orange indicates partial agreement between both parties and red indicates disagreement on appropriate value to be used for modelling. For input parameters where there is disagreement, a second iteration of the CRM has been conducted with the results provided in **Appendix A**– SNCB Parameters CRM Outputs which incorporates the input parameters currently advocated for use by Natural England and the RSPB. The CRM was run for each species with the input parameters advocated by Natural England / RSPB as advised through the EP process (OFF-ORN-2.32 to 2.37) in order to provide their (more precautionary) range of outputs.

Table 1: Comparison of CRM input parameters advocated by the Applicant and used in the evidence led approach and Natural England / RSPB advocated parameters used in the SNCB approach. Green cells indicate both parties agree on the input parameter, orange indicates partial agreement and red indicates disagreement on the input parameter.

Parameter	Species	Evidence led position			SNCB position		
		Minimum	Mean	Maximum	Minimum	Mean	Maximum
Species Biometrics (Body Length / Wingspan) (m)	Gannet	0.94 / 1.72	0.94 / 1.72	0.94 / 1.72	0.94 / 1.72	0.94 / 1.72	0.94 / 1.72
	Kittiwake	0.39 / 1.08	0.39 / 1.08	0.39 / 1.08	0.39 / 1.08	0.39 / 1.08	0.39 / 1.08
	Lesser black-backed gull	0.58 / 1.42	0.58 / 1.42	0.58 / 1.42	0.58 / 1.42	0.58 / 1.42	0.58 / 1.42
	Herring gull	0.60 / 1.44	0.60 / 1.44	0.60 / 1.44	0.60 / 1.44	0.60 / 1.44	0.60 / 1.44
	Great black-backed gull	0.71 / 1.58	0.71 / 1.58	0.71 / 1.58	0.71 / 1.58	0.71 / 1.58	0.71 / 1.58
Basic Avoidance Rate (BO1 & 2)	Gannet	0.987	0.989 / 0.995	0.991	0.987	0.989	0.991
	Kittiwake	0.987	0.989 / 0.990	0.991	0.987	0.989	0.991
	Lesser black-backed gull	0.994	0.995	0.996	0.994	0.995	0.996
	Herring gull	0.994	0.995	0.996	0.994	0.995	0.996
	Great black-backed gull	0.994	0.995	0.996	0.994	0.995	0.996
Extended Avoidance Rate (BO3)	Gannet	N/A	N/A	N/A	N/A	N/A	N/A
	Kittiwake	N/A	0.980	N/A	N/A	N/A	N/A
	Lesser black-backed gull	0.987	0.989 / 0.993	0.991	N/A	N/A	N/A
	Herring gull	0.988	0.990 / 0.993	0.992	N/A	N/A	N/A
	Great black-backed gull	0.987	0.989 / 0.993	0.991	N/A	N/A	N/A
Flight Speed (ms^{-1})	Gannet	13.33	13.33	13.33	14.9	14.9	14.9
	Kittiwake	13.1	13.1	13.1	13.1	13.1	13.1
	Lesser black-backed gull	13.1	13.1	13.1	13.1	13.1	13.1
	Herring gull	12.8	12.8	12.8	12.8	12.8	12.8
	Great black-backed gull	13.7	13.7	13.7	13.7	13.7	13.7
Nocturnal Activity (%)	Gannet	0	0	25	0	25	25
	Kittiwake	25	25	50	25	50	50
	Lesser black-backed gull	25	25	50	25	50	50
	Herring gull	25	25	50	25	50	50
	Great black-backed gull	25	25	50	25	50	50

Parameter	Species	Evidence led position			SNCB position		
		Minimum	Mean	Maximum	Minimum	Mean	Maximum
Flight Heights	Gannet	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2)	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2)[2]	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2)	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)	Johnston et al. (2014) maximum Likelihood (BO2)[2]	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)
	Kittiwake	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2)	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)[2]	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2)	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)	Johnston et al. (2014) maximum Likelihood (BO2)[2]	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)
	Lesser black-backed gull	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2)[2]	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)	Johnston et al. (2014) maximum Likelihood (BO2)[2]	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)
	Herring gull	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)[2]	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)	Johnston et al. (2014) maximum Likelihood (BO2)[2]	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)
	Great black-backed gull	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)[2]	Site specific (BO1) & Johnston et al. (2014) maximum Likelihood (BO2 & 3)	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)	Johnston et al. (2014) maximum Likelihood (BO2)[2]	Johnston et al. (2014) maximum Likelihood 95% CI (BO2)
Density Estimates	Gannet	Mean estimate - SD	Mean estimate	Mean estimate + SD	Lower 95% CI	Mean estimate	Upper 95% CI
	Kittiwake	Mean estimate - SD	Mean estimate	Mean estimate + SD	Lower 95% CI	Mean estimate	Upper 95% CI
	Lesser black-backed gull	Mean estimate - SD	Mean estimate	Mean estimate + SD	Lower 95% CI	Mean estimate	Upper 95% CI
	Herring gull	Mean estimate - SD	Mean estimate	Mean estimate + SD	Lower 95% CI	Mean estimate	Upper 95% CI
	Great black-backed gull	Mean estimate - SD	Mean estimate	Mean estimate + SD	Lower 95% CI	Mean estimate	Upper 95% CI

[2] Partial agreement due to both the Applicant and the SNCB position agree on using the Johnston et al. (2014) maximum likelihood data to calculate the mean collision estimate for Band Option 2.

2.2.2 Avoidance Rates

2.2.2.1 The species-specific avoidance rates that were applied in the CRM are presented in **Table 2** and **Table 3**. The avoidance rates in **Table 2** for all species follows the guidance from Cook et al. (2014) and the Statutory Nature Conservation Bodies (SNCB) review of avoidance rates to be applied in the Band models Joint Nature Conservation Committee (JNCC) et al., 2014 in response to Cook et al. 2014). The upper and lower values were derived from + / - two standard deviations (SD) from the central estimate, as agreed with Natural England (OFF-ORN-2.36). The avoidance rates in **Table 3** for all species are based on the more recent advocated avoidance rates from Bowgen and Cook (2018). It is understood that Natural England are currently reviewing the avoidance rates put forward by Bowgen and Cook (2018) and were due to publish an updated guidance note on avoidance rates in 2020 (OFF-ORN-2.44). In the absence of the updated guidance note, the avoidance rates advocated by Bowgen and Cook (2018) have been included on a precautionary basis.

Table 2: Avoidance rates based on Cook et al. (2014) for Hornsea Four for five species: gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull.

Species	Basic Avoidance Rates (Band Option 1 & 2)			Extended Avoidance Rates (Band Option 3)		
	Central – 2 SD	Central	Central + 2 SD	Central – 2 SD	Central	Central + 2 SD
Gannet	0.987	0.989	0.991	N/A	N/A	N/A
Kittiwake	0.987	0.989	0.991	N/A	N/A	N/A
Lesser black-backed gull	0.994	0.995	0.996	0.987	0.989	0.990
Herring gull	0.994	0.995	0.996	0.988	0.990	0.991
Great black-backed gull	0.994	0.995	0.996	0.97	0.989	0.990

Table 3: Avoidance rates based on Bowgen and Cook (2018) for Hornsea Four for five species: gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull.

Species	Basic Avoidance Rates (Band Option 1 & 2)	Extended Avoidance Rates (Band Option 3)
Gannet	0.995	N/A
Kittiwake	0.990	0.980
Lesser black-backed gull	0.995	0.993
Herring gull	0.995	0.993
Great black-backed gull	0.995	0.993

2.2.3 Species Biometrics

2.2.3.1 The species-specific biometric input parameters used in the CRM are provided in **Table 4**. The biometrics for all species were derived from Robinson (2005). The Donovan (2018) sCRM does provide automatic SD inputs for both body length and wingspan, which could have been used to model variability for these two input parameters. However, due to uncertainties on how these values were calculated, the approach of running species biometrics without variability has been taken, as agreed with Natural England (**OFF-ORN-2.32**).

Table 4: Species biometrics used in the CRM of Hornsea Four for five species: gannet, kittiwake, lesser black-backed gull, herring gull, and great black-backed gull.

Species	Body Length (m)	Wingspan (m)
Gannet	0.94	1.72
Kittiwake	0.39	1.08
Lesser black-backed gull	0.58	1.42
Herring gull	0.60	1.44
Great black-backed gull	0.71	1.58

2.2.4 Seabird Flight Speeds

2.2.4.1 Central estimates of flight speeds for kittiwake, lesser black-backed gull, herring gull, and great black-backed gull were derived from Cook et al. (2014), which presents flight speed values taken from Pennycuick (1997) and Alerstam et al. (2007) (OFF-ORN-2.19). Flight speed for gannet was derived from the ORJIP bird collision avoidance study (Skov et al. 2018), as no value was presented in Alerstam et al. (2007) for gannet and the flight speed presented in Pennycuick (1997) did not include SDs so unable to conclude the accuracy of the value. It should be noted that if the flight speeds for all species were derived from Skov et al. (2018) then further reductions in the collision results would occur for all other species. As agreed with Natural England no variability was included for seabird flight speeds (OFF-ORN-2.33). Flight speed and flight type for all five species are presented in Table 5.

Table 5: Seabird flight type and speeds used in the CRM of Hornsea Four for five species: gannet, kittiwake, lesser black-backed gull, herring gull, and great black-backed gull.

Species	Flight Speed (ms^{-1})	Flight Type
Gannet	13.33	Flapping
Kittiwake	13.10	Flapping
Lesser black-backed gull	13.10	Flapping
Herring gull	12.80	Flapping
Great black-backed gull	13.70	Flapping

2.2.5 Nocturnal Activity

2.2.5.1 The nocturnal activity rate for all species are represented as an upper and lower values in Table 6. A range of values were selected to account for the uncertainty in the currently available data sources on seabird nocturnal activity levels since no SDs are presented in the literature; this was agreed with the EP Technical Panel (OFF-ORN-2.34).

2.2.5.2 The upper values for nocturnal activity are based on the 1 to 5 scoring index for each species in Garthe and Hüppop (2004) and King et al. (2009), with the spreadsheet converting these factors into nocturnal activity as follows; 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75%, 5 = 100%. It is considered that these literature sources for nocturnal activity rates are overly precautionary (gannet: 2, kittiwake: 3, and large gulls: 3) and have been superseded by more recent studies (MacArthur Green, APEM & Royal HaskoningDHV 2015; Skov et al. 2018; Masden 2015), from which the values for the lower nocturnal activity rates are derived.

Table 6: Nocturnal activity rates used in the CRM of Hornsea Four for five species: gannet, kittiwake, lesser black-backed gull, herring gull, and great black-backed gull.

Species	Nocturnal Activity Rates	
	Maximum Estimate (%)	Mean / Minimum Estimate (%)
Gannet	25	0
Kittiwake	50	25
Lesser black-backed gull	50	25
Herring gull	50	25
Great black-backed gull	50	25

2.2.6 Proportion at Potential Collision Height

2.2.6.1 The proportion of individuals flying at PCH for use in Band Option 1 for each species were obtained from the site-specific boat based derived flight heights (Table 7), which provides a generic PCH per species which is used in this model. The site-specific boat-based surveys were undertaken between March 2010 and February 2013 by Cork Ecology and EMU Limited. The survey methods were based on Collaborative Offshore Wind Research Into The Environment (COWRIE) approved survey methodology (Camphuysen et al. 2004; Webb and Durinck 1992) with the surveys completed by European Seabirds at Sea (ESAS) accredited observers. Further information on the survey methodology and approach to analysis can be found in SMartWind (2011). It was not possible to calculate a SD around the PCH for the site-specific data due to the nature of boat-based flight height estimates being within flight height band categories.

2.2.6.2 The proportion of birds at PCH is based against MSL of 40 m for all five species. To calculate PCH, the number of records across the year and from the flight height category "37.5 – 42.5 m" and above, were summed and divided by the total recorded for each species.

2.2.6.3 For Band Option 2 and 3, the Johnston et al. (2014) maximum likelihood flight height data was selected for all five species. Currently the Johnston et al. (2014) datasets only provide PCH values up to a maximum of 300 m above MSL and the height of the turbines modelled for the Hornsea Four CRM measure 345 m from MSL to the maximum height of the blade tip. At present there is no guidance on how to incorporate the level of risk to seabirds within areas above 300 m above MSL, though Johnston et al. (2014) recognised that very few birds would be present flying above this height. As the risk is recognised to be extremely low to seabirds above 300 m above MSL, no modifications have been made to the modelling for Hornsea Four. This is because it is understood that further spreading the risk into these upper reaches when considering the same densities would reduce risk overall to each seabird species and so the outcomes of the CRM presented in this report are deemed more precautionary as a result. (OFF-ORN-2.45).

Table 7: Proportion at PCH used in the Band CRM Option 1 for Hornsea Four.

Species	Site-specific proportion at PCH for Band Option 1
Gannet	0.0284
Kittiwake	0.0038
Lesser black-backed gull	0.0614
Herring gull	0.1077
Great black-backed gull	0.1376

2.2.7 Density of Birds in Flight

2.2.7.1 Density estimates +/- SD were determined for Hornsea Four using data collected from the 24-month programme of digital aerial video surveys (carried out between April 2016 and March 2018, inclusive), which are presented in **Annex 5.1: Offshore Ornithology Baseline Characterisation Report**. For each species recorded in each survey, a mean density estimate and upper and lower 95% Confidence Limits of the density were calculated, which are presented in **Table 8**.

2.2.7.2 For each species, the maximum plausible density for each month (taking into account both survey precision and inter-annual variation) was calculated as the higher of the two upper confidence limits, and the minimum plausible density as the lower of the two lower confidence limits. The SD of density was then calculated as SD ≈ (maximum – minimum) / 4.

2.2.7.3 The CRM model was run for all five species with three possible density values: mean density (used to calculate the mean annual collision estimate); mean density + SD (used to calculate the maximum annual collision estimate); and mean density – SD (used to calculate the minimum annual collision estimate). In some cases, the SD was greater than the mean density and therefore the lower bound was taken to be 0 birds/km^2; these scenarios necessarily result in zero collision risk for that species in that month.

Table 8: Monthly values for the mean density + / - SD of flying birds used in the CRM for Hornsea Four for five species: gannet, kittiwake, lesser black-backed gull, herring gull, and great black-backed gull.

Species	Gannet			Kittiwake			Lesser black-backed gull			Herring gull			Great black-backed gull		
Month	Mean density	Density + SD (birds per km^2)	Density - SD (birds per km^2)	Mean density	Density + SD (birds per km^2)	Density - SD (birds per km^2)	Mean density	Density + SD (birds per km^2)	Density - SD (birds per km^2)	Mean density	Density + SD (birds per km^2)	Density - SD (birds per km^2)	Mean density	Density + SD (birds per km^2)	Density - SD (birds per km^2)
Jan	0.13	0.29	0.00	0.16	0.23	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.00
Feb	0.04	0.07	0.01	0.15	0.27	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00
Mar	0.12	0.18	0.06	0.14	0.26	0.03	0.00	0.00	0.00	0.01	0.03	0.00	0.05	0.10	0.00
Apr	0.26	0.42	0.10	2.87	5.15	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May	0.22	0.32	0.11	2.05	2.96	1.13	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00
Jun	0.33	0.51	0.15	0.98	1.35	0.61	0.04	0.09	0.00	0.04	0.07	0.01	0.01	0.02	0.00
Jul	0.47	0.70	0.25	0.40	0.54	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
Aug	0.52	0.67	0.37	3.29	5.54	1.04	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Sep	0.26	0.37	0.16	1.09	1.97	0.21	0.00	0.00	0.00	0.01	0.02	0.00	0.11	0.47	0.00
Oct	0.24	0.29	0.18	0.07	0.12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.22	0.00
Nov	0.53	0.75	0.31	0.12	0.24	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.01
Dec	0.14	0.25	0.03	0.41	0.76	0.06	0.00	0.00	0.00	0.03	0.06	0.00	0.03	0.07	0.00

2.2.8 Turbine Parameters

2.2.8.1 Input parameters for the wind turbine specifications used within the CRM are shown in Table 9 and Table 10. These values are based on the Maximum Design Scenario (MDS) turbines, as described in Volume A2, Chapter 5: Offshore and Intertidal Ornithology and Volume A1, Chapter 4: Project Description. The upper and lower values for rotation speed, pitch and wind speed were calculated by adding or subtracting the SD from the mean (central estimate) value supplied by Hornsea Four. Note that the choice of value for determining the maximum and minimum collision rate depended on the relationship between each parameter and collision risk; in some cases, the larger parameter value led to fewer estimated collisions. The parameters used in calculating the mean, minimum and maximum estimates of collision rates are presented in Appendix B to Appendix F.

Table 9: Wind turbine specifications Hornsea Four.

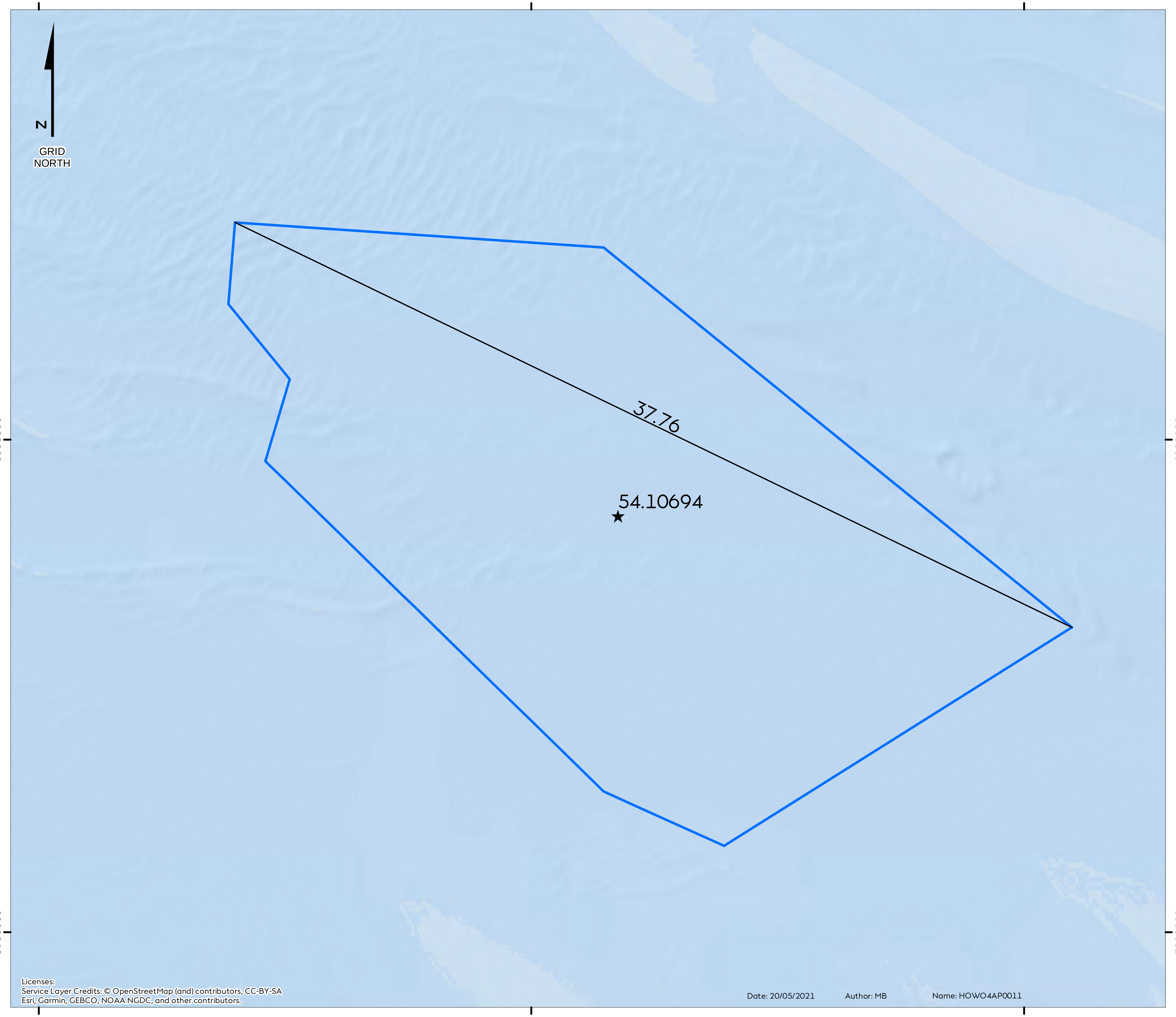
Input Parameter (units in brackets)	Values			Source
	Central – SD	Central	Central + SD	
Maximum number of turbines	180			Provided by the Applicant.
Rotor radius (m)	152.5			Provided by the Applicant.
Hub height (m)	190.22 (Highest Astronomical Tide (HAT))			Calculated by summing the rotor radius and air gap provided by the Applicant.
	192.50 (MSL)			
Air Gap (m)	37.72 (HAT)			Air gap measured against HAT; 40 m air gap provided by the Applicant based on MSL, tidal offset specified below used for conversion as supplied by the Applicant.
	40.00 (MSL)			
Number of blades	3			Provided by the Applicant.
Maximum blade width (m)	6			Provided by the Applicant.
Tidal offset (m)	2.28			To correct for flight heights calculated against SL (site-specific data assumed to be measured against MSL) and air gap in relation to HAT. Difference between HAT and MSL as provided by Hornsea Four (4.71 m and 2.43 m respectively).
Wind farm width (km)	37.75			See Figure 1.
Latitude (degrees)	54.11			Latitude of the centroid of Hornsea Four, Figure 1. Latitude informs daylight hours in the Band Model calculation. Longitude is not a requirement of the CRM input.
Rotation speed (rpm)	6.3	6.5	6.7	Provided by the Applicant.
Large array correction	Yes			Standard procedure.
Pitch (°)	3.6	4.6	5.6	Provided by the Applicant.
Wind speed (ms^{-1})	10.7	11.2	11.7	Provided by the Applicant.

2.2.8.2 Wind farm width was calculated using the longest distance across the wind farm (in this case the Hornsea Four array area), which is used in the CRM to calculate the maximum amount of time a bird could spend in the wind farm if it flew in a straight line through the longest length (Figure 1). The latitude was calculated from the shapefile provided by the Applicant and represents the centroid (Figure 1).

Hornsea Four

Figure 1

The Hornsea Four Development:
The Longest Distance Through
The Wind Farm (km)



Array Area

Longest line through the proposed site

★ Latitude of the centroid

Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:150,000

0 4 8 Kilometres

0 2 4 Nautical Miles

REV	REMARK	DATE
	First Issue	30/05/2019
A	Updated following PEIR consultations, for DCO	19/10/2020

The Hornsea Four Development:
The Longest Distance Through
The Wind Farm (km)
Document no: HOWO4AP0011
Created by: MB
Checked by: SS
Approved by: SS

Ørsted

Table 10: Theoretical operational time of Hornsea Four turbines as provided by the Applicant.

Month	Wind Availability (%)
January	92.15
February	92.58
March	92.42
April	91.46
May	91.25
June	90.04
July	89.87
August	90.49
September	91.75
October	92.61
November	92.60
December	92.45

3 Results

3.1 Introduction

3.1.1.1 This section provides the standard outputs from the CRM for each of the five seabird species. Tabulated monthly results are presented in Appendix B to Appendix F.

3.2 Gannet

3.2.1.1 Table 11 presents the annual gannet collision rates for Band Option 1 and 2 using the evidence-led approach input parameters. Monthly collision rates for Band Option 1 and 2 are presented in Figure 2 and Figure 3 respectively.

Table 11: Gannet evidence led approach annual predicted collisions.

	Annual Predicted Collisions		
Band Option	Mean Estimate	Minimum Estimate	Maximum Estimate
Option 1 (Cook et al. 2014)	36.83	16.04	78.50
Option 2 (Cook et al. 2014)	20.15	8.77	42.94
Option 1 (Bowgen & Cook 2018)	16.74	N/A	N/A
Option 2 (Bowgen & Cook 2018)	9.16	N/A	N/A

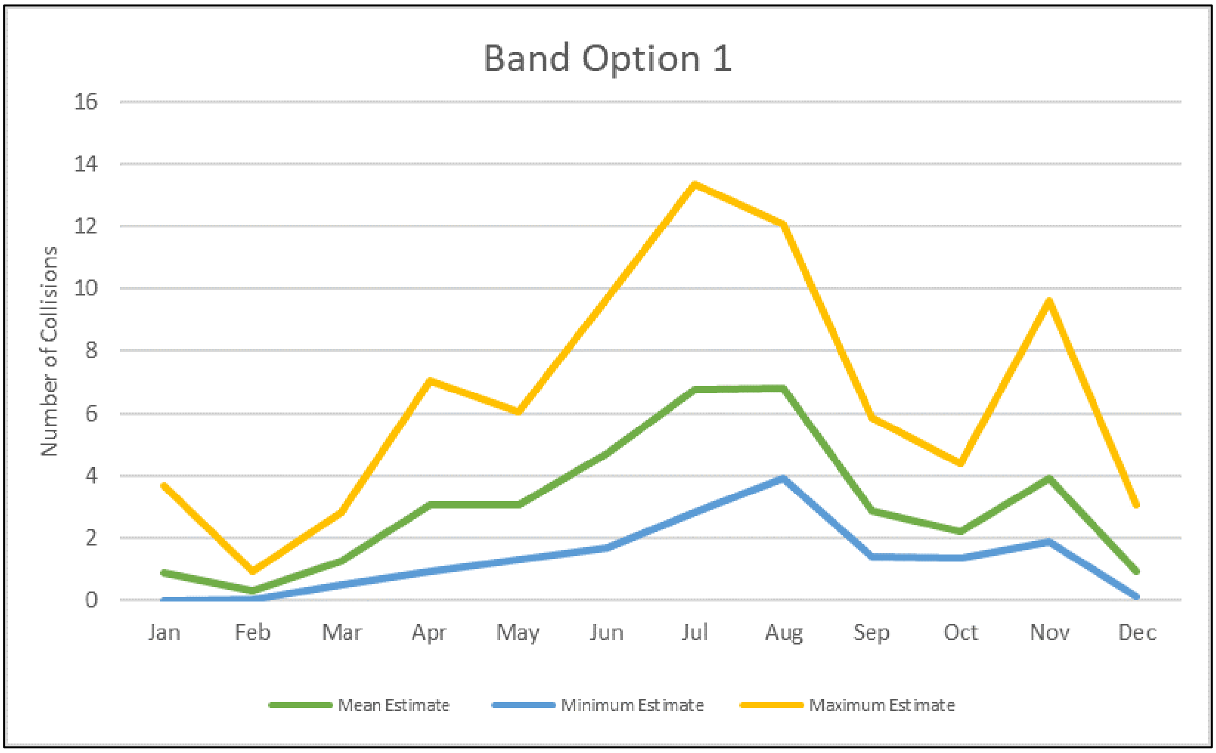


Figure 2: Gannet monthly collisions predicted using Band Option 1 with Cook et al. (2014) avoidance rates.

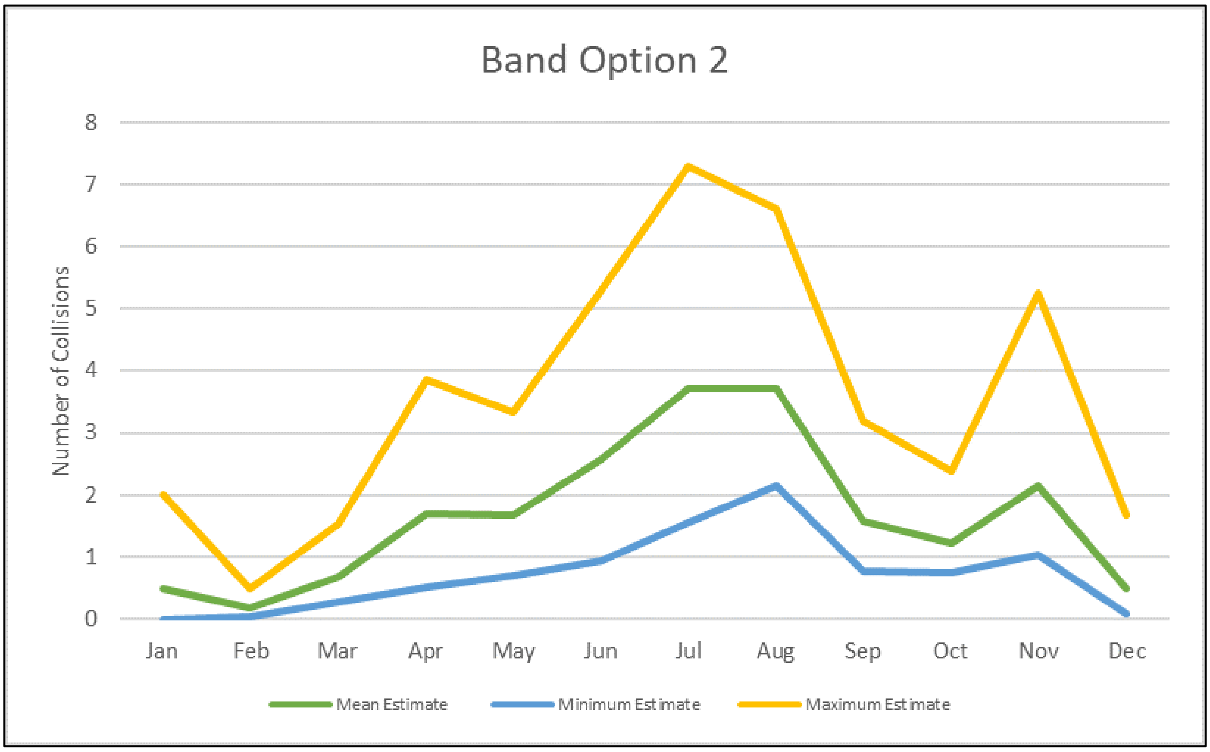


Figure 3: Gannet monthly collisions predicted using Band Option 2 with Cook et al. (2014) avoidance rates.

3.3 Kittiwake

3.3.1.1 Table 12 presents the annual kittiwake collision rates for Band Option 1, 2 and 3 using the evidence led approach input parameters. Monthly collision rates for Option 1 and 2 are presented in Figure 4 and Figure 5 respectively.

Table 12: Kittiwake evidence led approach annual predicted collisions.

Band Option	Annual Predicted Collisions		
	Mean Estimate	Minimum Estimate	Maximum Estimate
Option 1 (Cook et al. 2014)	16.19	4.72	36.25
Option 2 (Cook et al. 2014)	93.27	27.20	208.86
Option 1 (Bowgen & Cook 2018)	14.72	N/A	N/A
Option 2 (Bowgen & Cook 2018)	84.79	N/A	N/A
Option 3 (Bowgen & Cook 2018)	23.76	N/A	N/A

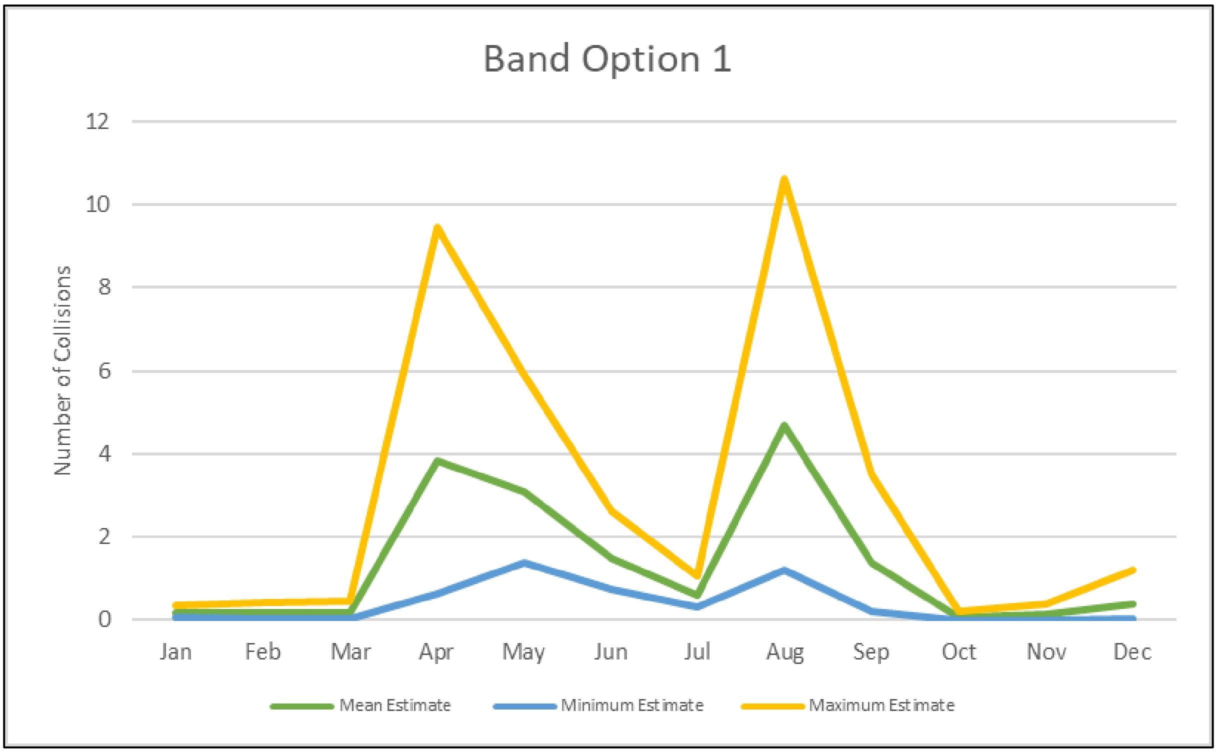


Figure 4: Kittiwake monthly collisions predicted using Band Option 1 with Cook et al. (2014) avoidance rates.

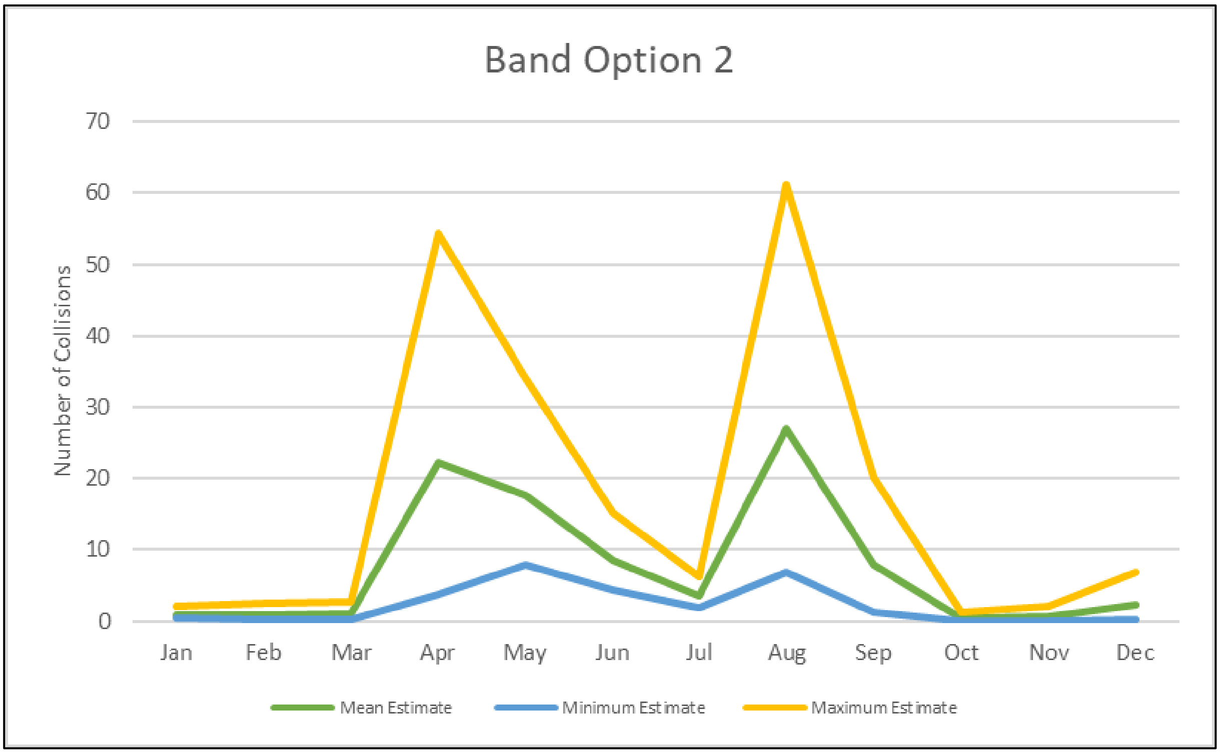


Figure 5: Kittiwake monthly collisions predicted using Band Option 2 with Cook et al. (2014) avoidance rates.

3.4 Lesser black-backed gull

3.4.1.1 Table 13 presents the annual lesser black-backed gull collision rates for Band Option 1, 2 and 3 using the evidence led approach input parameters. Monthly collision rates for Option 1, 2 and 3 are presented in Figure 6, Figure 7 and Figure 8 respectively.

Table 13: Lesser black-backed gull evidence led approach annual predicted collisions.

	Annual Predicted Collisions		
Band Option	**Mean Estimate**	**Minimum Estimate**	**Maximum Estimate**
Option 1 (Cook et al. 2014)	0.66	0.00	1.85
Option 2 (Cook et al. 2014)	0.83	0.00	2.34
Option 3 (Cook et al. 2014)	0.42	0.00	1.16
Option 1 (Bowgen & Cook 2018)	0.66	N/A	N/A
Option 2 (Bowgen & Cook 2018)	0.83	N/A	N/A
Option 3 (Bowgen & Cook 2018)	0.26	N/A	N/A

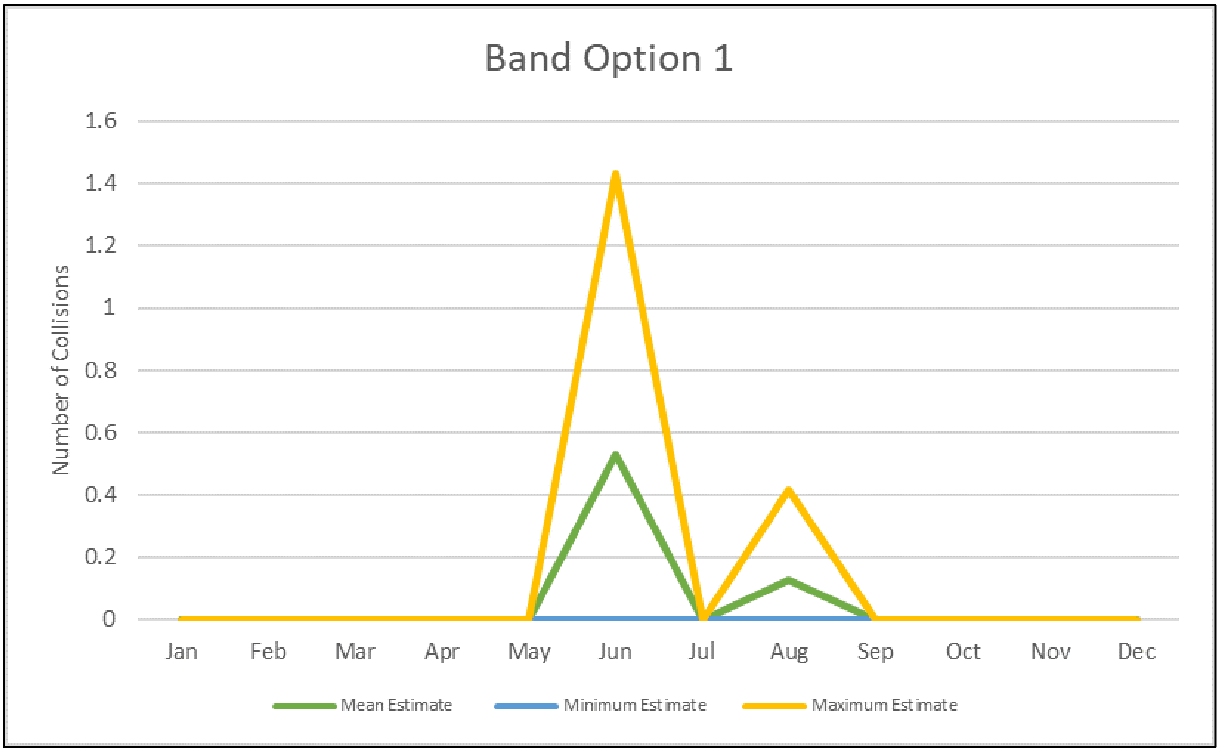


Figure 6: Lesser black-backed gull monthly collisions predicted using Band Option 1 with Cook et al. (2014) avoidance rates.

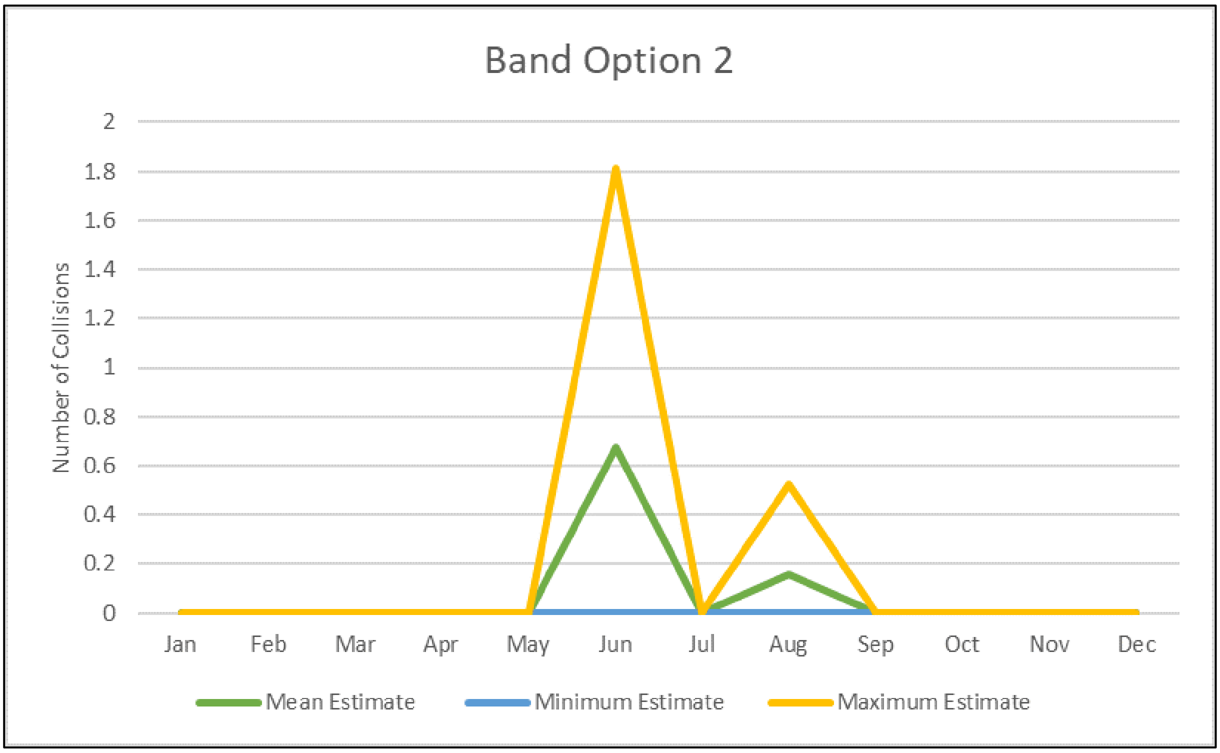


Figure 7: Lesser black-backed gull monthly collisions predicted using Band Option 2 with Cook et al. (2014) avoidance rates.

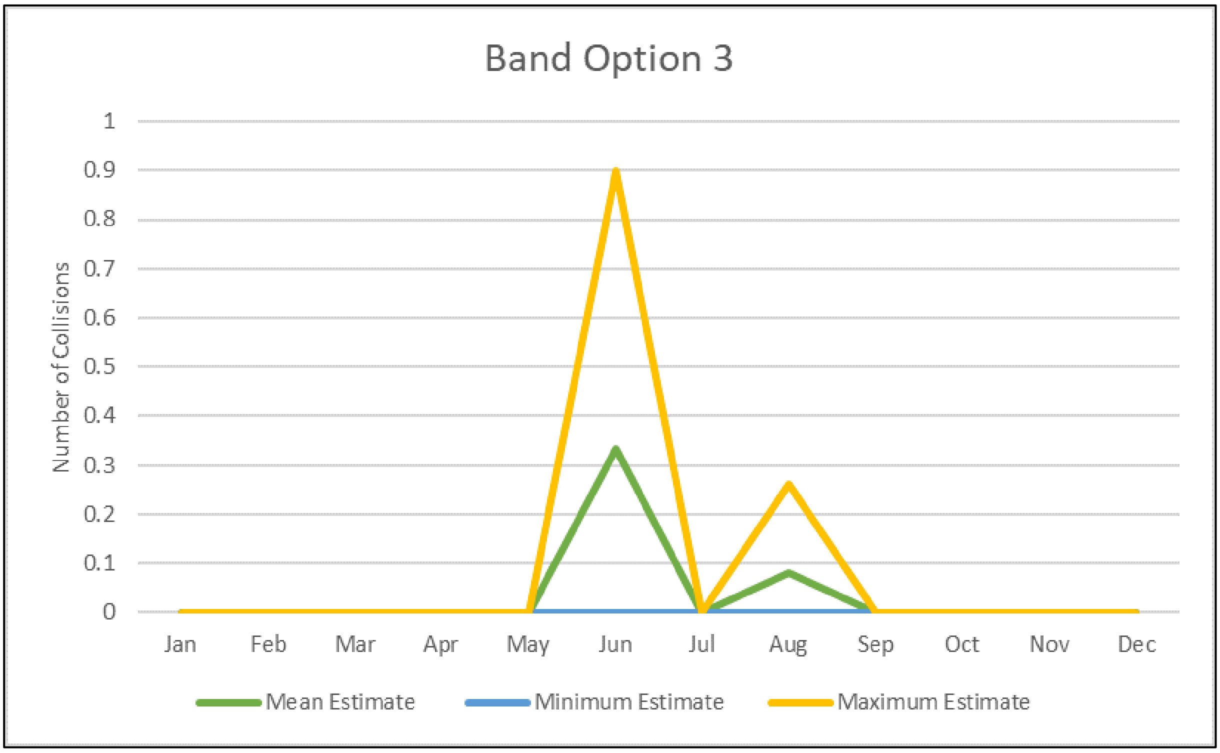


Figure 8: Lesser black-backed gull monthly collisions predicted using Band Option 3 with Cook et al. (2014) avoidance rates.

3.5 Herring gull

3.5.1.1 Table 14 presents the annual herring gull collision rates for Band Option 1, 2 and 3 using the evidence led approach input parameters. Monthly collision rates for Option 1, 2 and 3 are presented in Figure 9,Figure 10 and Figure 11 respectively.

Table 14: Herring gull evidence led approach annual predicted collisions.

	Annual Predicted Collisions		
Band Option	**Mean Estimate**	**Minimum Estimate**	**Maximum Estimate**
Option 1 (Cook et al. 2014)	1.71	0.18	5.01
Option 2 (Cook et al. 2014)	1.58	0.17	4.63
Option 3 (Cook et al. 2014)	0.79	0.08	2.33
Option 1 (Bowgen & Cook 2018)	1.71	N/A	N/A
Option 2 (Bowgen & Cook 2018)	1.58	N/A	N/A
Option 3 (Bowgen & Cook 2018)	0.55	N/A	N/A

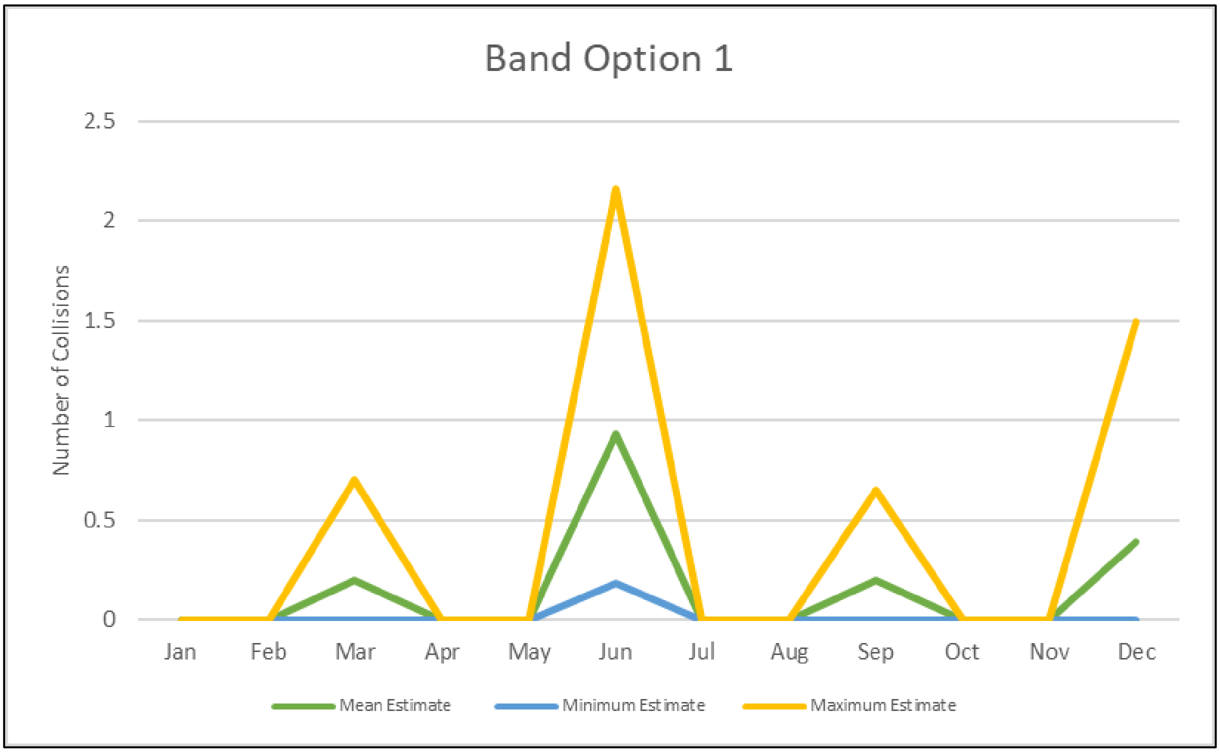


Figure 9: Herring gull monthly collisions predicted using Band Option 1 with Cook et al. (2014) avoidance rates.

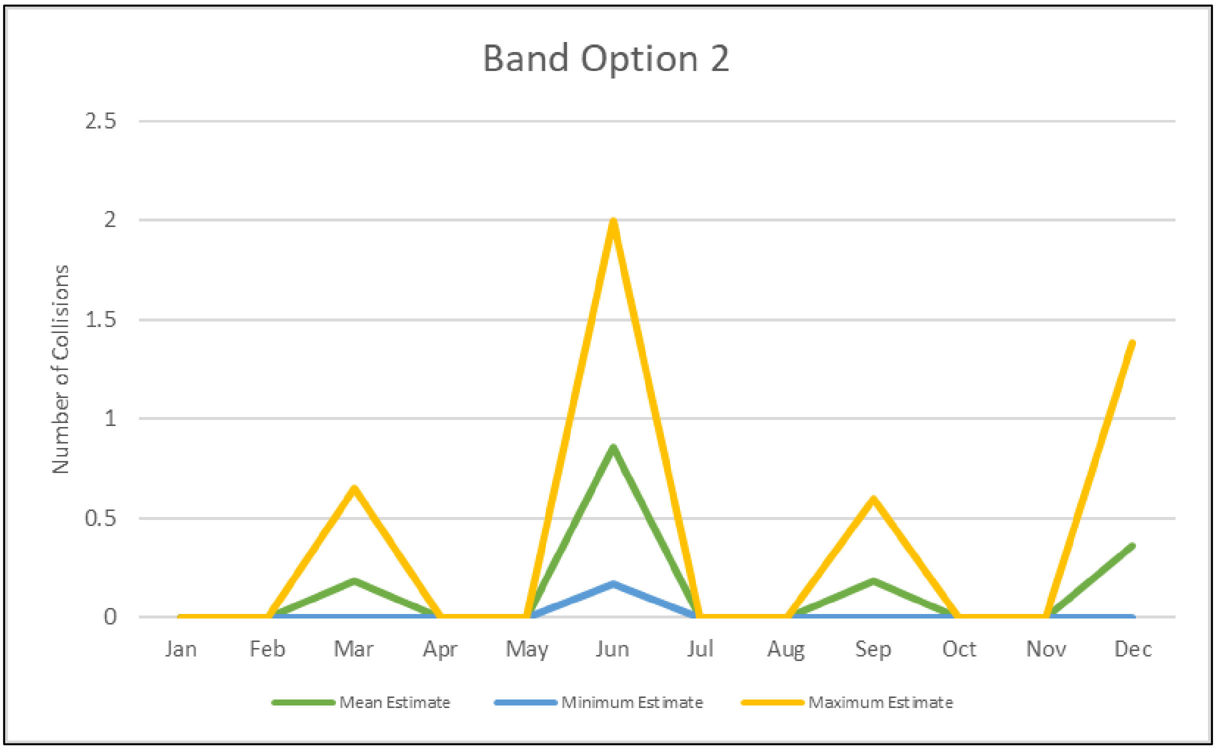


Figure 10: Herring gull monthly collisions predicted using Band Option 2 with Cook et al. (2014) avoidance rates.

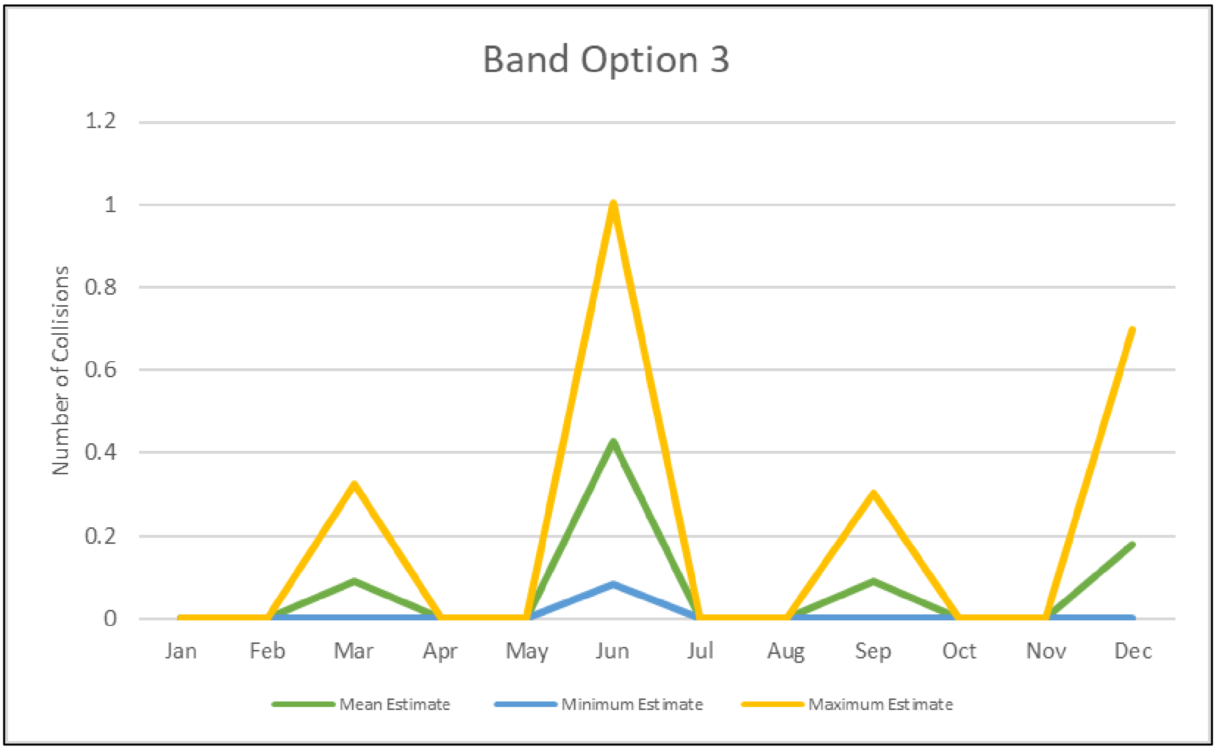


Figure 11: Herring gull monthly collisions predicted using Band Option 3 with Cook et al. (2014) avoidance rates.

3.6 Great black-backed gull

3.6.1.1 **Table 15** presents the annual great black-backed gull collision rates for Band Option 1 and 2 using the evidence led approach input parameters. Monthly collision rates for Option 1 and 2 are presented in **Figure 12**, **Figure 13** and **Figure 14** respectively.

Table 15: Great black-backed gull evidence led approach annual predicted collisions.

Band Option	Annual Predicted Collisions		
	Mean Estimate	Minimum Estimate	Maximum Estimate
Option 1 (Cook et al. 2014)	9.39	0.25	41.53
Option 2 (Cook et al. 2014)	7.19	0.19	31.76
Option 3 (Cook et al. 2014)	4.25	0.12	18.70
Option 1 (Bowgen & Cook 2018)	9.39	N/A	N/A
Option 2 (Bowgen & Cook 2018)	7.19	N/A	N/A
Option 3 (Bowgen & Cook 2018)	2.70	N/A	N/A

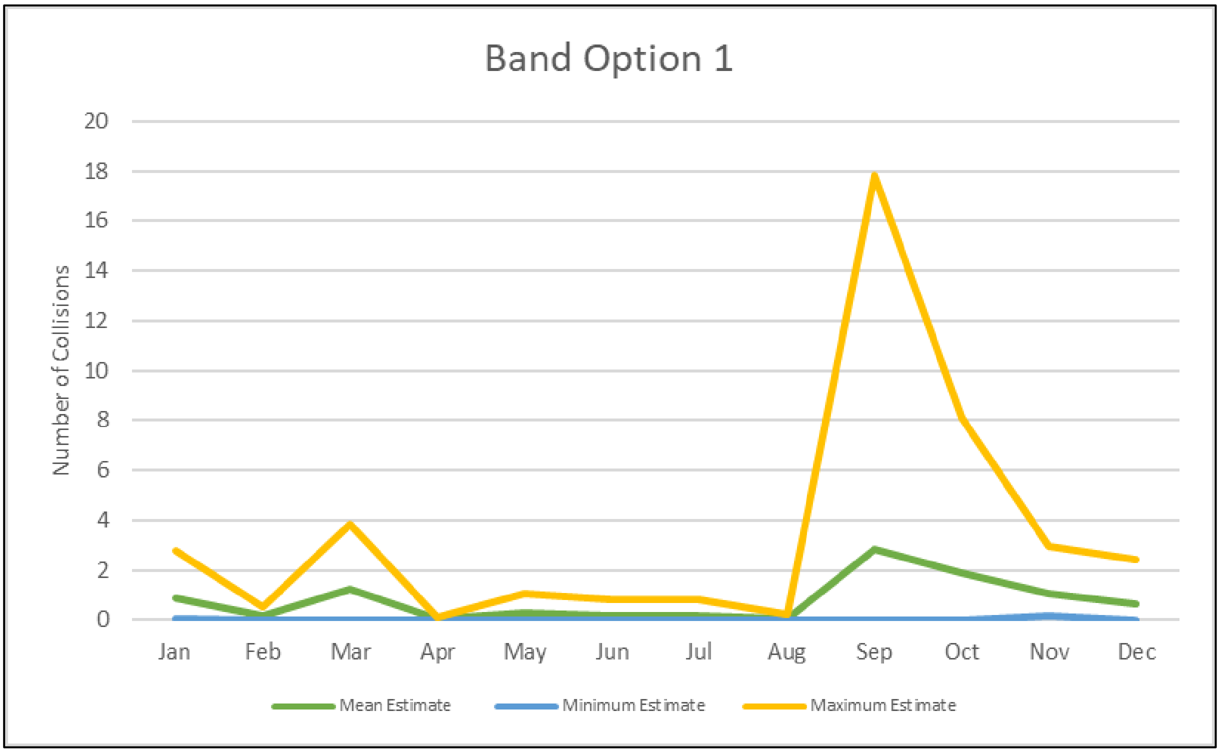


Figure 12: Great black-backed gull monthly collisions predicted using Band Option 1 with Cook et al. (2014) avoidance rates.

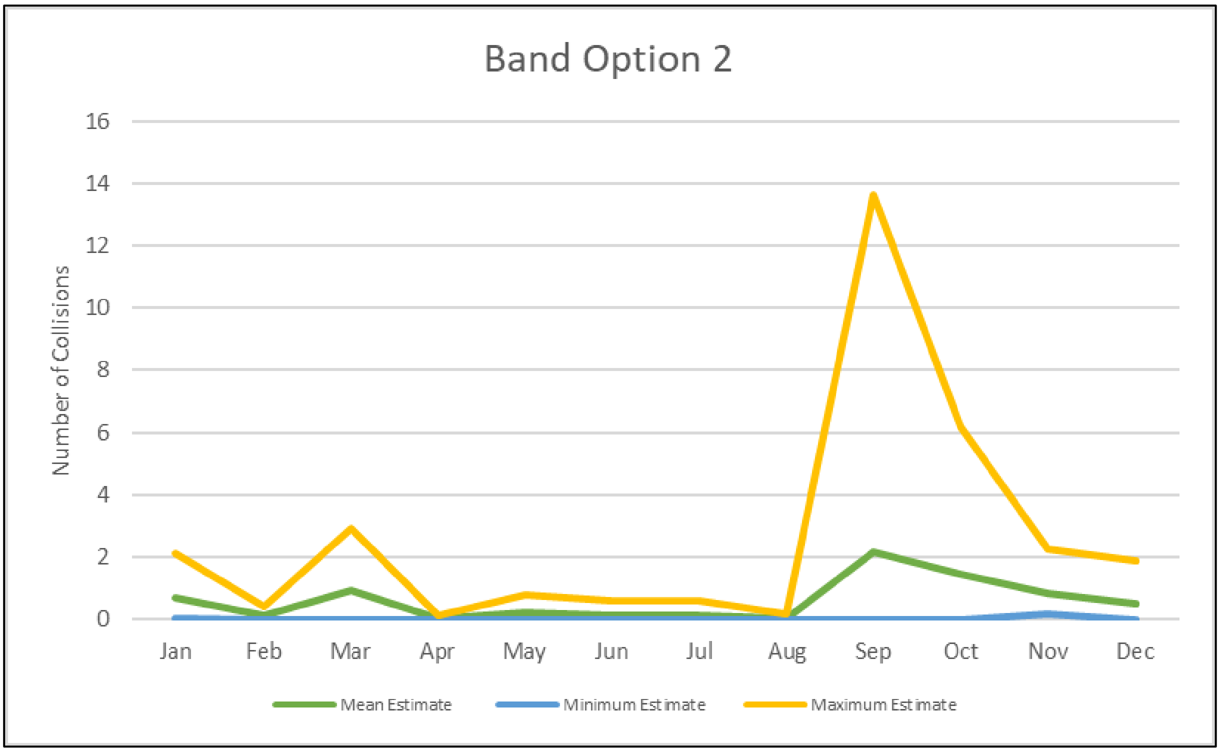


Figure 13: Great black-backed gull monthly collisions predicted using Band Option 2 with Cook et al. (2014) avoidance rates.

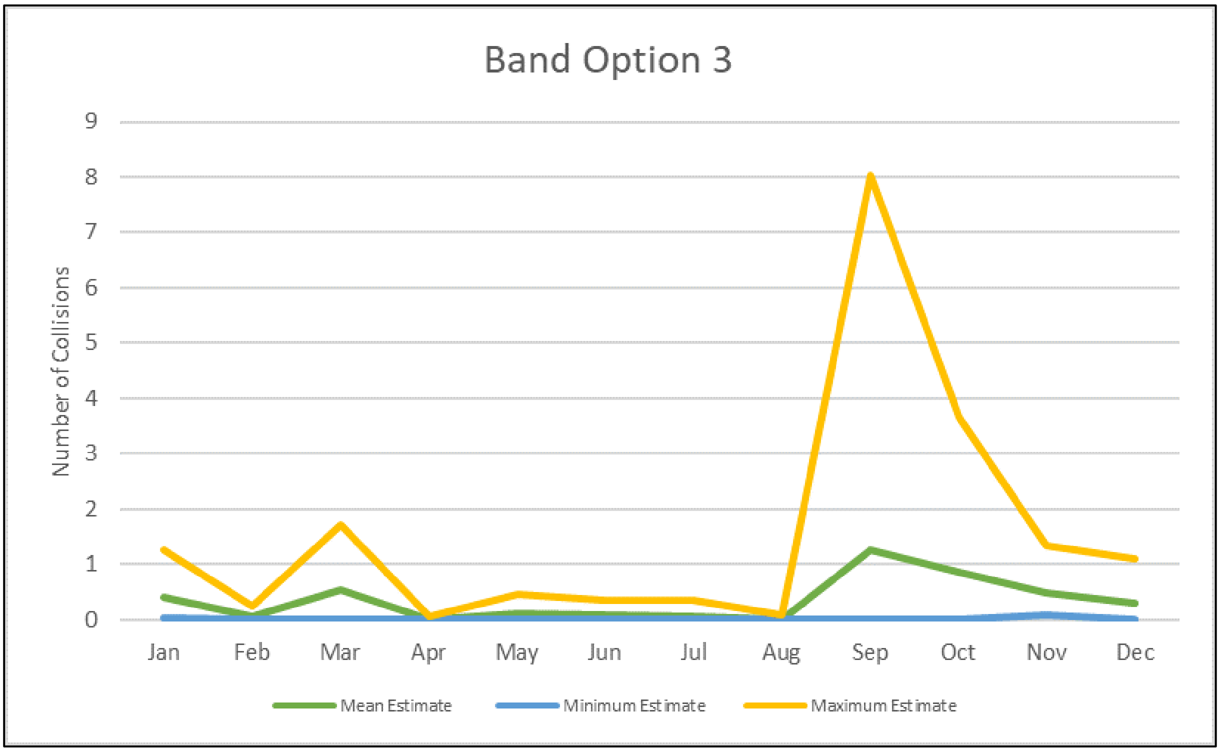


Figure 14: Great black-backed gull monthly collisions predicted using Band Option 3 with Cook et al. (2014) avoidance rates.

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Appendix A– SNCB Parameters CRM Outputs

Introduction to Second CRM Iteration

This Appendix presents CRM results based on the input parameters currently advocated for use by SNCBs (Natural England and RSPB), if they differ to those in the first presented throughout the main body this report. These CRM results follow the input parameters requested by SNCBs through the EP process, which provide their (more precautionary) range of outputs. A summary of the input parameters agreed and disagreed between the Applicant and SNCBs can be found in **Table 1** of the main report. The main difference of opinion remains that the SNCBs do not agree with the use of Band Option 1 and haven't advocated the use of Band Option 3 within the CRM for Hornsea Four (OFF-ORN-2.35). However, most of the main parameters for calculating collision risk using the CRM for Hornsea Four have been agreed for use in Band Option 2, so the differences between these two iterations are now only minor and are only applicable to flight speed value (gannet only), nocturnal activity factor to be used in the mean CRM estimate and the Band Option 2 flight height values to be used for calculating the minimum and maximum estimates.

Results from the first iteration of the CRM using the Applicant's advocated input parameters (termed: evidence-led approach) have been provided in the main body of this report which incorporates more recent evidence from the literature that is considered within the impact assessments concerned with collision risk. The outputs in this appendix incorporate the CRM parameters that Natural England recommended (OFF-ORN-2.32 to 2.37). In recognition of the evidence-led approach to CRM (**Volume A2, Chapter 5: Offshore and Intertidal Ornithology**), the results presented in this Appendix should therefore, in the Applicant's opinion, be considered overly precautionary, though the majority of the input parameters are similar or the same.

Methodology of Second CRM Iteration

The input parameters that have been altered to inform the second (SNCB) iteration of the CRM are presented in **Table A 1**.

All other input parameters remain the same as described under **Section 2.2** of the main body of this report.

In relation to flight speeds, the only difference between the first and second iteration of the CRM is that only one species has been modelled separately, gannet. For the SNCB iteration a flight speed of 14.9 ms^{-1} was inputted derived from Pennycuick (1997), as agreed with EP Technical Panel (OFF-ORN-2.19 and OFF-ORN-2.33) for the whole range of estimates.

For the SNCB mean collision estimates for all five species, the more precautionary nocturnal activity scoring index values were selected (Garthe and Hüppop (2004) and King et al. (2009)) were selected as recommended by Natural England through the EP process (OFF-ORN-2.34). As noted in **Section 2.2.5** these data have been superseded by more recent studies from which the Applicant's values were derived.

For all five species Natural England requested the minimum and maximum collision estimates were calculated using the upper and lower 95% CI values around the Johnston et al. (2014) flight height data (OFF-ORN-2.35). However, they also explained that any such values would not be used to estimate the risk from collision for Hornsea Four. As these values may produce additional variations that would not be used for the purpose of assessment, the Applicant does not consider the presentation of the 95% CI values appropriate for collision risk assessment and as such, have not included collision risk results incorporating these datasets. This is because, as stated in **Section 2.2**, the values selected for collision risk modelling can be considered sufficiently precautionary. The use of the 95% CI flight height datasets would add unnecessary layers of additional over-precautionary values and an element of confusion to those reviewing the more accurate levels of risk from Hornsea Four. The Applicant also recognises that such values have not been considered for assessment purposes in any recent OWF applications, underlining the case for not adding further layers of precaution to the assessment process.

Table A 1: Summary of the differing input parameters for the second (SNCB) iteration of the CRM for Hornsea Four for gannet.

Parameter	Species	Evidence led position			SNCB Position		
		Minimum	Mean	Maximum	Minimum	Mean	Maximum
Flight Speed (ms^{-1})	Gannet	13.33	13.33	13.33	14.9	14.9	14.9
Nocturnal Activity (%)	Gannet	0	0	25	0	25	25
	Kittiwake	25	25	50	25	50	50
	Lesser black-backed gull	25	25	50	25	50	50
	Herring gull	25	25	50	25	50	50
	Great black-backed gull	25	25	50	25	50	50
Flight Heights	Gannet	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2)	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2)	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2)	Johnston et al. (2014) maximum Likelihood (BO2 Only)	Johnston et al. (2014) maximum Likelihood (BO2 Only)	Johnston et al. (2014) maximum Likelihood (BO2 Only)
	Kittiwake	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Johnston et al. (2014) maximum Likelihood (BO2 Only)	Johnston et al. (2014) maximum Likelihood (BO2 Only)	Johnston et al. (2014) maximum Likelihood (BO2 Only)
	Lesser black-backed gull	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Johnston et al. (2014) maximum Likelihood (BO2 Only)	Johnston et al. (2014) maximum Likelihood (BO2 Only)	Johnston et al. (2014) maximum Likelihood (BO2 Only)
	Herring gull	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Site specific (BO1) / Johnston et al. (2014) maximum Likelihood (BO2 & 3	Johnston et al. (2014) maximum Likelihood (BO2 Only)	Johnston et al. (2014) maximum Likelihood (BO2 Only)	Johnston et al. (2014) maximum Likelihood (BO2 Only)
	Great black-backed gull	Site specific (BO1) / Johnston et al. (2014)	Site specific (BO1) / Johnston et al. (2014)	Site specific (BO1) / Johnston et al. (2014)	Johnston et al. (2014) maximum	Johnston et al. (2014) maximum	Johnston et al. (2014) maximum

		maximum Likelihood (BO2 & 3	maximum Likelihood (BO2 & 3	maximum Likelihood (BO2 & 3	Likelihood (BO2 Only)	Likelihood (BO2 Only)	Likelihood (BO2 Only)

Results of Second (SNCB) CRM Iteration

Introduction

This section provides the standard outputs from the second (SNCB) iteration of the CRM.

Gannet

Table A 2 presents the second (SNCB) iteration annual gannet collision rates for Band Option 2. Monthly collision rates for Band Option 2 are presented in Figure A 1.

Table A 2: SNCB gannet annual predicted collisions.

	Annual Predicted Collisions		
Band Option	Mean Estimate	Minimum Estimate	Maximum Estimate
Option 2	25.94	9.36	45.67

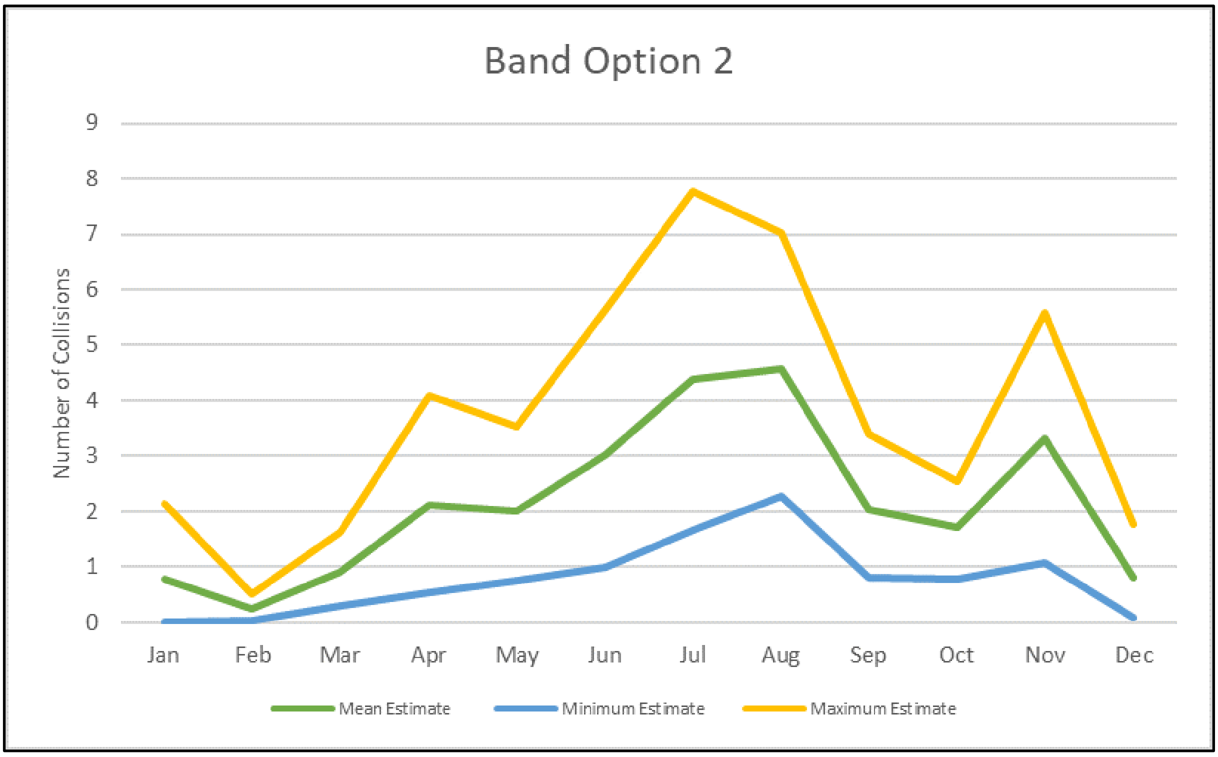

Figure A 1: SNCB gannet monthly collisions predicted using Band Option 2.

Kittiwake

Table A 3 presents the second (SNCB) iteration annual kittiwake collision rates for Band Option 2. Monthly collision rates for Band Option 2 are presented in Figure A 2.

Table A 3: SNCB kittiwake annual predicted collisions.

	Annual Predicted Collisions		
Band Option	Mean Estimate	Minimum Estimate	Maximum Estimate
Option 2	106.69	27.20	208.86

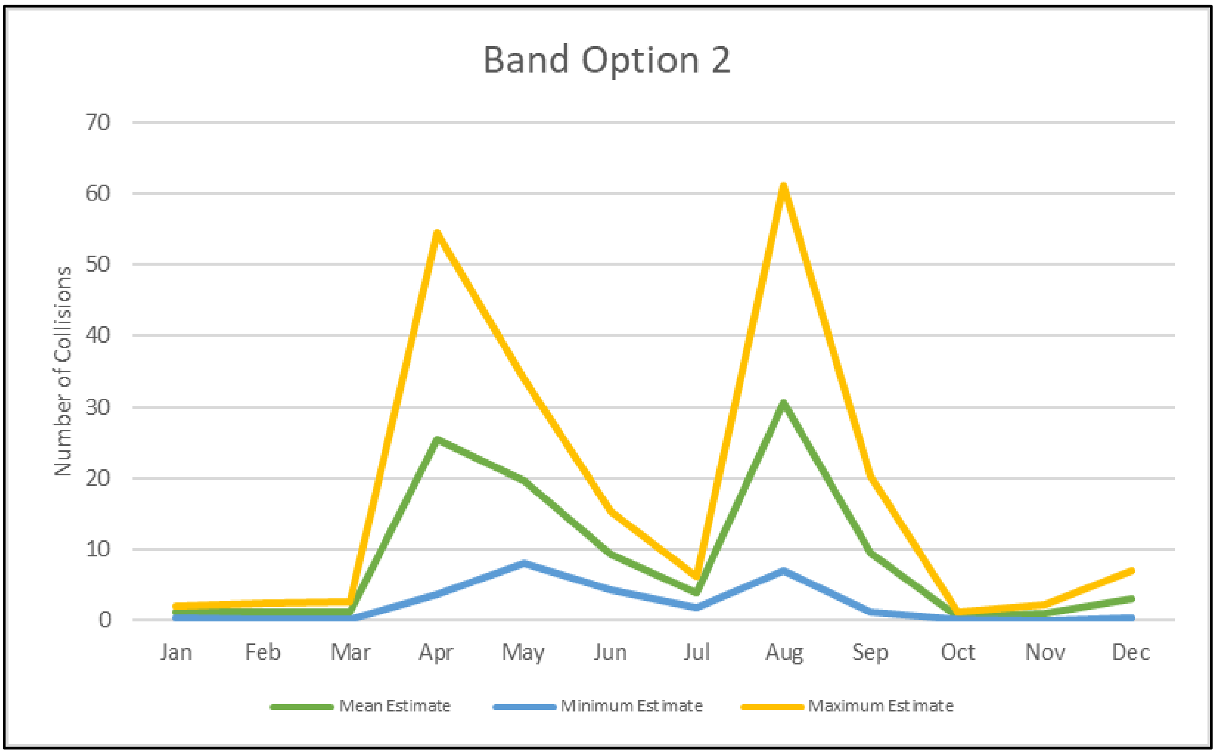

Figure A 2: SNCB kittiwake monthly collisions predicted using Band Option 2.

Lesser black-backed gull

Table A 4 presents the second (SNCB) iteration annual lesser black-backed gull collision rates for Band Option 2. Monthly collision rates for Band Option 2 are presented in Figure A 3.

Table A 4: SNCB lesser black-backed gull annual predicted collisions.

Band Option	Annual Predicted Collisions		
	Mean Estimate	Minimum Estimate	Maximum Estimate
Option 2	0.92	0.00	2.34

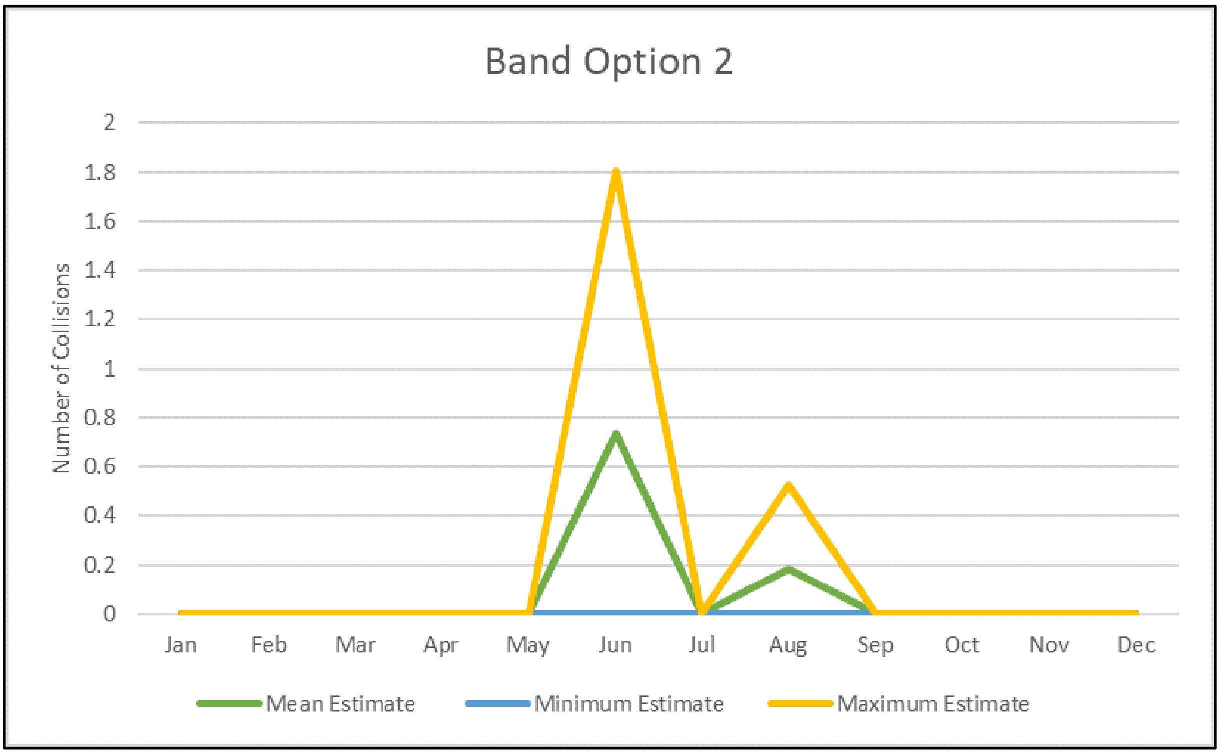

Figure A 3: SNCB lesser black-backed gull monthly collisions predicted using Band Option 2.

Herring gull

Table A 5 presents the second (SNCB) iteration annual herring gull collision rates for Band Option 2. Monthly collision rates for Band Option 2 are presented in Figure A 4.

Table A 5: SNCB herring gull annual predicted collisions.

Band Option	Annual Predicted Collisions		
	Mean Estimate	Minimum Estimate	Maximum Estimate
Option 2	1.86	0.17	4.63

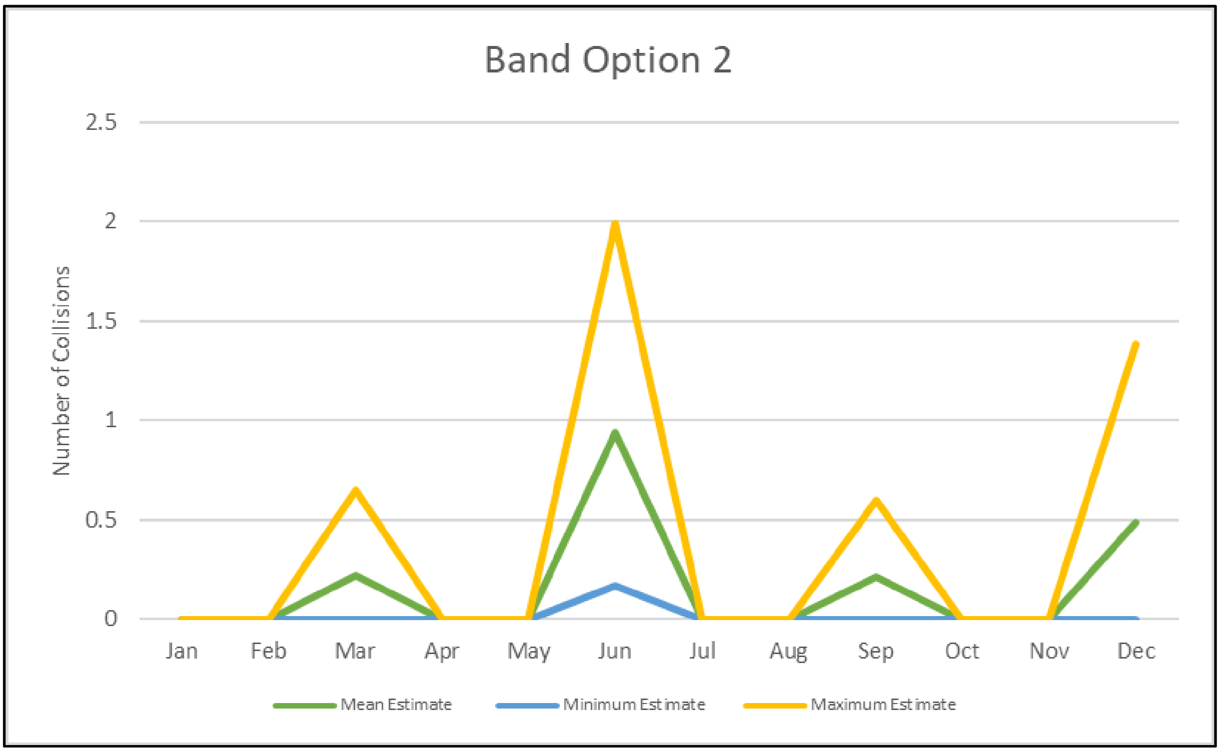

Figure A 4: SNCB herring gull monthly collisions predicted using Band Option 2.

Great black-backed gull

Table A 6 presents the second (SNCB) iteration annual great black-backed gull collision rates for Band Option 2. Monthly collision rates for Band Option 2 are presented in Figure A 5.

Table A 6: SNCB great black-backed gull annual predicted collisions.

	Annual Predicted Collisions		
Band Option	Mean Estimate	Minimum Estimate	Maximum Estimate
Option 2	8.86	0.19	31.76

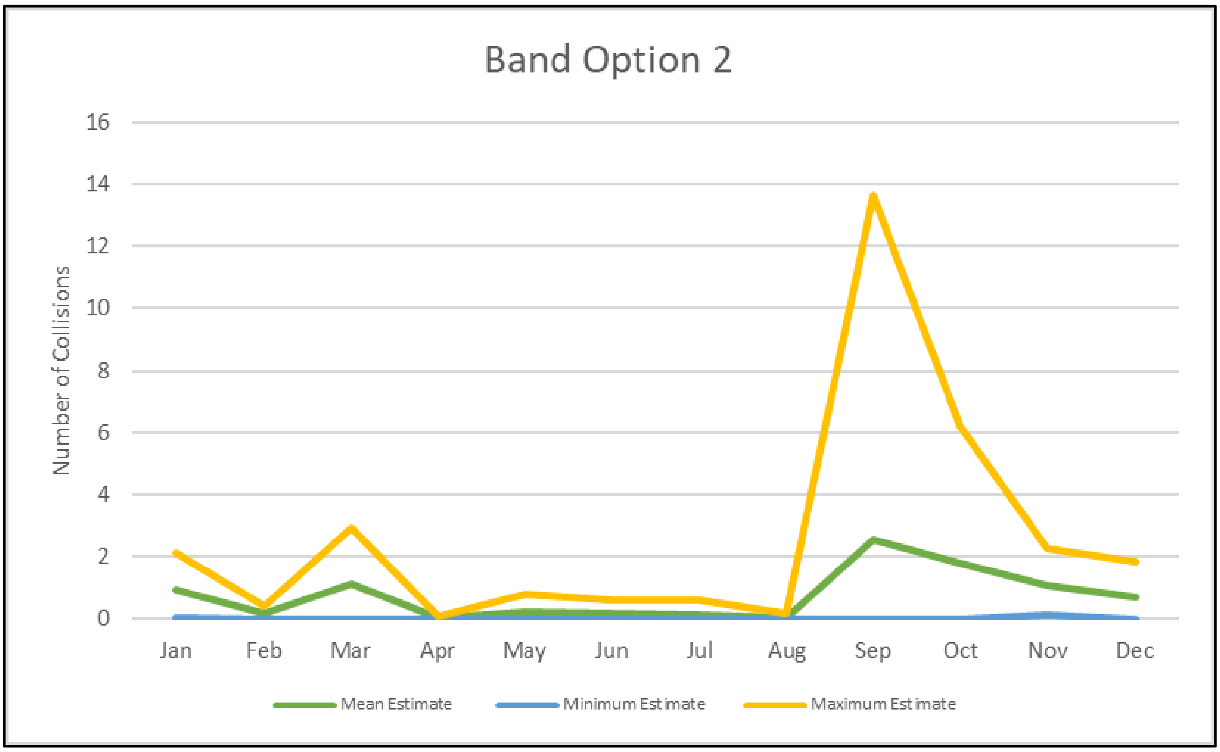

Figure A 5: SNCB great black-backed gull monthly collisions predicted using Band Option 2.

Appendix B – Gannet Monthly Collision Rates

Table B 1: Monthly gannet collision risk estimates for Band Option 1.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.905	0.411	0.000	3.682
Feb	0.308	0.14	0.051	0.906
Mar	1.243	0.565	0.500	2.812
Apr	3.081	1.401	0.946	7.041
May	3.058	1.390	1.301	6.072
Jun	4.725	2.148	1.701	9.687
Jul	6.777	3.081	2.847	13.347
Aug	6.792	3.088	3.915	12.062
Sep	2.870	1.305	1.404	5.842
Oct	2.231	1.014	1.36	4.378
Nov	3.933	1.788	1.867	9.624
Dec	0.909	0.413	0.147	3.044

Table B 2: Monthly gannet collision risk estimates for Band Option 2.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.495	0.225	0.000	2.014
Feb	0.169	0.077	0.028	0.496
Mar	0.680	0.309	0.274	1.538
Apr	1.685	0.766	0.517	3.851
May	1.673	0.760	0.711	3.321
Jun	2.585	1.175	0.931	5.299
Jul	3.707	1.685	1.557	7.301
Aug	3.715	1.689	2.141	6.597
Sep	1.570	0.714	0.768	3.196
Oct	1.221	0.555	0.744	2.395
Nov	2.151	0.978	1.021	5.264
Dec	0.497	0.226	0.080	1.665

Table B 3: SNCB Monthly gannet collision risk estimates for Band Option 2.

Month	Mean	Minimum	Maximum
Jan	0.791	0.000	2.142
Feb	0.246	0.030	0.527
Mar	0.911	0.292	1.636
Apr	2.115	0.552	4.097
May	2.006	0.759	3.533
Jun	3.033	0.992	5.636
Jul	4.389	1.660	7.766
Aug	4.563	2.283	7.018
Sep	2.039	0.819	3.399
Oct	1.711	0.793	2.547
Nov	3.316	1.089	5.600
Dec	0.823	0.086	1.771

Table B 4: Gannet sampled bird input parameters.

Parameter	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
AvoidanceBasic	0.989	0.995	0.991	0.987
AvoidanceExtended	N/A	N/A	N/A	N/A
WingSpan	1.72	1.72	1.72	1.72
BodyLength	0.94	0.94	0.94	0.94
PCH	0.0284	0.0284	0.0284	0.0284
FlightSpeed	13.33	13.33	13.33	13.33
NocturnalActivity	0.00	0.00	0.00	0.25

Table B 5: SNCB Gannet sampled bird input parameters.

Parameter	Mean	Minimum	Maximum
AvoidanceBasic	0.989	0.991	0.987
AvoidanceExtended	N/A	N/A	N/A
WingSpan	1.72	1.72	1.72
BodyLength	0.94	0.94	0.94
PCH	N/A	N/A	N/A
FlightSpeed	14.90	14.90	14.90
NocturnalActivity	0.00	0.25	0.25

Table B 6: Gannet sampled turbine input parameters.

Parameter	Mean	Minimum	Maximum
RotorRadius	152.5	152.5	152.5
HubHeight	190.22	190.22	190.22
BladeWidth	6	6	6
WindSpeed	0	0	0
RotorSpeed	6.5	6.3	6.7
Pitch_rad	0.0803	0.0628	0.0977
JanOp	92.15	92.15	92.15
FebOp	92.58	92.58	92.58
MarOp	92.42	92.42	92.42
AprOp	91.46	91.46	91.46
MayOp	91.25	91.25	91.25
JunOp	90.04	90.04	90.04
JulOp	89.87	89.87	89.87
AugOp	90.49	90.49	90.49
SepOp	91.75	91.75	91.75
OctOp	92.61	92.61	92.61
NovOp	92.60	92.60	92.60
DecOp	92.45	92.45	92.45

Appendix C – Kittiwake monthly collision risks

Table C 1: Monthly kittiwake collision risk estimates for Band Option 1.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.158	0.144	0.397	2.111
Feb	0.157	0.143	0.169	2.422
Mar	0.182	0.165	0.185	2.676
Apr	3.851	3.501	3.760	54.442
May	3.080	2.800	7.964	33.986
Jun	1.476	1.342	4.316	15.206
Jul	0.614	0.558	1.882	6.227
Aug	4.683	4.257	6.921	61.239
Sep	1.383	1.257	1.255	20.200
Oct	0.080	0.073	0.057	1.252
Nov	0.125	0.114	0.033	2.178
Dec	0.400	0.364	0.260	6.919

Table C 2: Monthly kittiwake collision risk estimates for Band Option 2.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.910	0.827	0.397	2.111
Feb	0.906	0.824	0.169	2.422
Mar	1.047	0.952	0.185	2.676
Apr	22.187	20.171	3.760	54.442
May	17.748	16.135	7.964	33.986
Jun	8.506	7.733	4.316	15.206
Jul	3.536	3.215	1.882	6.227
Aug	26.980	24.527	6.921	61.239
Sep	7.967	7.242	1.255	20.200
Oct	0.460	0.418	0.057	1.252
Nov	0.720	0.654	0.033	2.178
Dec	2.304	2.095	0.260	6.919

Table C 3: Monthly kittiwake collision risk estimates for Band Option 3.

Month	Mean (Bowgen & Cook 2018)
Jan	0.232
Feb	0.231
Mar	0.267
Apr	5.653
May	4.522
Jun	2.167
Jul	0.901
Aug	6.874
Sep	2.030
Oct	0.117
Nov	0.183
Dec	0.587

Table C 4: SNCB Monthly kittiwake collision risk estimates for Band Option 2.

Month	Mean	Minimum	Maximum
Jan	1.213	0.397	2.111
Feb	1.150	0.169	2.422
Mar	1.262	0.185	2.676
Apr	25.547	3.760	54.442
May	19.732	7.964	33.986
Jun	9.291	4.316	15.206
Jul	3.891	1.882	6.227
Aug	30.563	6.921	61.239
Sep	9.402	1.255	20.200
Oct	0.570	0.057	1.252
Nov	0.942	0.033	2.178
Dec	3.125	0.260	6.919

Table C 5: Kittiwake sampled bird input parameters.

Parameter	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
AvoidanceBasic	0.989	0.990	0.991	0.987
AvoidanceExtended	0.989	0.980	N/A	N/A
WingSpan	1.08	1.08	1.08	1.08
BodyLength	0.39	0.39	0.39	0.39
PCH	0.0038	0.0038	0.0038	0.0038
FlightSpeed	13.1	13.1	13.1	13.1
NocturnalActivity	0.25	0.25	0.25	0.50

Table C 6: SNCB Kittiwake sampled bird input parameters.

Parameter	Mean	Minimum	Maximum
AvoidanceBasic	0.989	0.991	0.987
AvoidanceExtended	N/A	N/A	N/A
WingSpan	1.08	1.08	1.08
BodyLength	0.39	0.39	0.39
PCH	0.0038	0.0038	0.0038
FlightSpeed	13.1	13.1	13.1
NocturnalActivity	0.50	0.25	0.50

Table C 7: Kittiwake sampled turbine input parameters.

Parameter	Mean	Minimum	Maximum
RotorRadius	152.5	152.5	152.5
HubHeight	190.22	190.22	190.22
BladeWidth	6	6	6
WindSpeed	0	0	0
RotorSpeed	6.5	6.3	6.7
Pitch_rad	0.0803	0.0628	0.0977
JanOp	92.15	92.15	92.15
FebOp	92.58	92.58	92.58
MarOp	92.42	92.42	92.42
AprOp	91.46	91.46	91.46
MayOp	91.25	91.25	91.25
JunOp	90.04	90.04	90.04
JulOp	89.87	89.87	89.87
AugOp	90.49	90.49	90.49
SepOp	91.75	91.75	91.75
OctOp	92.61	92.61	92.61
NovOp	92.60	92.60	92.60
DecOp	92.45	92.45	92.45

Appendix D – Lesser black-backed gull monthly collision rates

Table D 1: Monthly lesser black-backed gull collision risk estimates for Band Option 1.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000
Apr	0.000	0.000	0.000	0.000
May	0.000	0.000	0.000	0.000
Jun	0.533	0.533	0.000	1.433
Jul	0.000	0.000	0.000	0.000
Aug	0.127	0.127	0.000	0.417
Sep	0.000	0.000	0.000	0.000
Oct	0.000	0.000	0.000	0.000
Nov	0.000	0.000	0.000	0.000
Dec	0.000	0.000	0.000	0.000

Table D 2: Monthly lesser black-backed gull collision risk estimates for Band Option 2.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000
Apr	0.000	0.000	0.000	0.000
May	0.000	0.000	0.000	0.000
Jun	0.673	0.673	0.000	1.810
Jul	0.000	0.000	0.000	0.000
Aug	0.160	0.160	0.000	0.527
Sep	0.000	0.000	0.000	0.000
Oct	0.000	0.000	0.000	0.000
Nov	0.000	0.000	0.000	0.000
Dec	0.000	0.000	0.000	0.000

Table D 3: Monthly lesser black-backed gull collision risk estimates for Band Option 3.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000
Apr	0.000	0.000	0.000	0.000
May	0.000	0.000	0.000	0.000
Jun	0.335	0.213	0.000	0.898
Jul	0.000	0.000	0.000	0.000
Aug	0.080	0.051	0.000	0.262
Sep	0.000	0.000	0.000	0.000
Oct	0.000	0.000	0.000	0.000
Nov	0.000	0.000	0.000	0.000
Dec	0.000	0.000	0.000	0.000

Table D 4: SNCB Monthly lesser black-backed gull collision risk estimates for Band Option 2.

Month	Mean	Minimum	Maximum
Jan	0.000	0.000	0.000
Feb	0.000	0.000	0.000
Mar	0.000	0.000	0.000
Apr	0.000	0.000	0.000
May	0.000	0.000	0.000
Jun	0.735	0.000	1.810
Jul	0.000	0.000	0.000
Aug	0.181	0.000	0.527
Sep	0.000	0.000	0.000
Oct	0.000	0.000	0.000
Nov	0.000	0.000	0.000
Dec	0.000	0.000	0.000

Table D 5: Lesser black-backed gull sampled bird input parameters.

Parameter	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
AvoidanceBasic	0.995	0.995	0.996	0.994
AvoidanceExtended	0.989	0.993	0.991	0.987
WingSpan	1.42	1.42	1.42	1.42
BodyLength	0.58	0.58	0.58	0.58
PCH	0.0614	0.0614	0.0614	0.0614
FlightSpeed	13.1	13.1	13.1	13.1
NocturnalActivity	0.25	0.25	0.25	0.50

Table D 6: SNCB Lesser black-backed gull sampled bird input parameters.

Parameter	Mean	Minimum	Maximum
AvoidanceBasic	0.995	0.996	0.994
AvoidanceExtended	N/A	N/A	N/A
WingSpan	1.42	1.42	1.42
BodyLength	0.58	0.58	0.58
PCH	0.0614	0.0614	0.0614
FlightSpeed	13.1	13.1	13.1
NocturnalActivity	0.50	0.25	0.50

Table D 7: Lesser black-backed gull sampled turbine input parameters.

Parameter	Mean	Minimum	Maximum
RotorRadius	152.5	152.5	152.5
HubHeight	190.22	190.22	190.22
BladeWidth	6	6	6
WindSpeed	0	0	0
RotorSpeed	6.5	6.3	6.7
Pitch_rad	0.0803	0.0628	0.0977
JanOp	92.15	92.15	92.15
FebOp	92.58	92.58	92.58
MarOp	92.42	92.42	92.42
AprOp	91.46	91.46	91.46

Parameter	Mean	Minimum	Maximum
MayOp	91.25	91.25	91.25
JunOp	90.04	90.04	90.04
JulOp	89.87	89.87	89.87
AugOp	90.49	90.49	90.49
SepOp	91.75	91.75	91.75
OctOp	92.61	92.61	92.61
NovOp	92.60	92.60	92.60
DecOp	92.45	92.45	92.45

Appendix E – Herring gull monthly collision rates

Table E 1: Monthly herring gull collision risk estimates for Band Option 1.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000
Mar	0.196	0.196	0.000	0.701
Apr	0.000	0.000	0.000	0.000
May	0.000	0.000	0.000	0.000
Jun	0.931	0.931	0.183	2.160
Jul	0.000	0.000	0.000	0.000
Aug	0.000	0.000	0.000	0.000
Sep	0.197	0.197	0.000	0.649
Oct	0.000	0.000	0.000	0.000
Nov	0.000	0.000	0.000	0.000
Dec	0.390	0.390	0.000	1.497

Table E 2: Monthly herring gull collision risk estimates for Band Option 2.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000
Mar	0.181	0.181	0.000	0.648
Apr	0.000	0.000	0.000	0.000
May	0.000	0.000	0.000	0.000
Jun	0.860	0.860	0.169	1.995
Jul	0.000	0.000	0.000	0.000
Aug	0.000	0.000	0.000	0.000
Sep	0.182	0.182	0.000	0.600
Oct	0.000	0.000	0.000	0.000
Nov	0.000	0.000	0.000	0.000
Dec	0.361	0.361	0.000	1.383

Table E 3: Monthly herring gull collision risk estimates for Band Option 3.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000
Mar	0.090	0.063	0.000	0.326
Apr	0.000	0.000	0.000	0.000
May	0.000	0.000	0.000	0.000
Jun	0.428	0.300	0.083	1.005
Jul	0.000	0.000	0.000	0.000
Aug	0.000	0.000	0.000	0.000
Sep	0.091	0.064	0.000	0.302
Oct	0.000	0.000	0.000	0.000
Nov	0.000	0.000	0.000	0.000
Dec	0.180	0.126	0.000	0.697

Table E 4: SNCB Monthly herring gull collision risk estimates for Band Option 2.

Month	Mean	Minimum	Maximum
Jan	0.000	0.000	0.000
Feb	0.000	0.000	0.000
Mar	0.218	0.000	0.648
Apr	0.000	0.000	0.000
May	0.000	0.000	0.000
Jun	0.940	0.169	1.995
Jul	0.000	0.000	0.000
Aug	0.000	0.000	0.000
Sep	0.215	0.000	0.600
Oct	0.000	0.000	0.000
Nov	0.000	0.000	0.000
Dec	0.489	0.000	1.383

Table E 5: Herring gull sampled bird input parameters.

Parameter	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
AvoidanceBasic	0.995	0.995	0.996	0.994
AvoidanceExtended	0.990	0.993	0.992	0.988
WingSpan	1.44	1.44	1.44	1.44
BodyLength	0.60	0.60	0.60	0.60
PCH	0.1077	0.1077	0.1077	0.1077
FlightSpeed	12.8	12.8	12.8	12.8
NocturnalActivity	0.25	0.25	0.25	0.50

Table E 6: SNCB Herring gull sampled bird input parameters.

Parameter	Mean	Minimum	Maximum
AvoidanceBasic	0.995	0.996	0.994
AvoidanceExtended	N/A	N/A	N/A
WingSpan	1.44	1.44	1.44
BodyLength	0.60	0.60	0.60
PCH	0.1077	0.1077	0.1077
FlightSpeed	12.8	12.8	12.8
NocturnalActivity	0.50	0.25	0.50

Table E 7: Herring gull sampled turbine input parameters.

Parameter	Mean	Minimum	Maximum
RotorRadius	152.5	152.5	152.5
HubHeight	190.22	190.22	190.22
BladeWidth	6	6	6
WindSpeed	0	0	0
RotorSpeed	6.5	6.3	6.7
Pitch_rad	0.0803	0.0628	0.0977
JanOp	92.15	92.15	92.15
FebOp	92.58	92.58	92.58
MarOp	92.42	92.42	92.42

Parameter	Mean	Minimum	Maximum
AprOp	91.46	91.46	91.46
MayOp	91.25	91.25	91.25
JunOp	90.04	90.04	90.04
JulOp	89.87	89.87	89.87
AugOp	90.49	90.49	90.49
SepOp	91.75	91.75	91.75
OctOp	92.61	92.61	92.61
NovOp	92.6	92.6	92.6
DecOp	92.45	92.45	92.45

Appendix F – Great black-backed gull monthly collision rates

Table F 1: Monthly great black-backed gull collision risk estimates for Band Option 1.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.898	0.898	0.055	2.791
Feb	0.171	0.171	0.000	0.531
Mar	1.213	1.213	0.000	3.845
Apr	0.030	0.030	0.000	0.135
May	0.264	0.264	0.000	1.050
Jun	0.190	0.190	0.000	0.802
Jul	0.154	0.154	0.000	0.803
Aug	0.031	0.031	0.000	0.210
Sep	2.822	2.822	0.000	17.829
Oct	1.897	1.897	0.000	8.117
Nov	1.065	1.065	0.198	2.985
Dec	0.657	0.657	0.000	2.430

Table F 2: Monthly great black-backed gull collision risk estimates for Band Option 2.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.687	0.687	0.042	2.135
Feb	0.131	0.131	0.000	0.406
Mar	0.928	0.928	0.000	2.941
Apr	0.023	0.023	0.000	0.103
May	0.202	0.202	0.000	0.803
Jun	0.145	0.145	0.000	0.614
Jul	0.118	0.118	0.000	0.614
Aug	0.024	0.024	0.000	0.160
Sep	2.159	2.159	0.000	13.636
Oct	1.451	1.451	0.000	6.208
Nov	0.815	0.815	0.152	2.283
Dec	0.502	0.502	0.000	1.858

Table F 3: Monthly great black-backed gull collision risk estimates for Band Option 3.

Month	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
Jan	0.406	0.258	0.025	1.256
Feb	0.077	0.049	0.000	0.239
Mar	0.548	0.349	0.000	1.731
Apr	0.013	0.009	0.000	0.061
May	0.119	0.076	0.000	0.473
Jun	0.086	0.055	0.000	0.361
Jul	0.070	0.044	0.000	0.361
Aug	0.014	0.009	0.000	0.094
Sep	1.276	0.812	0.000	8.027
Oct	0.858	0.546	0.000	3.655
Nov	0.482	0.306	0.091	1.344
Dec	0.297	0.189	0.000	1.094

Table F 4: SNCB Monthly great black-backed gull collision risk estimates for Band Option 2.

Month	Mean	Minimum	Maximum
Jan	1.006	0.237	5.255
Feb	0.180	0.030	1.214
Mar	1.166	0.141	7.895
Apr	0.026	0.000	0.320
May	0.234	0.000	2.540
Jun	0.194	0.025	2.744
Jul	0.135	0.000	0.942
Aug	0.154	0.008	1.713
Sep	2.574	0.000	49.440
Oct	1.795	0.000	18.515
Nov	1.307	0.307	8.377
Dec	0.733	0.129	4.729

Table F 5: Great black-backed gull sampled bird input parameters.

Parameter	Mean (Cook et al. 2014)	Mean (Bowgen & Cook 2018)	Minimum (Cook et al. 2014)	Maximum (Cook et al. 2014)
AvoidanceBasic	0.995	0.995	0.996	0.994
AvoidanceExtended	0.989	0.993	0.991	0.987
WingSpan	1.58	1.58	1.58	1.58
BodyLength	0.71	0.71	0.71	0.71
PCH	0.1376	0.1376	0.1376	0.1376
FlightSpeed	13.7	13.7	13.7	13.7
NocturnalActivity	0.25	0.25	0.25	0.50

Table F 6: SNCB Great black-backed gull sampled bird input parameters.

Parameter	Mean	Minimum	Maximum
AvoidanceBasic	0.995	0.996	0.994
AvoidanceExtended	N/A	N/A	N/A
WingSpan	1.58	1.58	1.58
BodyLength	0.71	0.71	0.71
PCH	0.1376	0.1376	0.1376
FlightSpeed	13.7	13.7	13.7
NocturnalActivity	0.50	0.25	0.50

Table F 7: Great black-backed gull sampled turbine input parameters.

Parameter	Mean	Minimum	Maximum
RotorRadius	152.5	152.5	152.5
HubHeight	190.22	190.22	190.22
BladeWidth	6	6	6
WindSpeed	0	0	0
RotorSpeed	6.5	6.3	6.7
Pitch_rad	0.0803	0.0628	0.0977
JanOp	92.15	92.15	92.15
FebOp	92.58	92.58	92.58
MarOp	92.42	92.42	92.42

Parameter	Mean	Minimum	Maximum
AprOp	91.46	91.46	91.46
MayOp	91.25	91.25	91.25
JunOp	90.04	90.04	90.04
JulOp	89.87	89.87	89.87
AugOp	90.49	90.49	90.49
SepOp	91.75	91.75	91.75
OctOp	92.61	92.61	92.61
NovOp	92.6	92.6	92.6
DecOp	92.45	92.45	92.45