Norfolk Boreas Offshore Wind Farm

Alde-Ore Estuary Collision Risk Modelling and Population Viability Analysis

Applicant: Norfolk Boreas Limited
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Author: MacArthur Green

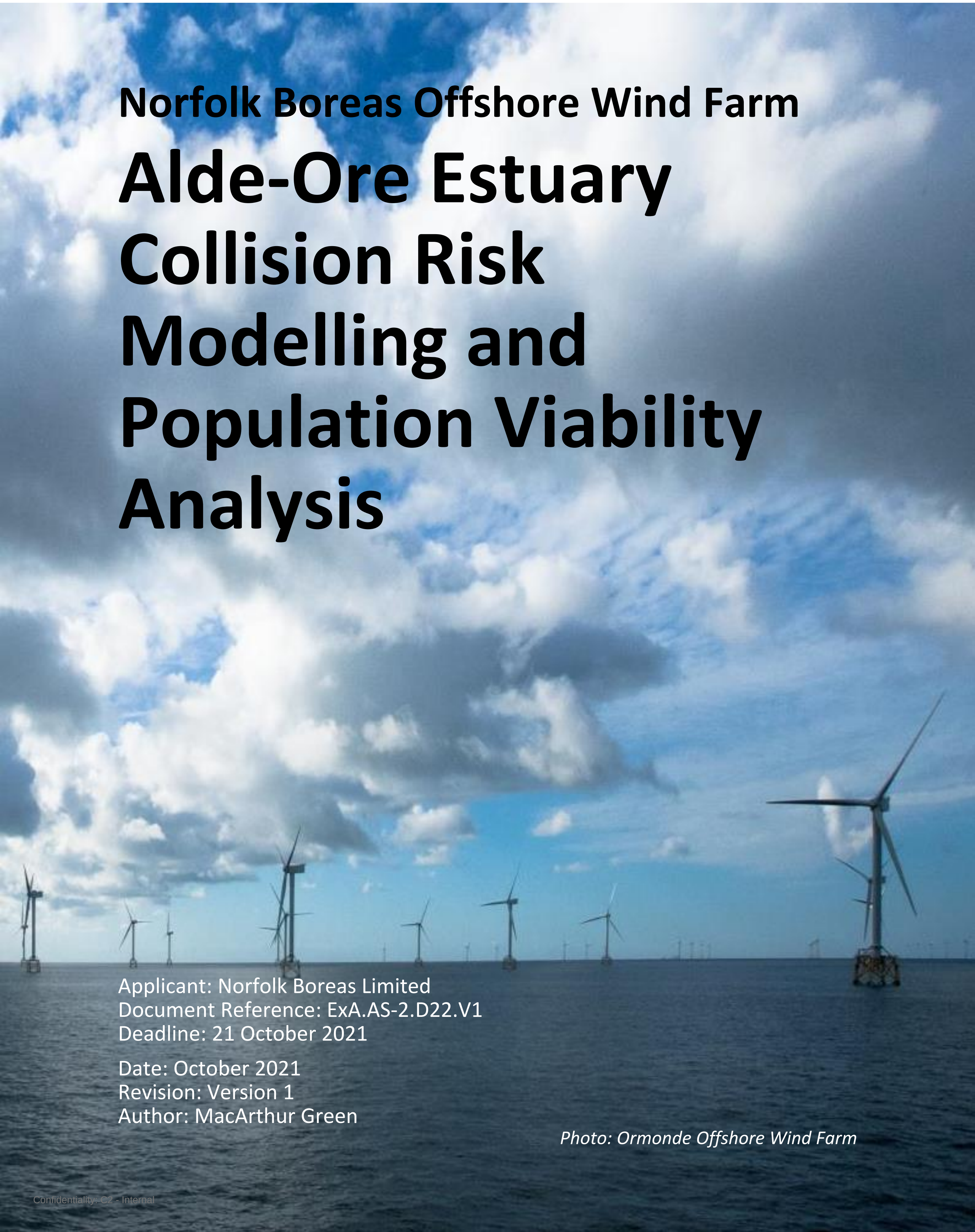

Photo: Ormonde Offshore Wind Farm

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
29/09/2021	01D	Draft for internal review	MT	VR	JL
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Glossary of Acronyms

AEoI	Adverse Effect on Integrity
AOE	Alde-Ore Estuary
BEIS	Department for Business, Energy & Industrial Strategy
CRM	Collision Risk Model
FFC	Flamborough and Filey Coast
HRA	Habitats Regulations Assessment
PVA	Population Viability Analysis
SoS	Secretary of State
SPA	Special Protection Area

1 Introduction

1. This note provides updated collision risk models (CRM) and population viability analysis (PVA) for lesser black-backed gulls as per the request from the Secretary of State for Business, Energy and Industrial Strategy (BEIS) received by the Applicant on the 22nd September 2021.

1.1 Updated Collision Risk Modelling

2. With respect to the CRM, the SoS requested that the Applicant should use Natural England's latest advised avoidance rates, with a reference to a recent publication by the British Trust for Ornithology (BTO), Cook (2021). This work, commissioned by Natural England, updates the previous avoidance rate review (Cook et al. 2014) and presents a review and analysis of data collected by a range of studies from which it is possible to estimate wind turbine collision avoidance rates.

3. The Applicant was only made aware of this work, via email from Natural England on the 28th July 2021, shortly before the report was due to be made available (although it in fact was only published on the 20th August 2021). Natural England has advised the Applicant that they are producing a guidance document on the use of the information in Cook (2021) jointly with the other statutory nature conservation bodies (SNCBS). In the meantime, as stated in Natural England's submission of the 20th August 2021[1]:

   '*Natural England is likely to recommend the revised AR going forwards'* (i.e. the rates recommended in Cook 2021).

4. The Applicant's ornithology consultant reviewed Cook (2021) and, assisted by the fact that the data and analysis scripts were also provided on the BTO website, has been able to examine the methods and results closely. A detailed report of this review is provided in Appendix 2 of The Applicant's Response to the Request for Additional Information (ExA.PDR.D22.V1) submitted on 21st October 2021, but in summary the Applicant is concerned that the analysis and conclusions contained in Cook (2021) are flawed for the following reasons:

   - There is considerable variation in the suitability and robustness of the individual studies which underpin the analysis;
   - Examination of the contribution from each study to the overall outputs has identified one study in particular which exerts a very strong influence on the

1 [redacted]

average avoidance rate estimates (and this point clearly meets the definition of a statistical outlier);

- There are strong evidential reasons why this study should not be included (due to a very short and unrepresentative period of study), and in fact this study was rejected for inclusion in Cook et al. (2014) on these grounds. There is no explanation provided in Cook (2021) for the reversal of this position and its subsequent inclusion in the analysis; and,
- Removal of this one study (1 row of data from 155 used to estimate the large gull avoidance rate appropriate for lesser black-backed gull) increases the avoidance rate from 98.6% to 99.4%. Compared with the current lesser black-backed gull avoidance rate (99.5%, from Cook et al. 2014) a rate of 99.4% would increase predicted collisions by 20%, while including this statistical outlier in the data increases predicted collisions by 280%.

5. For these reasons the Applicant does not consider the avoidance rate recommendations in Cook (2021) to be based on robust considerations of the available data. In addition, since the official Natural England guidance on the use of these rates has not yet been made available it is considered premature for collision modelling to be undertaken using the alternative rates.

6. The above concerns notwithstanding, due to the way the rates were calculated it is also not possible to update the collision estimates for other wind farms included in the cumulative and in-combination assessments using the Cook (2021) recommended avoidance rates. This is because to obtain avoidance rates Cook (2021) first estimated the predicted collision rate (to compare with actual collision observations) and in doing so used a different nocturnal activity rate for gulls (25%) than has been advised until relatively recently by Natural England (50%). Because the avoidance rate is obtained as the comparison between CRM predictions and observed mortalities, the resulting avoidance rate is specific to the suite of model input parameters used. For this reason the Cook (2021) avoidance rates cannot be applied retrospectively to other wind farms.

7. The above notwithstanding, in order for the SoS to have all the requested information on which to base conclusions, collision risks have been recalculated for Norfolk Boreas using the alternative avoidance rates (and nocturnal activity rates) in Cook (2021). However, for the above reasons, the estimates for other wind farms presented in the in-combination table are the same as provided previously (e.g. REP8-025).

1.2 Updated Population Viability Analysis

8. The SoS request was to provide updated PVA for lesser black-backed gull, comparing the counterfactual SPA population size after 30 years and in-combination

assessments should include all projects up to and including Hornsea Project 3. The Applicant sought clarification on the list of projects to include, and was informed that:

'*the in-combination assessment to include Hornsea Project 3, Norfolk Vanguard and Norfolk Boreas. For the avoidance of doubt, the in-combination assessment should not include East Anglia ONE North, East Anglia Two, Hornsea Project 4, or the Dudgeon and Sheringham extension projects*.'

9. The Applicant also enquired about the inclusion of Hornsea Project Three as this wind farm is beyond the mean maximum foraging range of lesser black-backed gull from the Alde-Ore Estuary SPA and has therefore not been included in the in-combination assessment to date. The SoS requested a reference to where this had been agreed with Natural England. Among other places, this was stated in Natural England's deadline 7 submission (REP7-047) at page 20:

'*Natural England notes that no collisions are apportioned to the Alde-Ore from Hornsea 3 or Hornsea 4, which we are content with as both sites are outside of the 141km foraging range of the Alde-Ore and no LBBG collisions are predicted in the non-breeding season for either project*.'

10. On the 1st October 2021 the Applicant received a request from Natural England to re-run the PVA for Flamborough and Filey Coast (FFC) SPA using slightly different model settings and Natural England's suggested values for productivity rates (the updated FFC PVA has been submitted in ExA.AS-4.D22.V1). While this advice did not include a suggested productivity rate to use for the Alde-Ore Estuary SPA lesser black-backed gull population, it did indicate that Natural England would expect the productivity rate to be calculated using SPA specific data, rather than the values built into the Natural England PVA tool. Accordingly, the Applicant has calculated an average productivity rate of 0.45 (SD 0.29) using the productivity values for the SPA covering the period from 2014 to 2021 presented in the RSPB's submission of the 20th August 2021[2] (Table 3 of the RSPB submission).

2 Methods – Density Dependence

11. The Natural England PVA tool includes an option to switch the model to run as either density independent, with no connection between population size and the demographic rates (survival and productivity) or density dependent, which includes a feedback link between population size and one or more demographic rates. For

[2] Written Submission for the Royal Society for the Protection of Birds ANNEX 2 Alde-Ore Estuary SPA 20 August 2021 [redacted]

example, this could take the form of a negative relationship between population size and productivity, such that as the population increases productivity decreases, and vice versa. In this manner the simulated population in the model is maintained around a stable level. Such feedback responses often occur in real populations due to competition between individuals for limited resources such as breeding space, breeding partners or food. There is a large amount of theoretical and empirical evidence for such population regulation, including for seabirds, although it must be acknowledged that the mechanisms and strength for how this operates in seabirds is less well understood, primarily due to the challenges of collecting the necessary data.

12. The Applicant has reviewed the Natural England PVA guidance on how density dependence is included in the online version of the tool. The density dependent function provided has been set to operate in a very weak manner, scaled to operate with a 10-fold change in population size. Comparted within the extent to which seabird populations change across periods of 30 years (as simulated here) changes of this size would be the exception rather than the norm (e.g. a population would need to increase from 10,000 individuals to 100,000, or decrease by this amount, for the full effect of density dependence to be observed). The practical consequence of this for the PVA tool is that density dependent model runs produce outputs which are largely indistinguishable from density independent outputs and little insight is gained as to how the population response to an impact varies with and without density dependence. This approach to modelling density dependence differs from that used in previous PVA for the FFC SPA (e.g. MacArthur Green 2018 as referenced in APP-201) which applied density dependence in a manner consistent with seabird populations (e.g. Cury et al. 2013). Indeed, the version of the Natural England PVA tool which can be run within the R programming environment[3] (rather than online) offers greater flexibility in this regard, with options to select different forms of density dependence which are better supported by the, albeit limited, empirical evidence. It is not explained why these options were not included in the online version (which Natural England has advised the Applicant should use).

13. Hence, while the Applicant had intended to run the PVA models using the Natural England PVA tool under both density dependent and density independent options and provide the results for comparison, due to the way the PVA tool is currently set up it was determined that there was little additional insight to be gained from doing so. It is acknowledged that care must be taken when setting the form and strength of density dependent regulation in a population model. However, it remains the case that density independent PVA predictions are, with very few exceptions, less realistic than density dependent ones which have been based on life history theory and

[3] [redacted]

evidence of how seabird populations are regulated. Indeed, if density dependence is considered as a continuum, from fully density independent to strongly density dependent, density independent predictions can be considered to have the least scientific support and to provide the least reliable predictions. While this could be justified on the basis of being precautionary and basing decisions on an assessment of the worst case outcomes, the Applicant considers that such an interpretation is overly simplistic for two reasons. Firstly, density dependent PVA undertaken in an appropriate manner is still precautionary. Secondly, density independent PVA is Natural England's preferred approach not because there is supporting evidence for density independent growth but because of the challenges in estimating how density dependence operates in natural populations. In almost all instances a density independent model will be over-precautionary and will provide unrealistic predictions.

14. Inclusion of density dependence also influences consideration of which counterfactual outputs are more appropriate. PVA counterfactuals are relative measures of population metrics, derived as the impacted value divided by the unimpacted (or baseline) value. Thus, if the impact has no effect on (for example) population size, the counterfactual metric will have a value of 1, while any reduction in the metric caused by the impact will result in a counterfactual with a value less than 1. These are often presented interchangeably on both a proportional scale (i.e. between 0 and 1) and also converted into percentages.

15. The SoS requested comparisons of the SPA population size of lesser black-backed gull after 30 years with and without the development (Norfolk Boreas). This metric is referred to as the counterfactual of population size (CPS). A second informative metric from PVA analysis is the counterfactual of the population growth rate (CPGR) which compares the population's rate of annual growth with and without the impact (averaged across a period of years).

16. Although both counterfactual measures (CPS and CPGR) are provided in this report, the Applicant considers that they are not equally appropriate for model interpretation in all cases, due to the role of density dependence. As discussed above, a density independent population has no constraint on growth. Thus, a density independent population with a positive growth rate will grow exponentially and the baseline and impacted populations will diverge by an increasing amount as the duration increases. In other words, the CPS is sensitive to the period it is measured over. But neither the baseline nor impacted population projections are likely to be credible since seabird populations are constrained by factors such as nest site availability, prey availability etc., as explained above (i.e. aspects which lead to density dependence). Hence a density independent CPS is a comparison of two unrealistic population predictions. In contrast, the CPGR is time invariant; the value

is the same whether the simulation runs for 20 years, 30 years or 100 years (while the CPS for these would be very different). All else being equal, a measure with lower sensitivity to input parameters is to be preferred, which in the case of density independent PVA is the CPGR.

17. The stable state for a density dependent population is a growth rate of 1. Therefore, if the PVA model is run with density dependence then the population growth of both the baseline and impacted runs will stabilise to 1 (i.e. zero net growth), but the impacted population will have a lower (average) stable population size. In this case the CPGR is of limited utility since it will have a value of around 1 irrespective of the impact magnitude, but the CPS will provide a measure of how much smaller the impacted population is predicted to be.

18. Thus, in summary if the PVA is density independent (as presented here for reasons outside the Applicant's control) then the CPGR is considered more robust and informative, while if the PVA is density dependent then the CPS is considered more robust and informative.

19. For these reasons, while both CPS and CPGR are provided, the interpretation of the density independent PVA outputs focusses on the CPGR.

20. In all cases models were run for 5,000 simulations, as advised by Natural England. The full model inputs are provided in Appendix 2 - Population Viability Analysis Parameter log.

3 Norfolk Boreas Alone Collision Risk Modelling

21. The updated parameters used to date in the lesser black-backed gull collision risk assessment and those used for the updated modelling are provided in Table 3.1. All other parameters in the model remain as provided in REP5-059, REP2-035 and APP-566.

Table 3.1 Collision modelling parameter values for the rates which have been updated.

Parameter	Original value (used in assessment to date)	Updated value (Cook 2021)	Updated value (MacArthur Green 2021[4])
Avoidance rate	99.5%	98.6%	99.4%
Nocturnal activity rate	50%	25%	25%

22. The collision estimates are provided in Table 3.2. This includes total collisions at the wind farm and those apportioned to the Alde-Ore Estuary (AOE) SPA.

[4] Appendix 2 of The Applicant's Response to the Request for Additional Information (ExA.PDR.D22.V1)

Table 3.2 Original and updated collision mortality estimates. Mean values and 95% confidence intervals.

Parameter	Original mortality (used in assessment to date)		Alternative mortality (Cook 2021)		Updated mortality (MacArthur Green 2021[4])	
	Total	AOE SPA	Total	AOE SPA	Total	AOE SPA
Jan	0.6 (0-1.8)	0.03 (0-0.09)	1.3 (0-3.7)	0.07 (0-0.19)	0.5 (0-1.6)	0.03 (0-0.08)
Feb	0.1 (0-0.8)	0.01 (0-0.04)	0.3 (0-1.8)	0.02 (0-0.09)	0.1 (0-0.8)	0.01 (0-0.04)
Mar	0.2 (0-1)	0.01 (0-0.03)	0.4 (0-2.3)	0.01 (0-0.08)	0.2 (0-1)	0.01 (0-0.03)
Apr	0.5 (0-2.3)	0.15 (0-0.69)	1.3 (0-5.7)	0.39 (0-1.71)	0.5 (0-2.4)	0.15 (0-0.72)
May	0.4 (0-1.1)	0.12 (0-0.33)	0.9 (0-2.7)	0.27 (0-0.81)	0.4 (0-1.2)	0.12 (0-0.36)
Jun	0.5 (0-2.2)	0.15 (0-0.66)	1.3 (0-5.5)	0.39 (0-1.65)	0.6 (0-2.4)	0.18 (0-0.72)
Jul	2 (0.4-4.8)	0.6 (0.12-1.44)	5 (0.9-12.1)	1.5 (0.27-3.63)	2.2 (0.4-5.2)	0.66 (0.12-1.56)
Aug	2.8 (1.1-4.9)	0.84 (0.33-1.47)	6.9 (2.6-12.2)	2.07 (0.78-3.66)	3 (1.1-5.2)	0.9 (0.33-1.56)
Sep	5.9 (0-15.2)	0.19 (0-0.5)	14.1 (0-36.1)	0.47 (0-1.19)	6 (0-15.5)	0.2 (0-0.51)
Oct	0.5 (0-1.9)	0.02 (0-0.06)	1.1 (0-4.3)	0.04 (0-0.14)	0.5 (0-1.8)	0.02 (0-0.06)
Nov	0.3 (0-1.4)	0.02 (0-0.07)	0.6 (0-3.1)	0.03 (0-0.16)	0.3 (0-1.3)	0.02 (0-0.07)
Dec	0.5 (0-1.5)	0.03 (0-0.08)	0.9 (0-3)	0.05 (0-0.15)	0.4 (0-1.3)	0.02 (0-0.07)
Annual	**14.3 (1.5-38.9)**	**2.15 (0.45-5.46)**	**34.1 (3.5-92.5)**	**5.29 (1.05-13.45)**	**14.7 (1.5-39.7)**	**2.3 (0.45-5.77)**

23. Using the previously agreed avoidance rate (99.5%) and nocturnal activity rate (50%) the total lesser black-backed gull collision mortality is 14.3 and the mortality apportioned to the AOE SPA is 2.1.

24. Using the rates in Cook (2021) these values are 34.1 and 5.3 respectively. Using the Applicant's rates estimated from the Cook (2021) data and analysis but with the statistical outlier data point omitted the values are 14.7 and 2.3 respectively.

25. As set out in Appendix 2 of The Applicant's Response to the Request for Additional Information (ExA.PDR.D22.V1), the Applicant does not consider the Cook (2021) avoidance rate to be robust due to the inclusion of one unreliable outlying study. When this data point is removed, and the lower nocturnal rate applied, the lesser black-backed gull collision estimate apportioned to the AOE SPA is increased by only 2.8% from 2.15 to 2.3, an increase which would have no material bearing on the assessment (and since it lies within the range of values assessed using the PVA, below, has not been specifically modelled).

4 In-combination Collision Risk Assessment

26. The summary cumulative and in-combination lesser black-backed gull collision estimates are provided in Table 4.1.

Table 4.1 Lesser black-backed gull cumulative and in-combination collisions apportioned to the AOE SPA. The 'Previous OWFs' is a summed total including all wind farms in the assessment up to Hornsea Project Three in England and Moray West in Scotland (full table in Appendix 1 - Cumulative and In-combination Collision Table).

Wind Farm	Breeding		Nonbreeding		Annual	
	Total	AOE SPA	Total	AOE SPA	Total	AOE SPA
Previous OWFs	138.4	31.8	358.8	14.3	497.2	46.1
Norfolk Boreas (REP5-059)	6.2	1.9	8.1	0.2	14.3	2.1
Total (as per REP5-059)	**144.6**	**33.7**	**366.9**	**14.5**	**511.5**	**48.2**
Norfolk Boreas (using Cook 2021)	15.5	4.6	18.7	0.7	34.2	5.3
Total (using Cook 2021)	**153.9**	**36.4**	**377.5**	**15**	**531.4**	**51.4**

27. The figures in the final column of Table 4.1 were entered as additional mortality into the Natural England PVA tool (see Appendix 2 - Population Viability Analysis Parameter log). The CPS and CPGR for each mortality are provided in Table 4.2.

Table 4.2 Lesser black-backed gull AOE SPA mortalities and population modelling results using the Natural England PVA tool

Scenario	Norfolk Boreas (mortality included)	Total additional adult mortality	Density independent counterfactual metric (after 30 years)	
			Growth rate	Population size
Norfolk Boreas alone (as per REP5-059)	2.1	2.1	0.9992	0.9757
Norfolk Boreas alone (using Cook 2021)	5.3	5.3	0.9980	0.9394
In-combination minus Norfolk Boreas	0	46.1	0.9826	0.5802
In-combination (as per REP5-059)	2.1	48.2	0.9818	0.5662
In-combination (using Cook 2021)	5.3	51.4	0.9806	0.5450

28. Using the Cook (2021) avoidance rate for Norfolk Boreas, giving an in-combination collision mortality of 51.4, the density independent PVA results indicated that the maximum reduction in growth rate was 1.94% (0.9806). At this mortality the CPS indicated the lesser black-backed gull population would be 55% (0.5450) of the baseline (unimpacted) size after 30 years.

29. Using the previous avoidance rate (as per REP5-059), the in-combination collision mortality was 48.2, the maximum reduction in growth rate was 1.82% (0.9818) and the CPS was 57% (0.5662).

30. Comparing the in-combination collision mortality results, the addition of Norfolk Boreas reduced the population growth rate by 0.2% (0.9826-0.9806) using the Cook (2021) avoidance rates and 0.08% (0.9826-0.9818) using the previous avoidance rates. The equivalent reductions in population size were 3.5% and 1.4%, however as noted above the CPS is considered a less reliable metric for density independent simulations.

31. The AOE SPA lesser black-backed gull population has remained relatively stable for over 10 years (see RSPB submission for previous deadline). Therefore, the maximum predicted reduction in growth rate of less than 2% is not considered likely to result in a decline in this population, especially when the sources of precaution (e.g. density independent predictions, consented rather than as-built collision estimates, etc.) are taken into account.

32. On the basis of the population model predictions, the number of predicted collision mortalities at Norfolk Boreas in-combination with other North Sea wind farms with potential connectivity to the AOE SPA is not at a level which would trigger a risk of population decline but would only result in a slight reduction in the growth rate currently seen at this colony.

33. The contribution of Norfolk Boreas to the in-combination totals is also very small, making an additional reduction to the growth rate of no more than 0.2% and an additional reduction in the CPS of no more than 3.5%, which means that the population size would be 3.5% below the size it would reach without the wind farm. Furthermore, both of these contributions are halved if the more robust avoidance rates are used, as estimated without the statistically unsupported study which Cook (2021) included.

34. Given the degree of precaution in collision assessments and the very small contribution from Norfolk Boreas, it is concluded that there will be no adverse effect on the integrity of the Alde Ore Estuary SPA due to in-combination collisions of lesser black-backed gull.

5 References

Cook, A (2021) Additional Analysis to Support SNCB Recommendations Regarding Collision Risk Modelling. BTO Research Report 739.

Cury P. M., Boyd I., Bonhommeau S., Anker-Nilssen T., Crawford R. J. M., Furness R. W., Mills J. A., et al. (2011). Global seabird response to forage fish depletion: one-third for the birds. Science 334: 1703–1706.

MacArthur Green (2018). Flamborough and Filey Coast pSPA Seabird PVA Report Supplementary matched run outputs 2018. Submitted as Appendix 9 to Deadline 1 submission – PVA. Hornsea Project Three.

MacArthur Green (2021). Avoidance Rates Note. Appendix 2 to the Response to the Request for Further Information (ExA.PDR.D22.V1) submitted 21st October 2021.

Appendix 1 - Cumulative and In-combination Collision Table

Table A1.1 Lesser black-backed gull cumulative and in-combination collision risk. Note that the AOE annual total includes all the apportioned nonbreeding season estimates plus apportioned breeding season estimates for wind farms within 141km.

Windfarm	Breeding season		Nonbreeding season		Annual	
	Total	AOE SPA	Total	AOE SPA	Total	AOE SPA
Beatrice Demonstrator	-	-	-	-	-	-
Greater Gabbard	12.4	8	49.6	2	62	10
Gunfleet Sands	1	0.3	0	0	1	0.3
Kentish Flats	-	-	-	-	-	-
Kentish Flats Extension	0.3	0.1	1.3	0.1	1.6	0.2
Lincs	1.7		6.8	0.3	8.5	0.3
London Array	-	-	-	-	-	-
Lynn and Inner Dowsing	-	-	-	-	-	-
Scroby Sands	-	-	-	-	-	-
Sheringham Shoal	1.7	0.3	6.6	0.3	8.3	0.6
Teesside	0		0	0	0	0
Thanet	3.2	1.4	12.8	0.5	16	1.9
Humber Gateway	0.3		1.1	0	1.4	0
Westermost Rough	0.1		0.3	0	0.4	0
Hywind	0		0	0	0	0
Kincardine	0		0	0	0	0
Beatrice	0		0	0	0	0
Dudgeon	7.7	1.1	30.6	1.2	38.3	2.3
Galloper	27.8	18	111	4.4	138.8	22.4
Race Bank	43.2		10.8	0.4	54	0.4
Rampion	1.6		6.3	0.3	7.9	0.3
Hornsea Project One	4.4		17.4	0.7	21.8	0.7
Blyth Demonstration Project	0		0	0	0	0
Dogger Bank Creyke Beck Projects A and B	2.6		10.4	0.4	13	0.4
East Anglia ONE	5.9	2.2	33.8	1.4	39.7	3.6
European Offshore Wind Deployment Centre	0		0	0	0	0
Firth of Forth Alpha and Bravo	2.1		8.4	0.3	10.5	0.3
Inch Cape	0		0	0	0	0
Methil	0.5		0	0	0.5	0
Moray Firth (EDA)	0		0	0	0	0
Neart na Gaoithe	0.3		1.2	0	1.5	0
Dogger Bank Teesside Projects A and B	2.4		9.6	0.4	12	0.4
Triton Knoll	7.4		29.6	1.2	37	1.2
Hornsea Project Two	2		2	0.1	4	0.1
East Anglia THREE	1.8	0.4	8.2	0.3	10	0.7
Moray West	0		0	0	0	0
Hornsea Project Three (revised)	8		1	0	9	0
Norfolk Boreas (as per REP5-059)	6.2	1.9	8.1	0.2	14.3	2.1
Norfolk Boreas (using Cook 2021)	15.5	4.6	18.7	0.7	34.2	5.3
Total without Norfolk Boreas	**138.4**	**31.8**	**358.8**	**14.3**	**497.2**	**46.1**
Total with Norfolk Boreas (as per REP5-059)	**144.6**	**33.7**	**366.9**	**14.5**	**511.5**	**48.2**
Total with Norfolk Boreas (using Cook 2021)	**153.9**	**36.4**	**377.5**	**15**	**531.4**	**51.4**

Appendix 2 - Population Viability Analysis Parameter log

Set up

The log file was created on: 2021-10-04 09:09:37 using Tool version 2, with R version 3.5.1, PVA package version: 4.17 (with UI version 1.7)

```
##                  Package          Version
## popbio           "popbio"         "2.4.4"
## shiny            "shiny"          "1.1.0"
## shinyjs          "shinyjs"        "1.0"
## shinydashboard   "shinydashboard" "0.7.1"
## shinyWidgets     "shinyWidgets"   "0.4.5"
## DT               "DT"             "0.5"
## plotly           "plotly"         "4.8.0"
## rmarkdown        "rmarkdown"      "1.10"
## dplyr            "dplyr"          "0.7.6"
## tidyr            "tidyr"          "0.8.1"
```

Basic information

This run had reference name “LBBG DI AOE SPA”.
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 50.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Lesser Black-Backed Gull.
Region type to use for breeding success data: Country.
Available colony-specific survival rate: National. Sector to use within breeding success region: England.
Age at first breeding: 5.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 3022 in 2025

Productivity rate per pair: mean: 0.4563 , sd: 0.2882
Adult survival rate: mean: 0.885 , sd: 0.056
Immatures survival rates:

Age class 0 to 1 - mean: 0.82 , sd: 0.056 , DD: NA
Age class 1 to 2 - mean: 0.885 , sd: 0.056 , DD: NA
Age class 2 to 3 - mean: 0.885 , sd: 0.056 , DD: NA
Age class 3 to 4 - mean: 0.885 , sd: 0.056 , DD: NA
Age class 4 to 5 - mean: 0.885 , sd: 0.056 , DD: NA

Impacts

Number of impact scenarios: 5.

Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2026 to 2056

Impact on Demographic Rates

Scenario A - Name: mort2.1

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000694904 , se: NA

Scenario B - Name: mort5.3

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001753805 , se: NA

Scenario C - Name: mort46.1

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0152548 , se: NA

Scenario D - Name: mort48.2

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0159497 , se: NA

Scenario E - Name: mort51.4

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0170086 , se: NA

Output:

First year to include in outputs: 2026
Final year to include in outputs: 2056
How should outputs be produced, in terms of ages?: whole.population
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA