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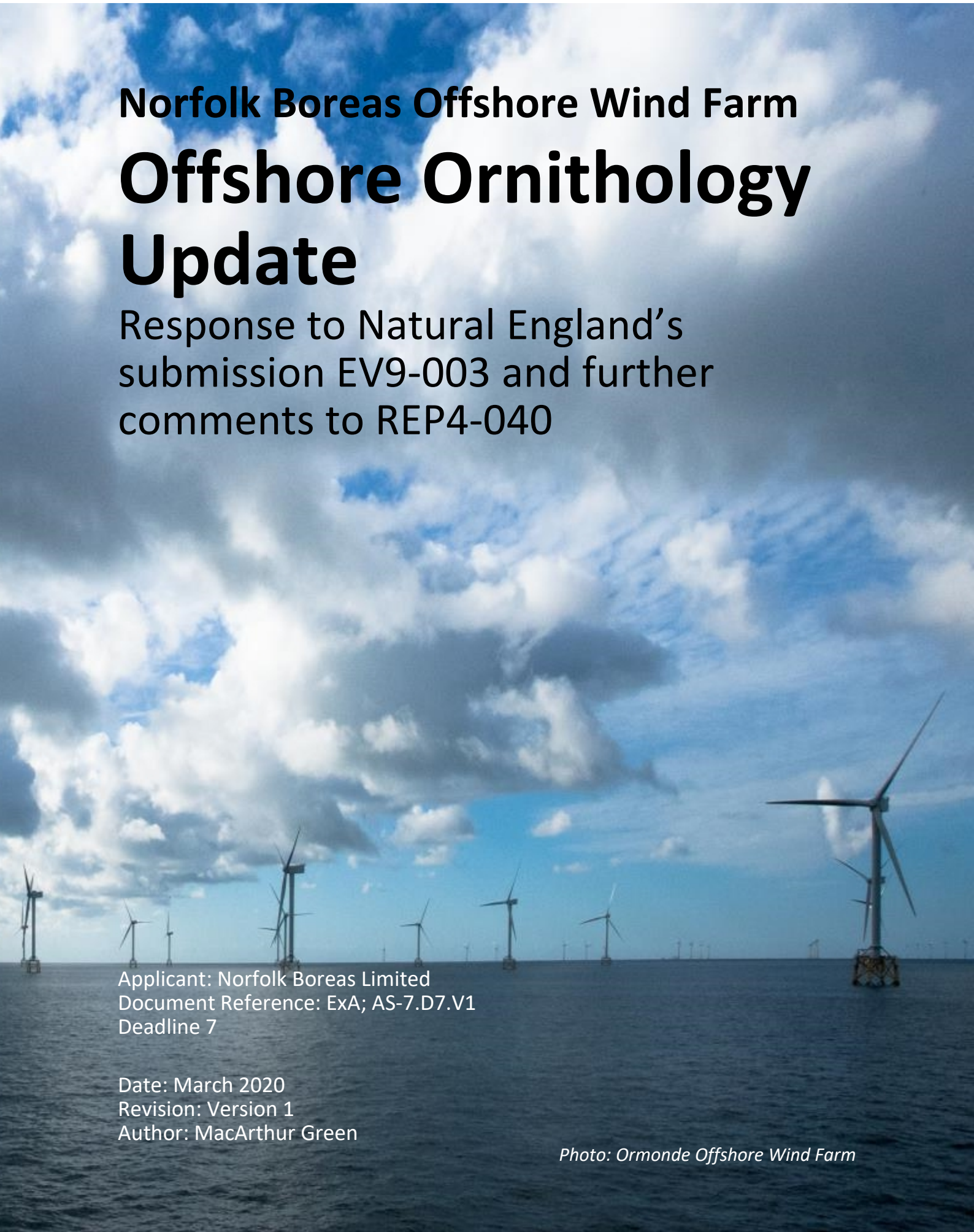

Norfolk Boreas Offshore Wind Farm

Offshore Ornithology Update

Response to Natural England's submission EV9-003 and further comments to REP4-040

Applicant: Norfolk Boreas Limited
Document Reference: ExA; AS-7.D7.V1
Deadline 7

Date: March 2020
Revision: Version 1
Author: MacArthur Green

Photo: Ormonde Offshore Wind Farm

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
31/03/20	01F	First draft for Deadline 7	MT	EVD	JL

Table of Contents

Table of Tables

Table of Figures

Glossary of Acronyms

BDMPS	Biologically Defined Minimum Population Scale
CGR	Counterfactual of population growth rate
CPS	Counterfactual of population size
CRM	Collision Risk Model
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
MSL	Mean Sea Level
MW	Megawatt
PVA	Population Viability Analysis

1 Introduction

1. This note provides the Applicant's responses to the points raised by Natural England in their submission in lieu of attendance at Issue Specific Hearing 5 (EV9-003). This note also provides a comparison of Population Viability Analysis (PVA) outputs obtained with 500, 1,000 and 5,000 simulations using the Natural England PVA tool (as requested by Natural England in REP4-040) which demonstrates that the counterfactual measures are virtually identical and materially unaffected by the additional simulations.

2 Norfolk Boreas' response to Natural England submission EV9-003

2.1 General comments

2. Natural England (EV9-003) has requested that the collision risk modelling (CRM) parameters are all provided in one place in order to make it simpler for future reference to be made to the inputs and collision estimates.

3. The Applicant has submitted a revised project alone collision assessment at Deadline 7 which contains the same modelling outputs presented in REP5-059 with the addition of the tables of CRM input parameters previously submitted in APP-566.

2.2 Detailed comments: 4.a. Increases in draught height

2.2.1 Explanation of tide levels with respect to collision risk modelling

4. The height of rotor blades in relation to the sea surface is a key parameter in estimating the collision risk for seabirds at offshore wind farms. This is because the density of birds in flight decreases with increasing height above the sea surface and it is for this reason that Natural England has requested that the Applicant increase the turbine draught height (the gap between the sea surface and lower rotor tip height) in order to minimise collision risks. Following detailed investigations into the constraints on turbine height the Applicant has committed to a large increase in draught height, from 22m above Mean High Water Springs (MHWS) to 30m for turbines of 14.7MW capacity and above and to 35m for turbines of up to 14.6MW capacity (REP5-059).

5. Seabird flight height data used in collision risk modelling (CRM) are measured against Mean Sea Level (MSL). Therefore, if a different sea level datum (e.g. MHWS, or Highest Astronomical Tide) is used as the reference for turbine height then an adjustment is required within the collision risk model to ensure that the seabird flight heights and the turbine heights are modelled from the same sea level reference (i.e. MSL). For this reason, when defining the height of the turbines, and therefore also the draught height, it is necessary to state to which sea level datum these have been measured from, and to present the difference (tidal offset)

between this and MSL. Figure 1 illustrates the sea level datums and how they relate to one another.

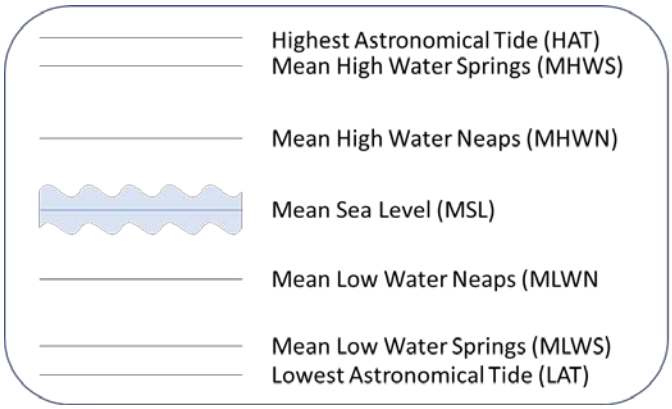

Figure 2.1. Illustration of the relative height of sea level datums. Note these are not presented to scale and are only intended as a guide to their relative positions.

6. The average range of spring tides lies between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS), while the smaller neap tidal range lies between Mean High Water Neaps (MHWN) and Mean Low Water Neaps (MLWN). Slightly beyond the spring tidal range are the Highest Astronomical Tide (HAT) and Lowest Astronomical Tide (LAT), which are the highest and lowest tides respectively which can be expected under average meteorological conditions and under any combination of astronomical conditions.

7. In their response to the updated collision risk modelling, Natural England (EV9-003) has queried the apparent change in datum used, from HAT (in APP-566) to MHWS in the updated assessment (REP5-059 and REP6-024). As noted above, it is important to state the datum used and the height difference between this and MSL in order to ensure the correct tidal offset is applied in CRM and that all heights in the calculations are based on MSL. In the case of Norfolk Boreas, the datum used throughout the assessment (in APP-566, REP5-059, REP6-024) has been MHWS with an offset value of 0.8m to MSL (i.e. the vertical difference between MSL and MHWS). However, as stated in REP5-059, this was erroneously labelled as HAT in APP-566, although the offset value used (0.8m) was in fact to MHWS. This was therefore an error in labelling only and the collision estimates are unaffected which was noted in REP5-059.

8. Natural England (EV9-003) states that their understanding of the Band (2012) CRM is that the hub height '*should*' be referenced to HAT. However, Band (2012) does not state that turbine height *must* be with reference to HAT, just that this is normally the case and this is stated in the text from Band (2012) reproduced by Natural England: '*Normally, the hub height of wind turbines is measured from Highest Astronomical*

Tide (HAT),'. The hub height can in fact be referenced to any sea level datum (HAT, LAT, MSL, MHWS, etc.) so long as the appropriate tidal offset value for adjusting the hub height to MSL is applied (note that if the turbine reference datum is lower than MSL, e.g. LAT, then the offset value will be negative, or if the turbine height is measured against MSL itself then the offset is 0). Thus, the critical aspect is to ensure that the value of the tidal offset adjustment (as used in the CRM calculations) is appropriate for the difference between the turbine height datum used and MSL. The Norfolk Boreas assessment has consistently used an offset of 0.8m which is the difference between MHWS and MSL.

9. Thus, the Applicant can confirm that the reference point and the tidal adjustment in the Norfolk Boreas CRM are correct, and that the only error was in labelling in APP-566 and this has now been corrected in REP5-059.

2.3 Minor comments: 5. DCO Wording

10. It should be noted that the Applicant has modelled turbines of 11.55MW and above for the purposes of collision risk modelling. However, it is not necessary to restrict the project to the precise turbine generating capacities modelled. The purpose of the Rochdale envelope is to assess and secure relevant parameters (of a particular turbine model in this case) which allow flexibility for the final design, provided that those parameters can still be observed. A minimum turbine capacity has never been included as a parameter in the dDCO for the project, and to the Applicant's knowledge has never been included in any other offshore wind farm DCO. This is because the relevant parameters for the project, and which form part of the Rochdale envelope, do not include individual turbine capacity. All relevant parameters are already secured in the dDCO as follows:

- The maximum export capacity of 1,800MW is referred to in the dDCO at Schedule 1, Part 1, 1(a); Paragraph 2(1)(a) of Part 3 of the Generation DMLs (Schedule 9-10), and Condition 8(1)(a) of the Generation DMLs (Schedule 9-10, Part 4). As the Explanatory Memorandum explains, all other parameters are in effect subordinate to this description.
- The maximum number of turbines (158) is referred to in the dDCO at Schedule 1, Part 1, 1(a), Schedule 1, Part 3, Requirement 3(1), Paragraph 2(1)(a) of Part 3 of the Generation DMLs (Schedule 9-10), and Condition 8(1)(b) of the Generation DMLs (Schedule 9-10, Part 4). If the maximum export capacity is divided by the maximum number of turbines, it can be seen that in order to reach full export capacity, each individual turbine would need to have an installed capacity which exceeds 11MW (hence the 11.55MW turbine has been modelled). This parameter was changed in the dDCO at Deadline 5 to reflect the change in the turbine modelled.

- The spacing of turbines are referred to in the dDCO at Condition 1(1)(g) of the Generation DMLs (Schedule 9-10, Part 4). This requires spacing of at least 800m (increased from the previous spacing of 760m) to reflect the reduction in the maximum number of turbines referred to above. As with the maximum number of turbines, this parameter was changed in the dDCO at Deadline 5 to reflect the change in the turbine modelled.
- The maximum wind turbine generator parameters, on which the collision risk modelling is based, are referred to in the dDCO at Schedule 1, Part 3 Requirement 2(1) and in Condition 1(1) of the Generation DMLs (Schedule 9-10, Part 4). For example, the maximum height and rotor diameter for the turbines.
- The minimum draught heights referred to in the dDCO at Schedule 1, Part 3, Requirement 2(1)(e), and Condition 1(1)(e) of the Generation DMLs (Schedule 9-10). This was introduced as further mitigation at Deadline 5, and specifically avoids referring to a minimum or maximum individual turbine capacity because this is not a parameter which is otherwise secured.

11. Provided that all of these parameters are observed, collision risks will not exceed the worst case modelled in the collision risk assessment. If, for commercial reasons, the Applicant chooses to rely on the flexibility of the Rochdale envelope to construct less than 1,800MW, potentially using turbines of less than 11.55MW (or a mix of turbine sizes) then the Applicant should be entitled to do so, as this would not invalidate the collision risk assessment (REP5-059 and REP6-024).

12. Therefore the Applicant is not proposing to revise Requirement 2(1)(e) of the draft DCO (and the corresponding DML conditions), as submitted at Deadline 5, since the current condition wording is appropriate.

2.4 Minor comments: 5. Kittiwake collisions apportioned to the Flamborough and Filey Coast SPA for the removed 10MW turbine

13. The Applicant has checked the collision calculations made in REP5-059 and is confident that all the estimates are correct. Furthermore, the Applicant notes that this comment from Natural England relates to the collision risk estimates for the 10MW turbine, which has now been removed from the design envelope (the smallest turbine under consideration is now 11.55MW) and that the figures for this turbine were only presented in REP5-059 for comparative purposes. Thus, irrespective of Natural England's comment, the collision estimate in question (49.5 estimated by the Applicant, or 45.4 estimated by Natural England) is no longer relevant to the application and has been replaced by a much lower worst case prediction for the 14.7MW turbine of 14 kittiwake collisions (using Natural England's preferred methods) or 6.1 (using the Applicant's preferred evidence based methods) apportioned to the Flamborough and Filey Coast SPA (REP5-059).

3 Norfolk Boreas' response to Natural England submission REP4-040-Comparison of PVA outputs from 500, 1,000 and 5,000 simulations

14. In the Applicant's offshore ornithology assessment update submitted at Deadline 2 (REP2-035) the Applicant used the recently developed Natural England PVA tool to estimate the population consequences for the project alone, cumulative and in-combination assessments where the increase in background mortality was greater than 1% (as advised by Natural England).

15. For two of these PVA simulations (kittiwake at the EIA cumulative scale and guillemot at the Flamborough and Filey Coast SPA scale) the Applicant was unable to run the recommended minimum number of simulations (1,000) and only runs with smaller numbers of simulations could be completed successfully (i.e. 500; the source of the error was unclear as the online tool provides no specific error codes, however the problem occurred repeatedly). In their response to REP2-035, Natural England stated in relation to kittiwake that:

the kittiwake BDMPS and biogeographic density independent models have been run for only 500 simulations, which Natural England notes to be quite low and we consider that a larger number of simulations would potentially be needed to generate reliable results.

16. A similar statement was also made in relation to guillemot:

We note that the guillemot models have been run for only 500 simulations. The Seabird PVA Tool report (Searle et al. 2019) states that 'it is not recommended to use small values of sim.n (number of simulations) because PVAs based on small numbers of simulations are likely to be unreliable (using a value of less than 1,000 will generate a warning message in the tool, but in practice the minimum number of simulations may need to be substantially higher than this in order to achieve reliable results)'. Natural England considers that a larger number of simulations than 500 would be needed to generate reliable results.

17. Following a recent update to the PVA tool the Applicant has been able to re-run the kittiwake and guillemot models successfully with 500, 1,000 and 5,000 simulations. The counterfactual metrics preferred by Natural England, the counterfactual of population growth rate (CGR) and the counterfactual of population size (CPS), obtained for these numbers of simulations for each species are provided in Table 3.1, Table 3.2 and Table 3.3 below. These tables also present the percentage differences between the CGR and CPS between the runs for 500 simulations (from REP2-035) and with 1,000 and 5,000 simulations (the PVA log files containing the input parameters for the 1,000 and 5,000 simulations are appended to this note for reference: Appendix 1. PVA input log files). The log files for the 500 simulation runs were included in REP2-035.

Table 3.1 Kittiwake PVA, Biologically Defined Minimum Population Scale (BDMPS). Comparison of counterfactuals of population growth rate and population size obtained with 500, 1,000 and 5,000 simulations.

Impact level	Counterfactual of population growth rate (CGR)					Counterfactual of population size (CPS)				
	500	1000	5,000	Difference between 500 & 1,000 (%)	Difference between 500 & 5,000 (%)	500	1000	5,000	Difference between 500 & 1,000 (%)	Difference between 500 & 5,000 (%)
3900	0.9944	0.9944	0.9944	0.00002	-0.0012	0.8410	0.8415	0.8413	-0.0613	-0.0360
4000	0.9943	0.9943	0.9943	0.00000	0.0005	0.8377	0.8376	0.8375	0.0013	0.0165
4100	0.9941	0.9942	0.9942	0.00002	-0.0006	0.8336	0.8340	0.8337	-0.0510	-0.0189
4200	0.9940	0.9940	0.9940	0.00001	0.0006	0.8302	0.8304	0.8301	-0.0186	0.0178
4300	0.9939	0.9939	0.9939	-0.00001	0.0019	0.8269	0.8266	0.8264	0.0341	0.0598
4400	0.9937	0.9937	0.9937	0.00000	0.0012	0.8229	0.8230	0.8226	-0.0044	0.0378

18. For kittiwake at the biologically defined minimum population scale (Table 3.1), the difference in CGR for 500 and 1,000 simulations were negligible (all less than 0.0002%) and between 500 and 5,000 simulations were only slightly larger, with the biggest difference 0.0019% (note that this represents CGR values of 99.389% for 500 compared with 99.387% for 5,000). Differences in CPS were slightly larger at up to 0.06% for both 500 compared with 1,000 (with CPS values of 84.10 and 84.15% respectively) and 500 compared with 5,000 (with CPS values of 82.69% and 82.64% respectively).

Table 3.2 Kittiwake PVA, biogeographical scale. Comparison of counterfactuals of population growth rate and population size obtained with 500, 1,000 and 5,000 simulations.

Impact level	Counterfactual of population growth rate (CGR)					Counterfactual of population size (CPS)				
	500	1000	5,000	Difference between 500 & 1,000 (%)	Difference between 500 & 5,000 (%)	500	1000	5,000	Difference between 500 & 1,000 (%)	Difference between 500 & 5,000 (%)
3900	0.9937	0.9937	0.9937	0.00000	0.0012	0.8229	0.8230	0.8226	-0.0044	0.0378
4000	0.9991	0.9991	0.9991	-0.00001	0.0007	0.9726	0.9723	0.9723	0.0286	0.0217
4100	0.9991	0.9991	0.9991	0.00000	0.0001	0.9717	0.9716	0.9717	0.0123	0.0021
4200	0.9991	0.9990	0.9991	-0.00001	0.0005	0.9711	0.9708	0.9710	0.0334	0.0149
4300	0.9990	0.9990	0.9990	0.00000	0.0003	0.9703	0.9703	0.9702	0.0018	0.0081
4400	0.9990	0.9990	0.9990	0.00000	0.0005	0.9697	0.9696	0.9696	0.0109	0.0150

19. For kittiwake at the biogeographic scale (Table 3.2) the differences between the CGR and CPS for 500 and 1,000 simulations and 500 and 5,000 simulations are even smaller than for the BDMPS runs (CGR differences all less than 0.0012%, CPS differences all less than 0.038%).

Table 3.3 Guillemot PVA, Flamborough and Filey Coast SPA. Comparison of counterfactuals of population growth rate and population size obtained with 500, 1,000 and 5,000 simulations.

Impact level	Counterfactual of population growth rate (CGR)					Counterfactual of population size (CPS)				
	500	1000	5,000	Difference between 500 & 1,000 (%)	Difference between 500 & 5,000 (%)	500	1000	5,000	Difference between 500 & 1,000 (%)	Difference between 500 & 5,000 (%)
100	0.9987	0.9987	0.9987	0.00001	-0.0001	0.9592	0.9595	0.9592	-0.0297	-0.0020
200	0.9973	0.9973	0.9973	-0.00001	0.0010	0.9204	0.9203	0.9201	0.0169	0.0303
1700	0.9772	0.9773	0.9772	0.00003	-0.0026	0.4895	0.4901	0.4899	-0.1101	-0.0817
2900	0.9612	0.9612	0.9612	0.00000	-0.0011	0.2932	0.2931	0.2933	0.0150	-0.0327
3050	0.9591	0.9592	0.9592	0.00004	-0.0045	0.2745	0.2748	0.2748	-0.1225	-0.1382

20. For guillemot at the FFC SPA scale (Table 3.3) the CGR differences for 500 and 1,000 simulations are all less than 0.00004% and for 500 and 5,000 simulation are all less than 0.004% (the biggest difference relates to CGR values of 95.91% and 95.92% for 500 and 5,000 respectively). For CPS the differences are all less than 0.14%, with the biggest difference relating to CPS values of 27.45% and 27.48% for 500 and 5,000 simulations respectively.

21. These differences in CGR and CPS for 500, 1,000 and 5,000 simulations are all very small, and are also both positive and negative, indicating that there is no systematic bias in the outputs from different numbers of simulations. Consequently, while Natural England raised concerns (REP4-040) that the results for these two species based on 500 simulations (in REP2-035) may not have been reliable due to the problems encountered with the original PVA tool, it is clear that in fact this has had no material effect on the results obtained and the outputs presented in REP2-035 are robust for use in impact assessment.

22. Natural England also noted in REP4-040 that PVA outputs based on 1,000 simulations may not be reliable:

We note that some of the EIA scale PVA models have been run for only 500 or 1,000 simulations. The Seabird PVA Tool report (Searle et al. 2019) states that 'it is not recommended to use small values of sim.n (number of simulations) because PVAs based on small numbers of simulations are likely to be unreliable (using a value of less than 1,000 will generate a warning message in the tool, but in practice the

minimum number of simulations may need to be substantially higher than this in order to achieve reliable results)'. Natural England considers that a larger number of simulations than 500 would be needed to generate reliable results and for models run for 1,000 simulations, we recommend that the Applicant presents evidence to demonstrate that using 1,000 simulations in the models produces reliable results.

23. It is clear from the CPR and CPS values for 500, 1,000 and 5,000 simulations presented above that Natural England's concern that outputs in REP2-035 based on 500 simulations are unreliable is not in fact the case. Furthermore, it can be seen from a comparison of the outputs for 1,000 and 5,000 simulations in Table 3.1, Table 3.2 and Table 3.3 that the PVA results in REP2-035 derived from 1,000 simulations are also reliable and suitable for impact assessment.

4 References

Band, W. 2012. Using a collision risk model to assess bird collision risks for offshore wind farms. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02

Searle, K., Mobbs, D., Daunt, F. & Butler, A. 2019. A Population Viability Analysis Modelling Tool for Seabird Species. Natural England Commissioned Reports, Number 274.

Appendix 1. PVA input log files

Population Viability Analysis Parameter log

Kittiwake BDMPS 1,000 simulations

Set up

The log file was created on: 2020-03-17 14:21:10 using Tool version 2, with R version 3.5.3, PVA package version: 4.15 (with UI version 1.7)

```
##                Package           Version
## popbio         "popbio"          "2.4.4"
## shiny          "shiny"           "1.4.0"
## shinyjs        "shinyjs"         "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"    "0.5.0"
## DT             "DT"              "0.10"
## plotly         "plotly"          "4.9.2"
## rmarkdown      "rmarkdown"       "1.18"
## dplyr          "dplyr"           "0.8.3"
## tidyr          "tidyr"           "1.0.0"
```

Basic information

This run had reference name “KI BDMPS 1000sims 3900to4400”.
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: 1000.
Random seed: 1.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.

Units for initial population size: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 829937 in 2020

Productivity rate per pair: mean: 0.6036278 , sd: 0.325783

Adult survival rate: mean: 0.854 , sd: 0.077

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts

Number of impact scenarios: 6.

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: 2021 to 2051

Impact on Demographic Rates

Scenario A - Name: 3900

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004699152 , se: NA

Scenario B - Name: 4000

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004819643 , se: NA

Scenario C - Name: 4100

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004940134 , se: NA

Scenario D - Name: 4200

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005060625 , se: NA

Scenario E - Name: 4300

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005181116 , se: NA

Scenario F - Name: 4400

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005301607 , se: NA

Output:

First year to include in outputs: 2021
Final year to include in outputs: 2051
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

Population Viability Analysis Parameter log

Kittiwake BDMPS 5,000 simulations

Set up

The log file was created on: 2020-03-18 17:35:42 using Tool version 2, with R version 3.5.3, PVA package version: 4.15 (with UI version 1.7)

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##                Package           Version
## popbio         "popbio"          "2.4.4"
## shiny          "shiny"           "1.4.0"
## shinyjs        "shinyjs"         "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"    "0.5.0"
## DT             "DT"              "0.10"
## plotly         "plotly"          "4.9.2"
## rmarkdown      "rmarkdown"       "1.18"
## dplyr          "dplyr"           "0.8.3"
## tidyr          "tidyr"           "1.0.0"
```

Basic information

This run had reference name “KI BDMPS 5000sims 3900to4400”.
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: 1.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.

Units for initial population size: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 829937 in 2020

Productivity rate per pair: mean: 0.6036278 , sd: 0.325783

Adult survival rate: mean: 0.854 , sd: 0.077

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts

Number of impact scenarios: 6.

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: 2021 to 2051

Impact on Demographic Rates

Scenario A - Name: 3900

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004699152 , se: NA

Scenario B - Name: 4000

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004819643 , se: NA

Scenario C - Name: 4100

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004940134 , se: NA

Scenario D - Name: 4200

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005060625 , se: NA

Scenario E - Name: 4300

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005181116 , se: NA

Scenario F - Name: 4400

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005301607 , se: NA

Output:

First year to include in outputs: 2021
Final year to include in outputs: 2051
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

Population Viability Analysis Parameter log

Kittiwake biogeographic 1,000 simulations

Set up

The log file was created on: 2020-03-17 14:30:01 using Tool version 2, with R version 3.5.3, PVA package version: 4.15 (with UI version 1.7)

```
##                Package           Version
## popbio         "popbio"          "2.4.4"
## shiny          "shiny"           "1.4.0"
## shinyjs        "shinyjs"         "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"    "0.5.0"
## DT             "DT"              "0.10"
## plotly         "plotly"          "4.9.2"
## rmarkdown      "rmarkdown"       "1.18"
## dplyr          "dplyr"           "0.8.3"
## tidyr          "tidyr"           "1.0.0"
```

Basic information

This run had reference name “KI biogeo 1000sims 3900to4400”.
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: 1000.
Random seed: 1.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.

Units for initial population size: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 5100000 in 2020

Productivity rate per pair: mean: 0.6036278 , sd: 0.325783

Adult survival rate: mean: 0.854 , sd: 0.077

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts

Number of impact scenarios: 6.

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: 2021 to 2051

Impact on Demographic Rates

Scenario A - Name: 3900

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000764706 , se: NA

Scenario B - Name: 4000

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000784314 , se: NA

Scenario C - Name: 4100

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000803922 , se: NA

Scenario D - Name: 4200

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000823529 , se: NA

Scenario E - Name: 4300

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.00084313 , se: NA

Scenario F - Name: 4400

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000862745 , se: NA

Output:

First year to include in outputs: 2021
Final year to include in outputs: 2051
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

Population Viability Analysis Parameter log

Kittiwake biogeographic 5,000 simulations

Set up

The log file was created on: 2020-03-18 17:44:12 using Tool version 2, with R version 3.5.3, PVA package version: 4.15 (with UI version 1.7)

```
##                Package           Version
## popbio         "popbio"          "2.4.4"
## shiny          "shiny"           "1.4.0"
## shinyjs        "shinyjs"         "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"    "0.5.0"
## DT             "DT"              "0.10"
## plotly         "plotly"          "4.9.2"
## rmarkdown      "rmarkdown"       "1.18"
## dplyr          "dplyr"           "0.8.3"
## tidyr          "tidyr"           "1.0.0"
```

Basic information

This run had reference name “KI biogeo 5000sims 3900to4400”.
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: 1.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.

Units for initial population size: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 5100000 in 2020

Productivity rate per pair: mean: 0.6036278 , sd: 0.325783

Adult survival rate: mean: 0.854 , sd: 0.077

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts

Number of impact scenarios: 6.

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: 2021 to 2051

Impact on Demographic Rates

Scenario A - Name: 3900

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000764706 , se: NA

Scenario B - Name: 4000

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000784314 , se: NA

Scenario C - Name: 4100

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0008039224 , se: NA

Scenario D - Name: 4200

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000823529 , se: NA

Scenario E - Name: 4300

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.00084313 , se: NA

Scenario F - Name: 4400

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000862745 , se: NA

Output:

First year to include in outputs: 2021
Final year to include in outputs: 2051
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

Population Viability Analysis Parameter log

Guillemot Flamborough and Filey Coast SPA 1,000 simulations

Set up

The log file was created on: 2020-03-17 13:40:47 using Tool version 2, with R version 3.5.3, PVA package version: 4.15 (with UI version 1.7)

```
##                Package           Version
## popbio         "popbio"          "2.4.4"
## shiny          "shiny"           "1.4.0"
## shinyjs        "shinyjs"         "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"    "0.5.0"
## DT             "DT"              "0.10"
## plotly         "plotly"          "4.9.2"
## rmarkdown      "rmarkdown"       "1.18"
## dplyr          "dplyr"           "0.8.3"
## tidyr          "tidyr"           "1.0.0"
```

Basic information

This run had reference name “FFC GU DI 1000 100to3050”.
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: 1000.
Random seed: 10.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Common Guillemot.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 6.
Is there an upper constraint on productivity in the model?: Yes, constrained to 1 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 83217 in 2020

Productivity rate per pair: mean: 0.5826832 , sd: 0.1894517

Adult survival rate: mean: 0.94 , sd: 0.025

Immatures survival rates:

Age class 0 to 1 - mean: 0.56 , sd: 0.058 , DD: NA

Age class 1 to 2 - mean: 0.792 , sd: 0.152 , DD: NA

Age class 2 to 3 - mean: 0.917 , sd: 0.098 , DD: NA

Age class 3 to 4 - mean: 0.938 , sd: 0.107 , DD: NA

Age class 4 to 5 - mean: 0.94 , sd: 0.025 , DD: NA

Age class 5 to 6 - mean: 0.94 , sd: 0.025 , 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: 2021 to 2051

Impact on Demographic Rates

Scenario A - Name: 100

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001201678 , se: NA

Scenario B - Name: 200

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002403355 , se: NA

Scenario C - Name: 1700

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.02042852 , se: NA

Scenario D - Name: 2900

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.03484865 , se: NA

Scenario E - Name: 3050

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.03665116 , se: NA

Output:

First year to include in outputs: 2021
Final year to include in outputs: 2051
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

Population Viability Analysis Parameter log

Guillemot Flamborough and Filey Coast SPA 5,000 simulations

Set up

The log file was created on: 2020-03-18 18:00:48 using Tool version 2, with R version 3.5.3, PVA package version: 4.15 (with UI version 1.7)

```
##                Package           Version
## popbio         "popbio"          "2.4.4"
## shiny          "shiny"           "1.4.0"
## shinyjs        "shinyjs"         "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"    "0.5.0"
## DT             "DT"              "0.10"
## plotly         "plotly"          "4.9.2"
## rmarkdown      "rmarkdown"       "1.18"
## dplyr          "dplyr"           "0.8.3"
## tidyr          "tidyr"           "1.0.0"
```

Basic information

This run had reference name “FFC GU DD 5000 100to3050”.
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: 10.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Common Guillemot.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 6.
Is there an upper constraint on productivity in the model?: Yes, constrained to 1 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 83217 in 2020

Productivity rate per pair: mean: 0.5826832 , sd: 0.1894517

Adult survival rate: mean: 0.94 , sd: 0.025

Immatures survival rates:

Age class 0 to 1 - mean: 0.56 , sd: 0.058 , DD: NA

Age class 1 to 2 - mean: 0.792 , sd: 0.152 , DD: NA

Age class 2 to 3 - mean: 0.917 , sd: 0.098 , DD: NA

Age class 3 to 4 - mean: 0.938 , sd: 0.107 , DD: NA

Age class 4 to 5 - mean: 0.94 , sd: 0.025 , DD: NA

Age class 5 to 6 - mean: 0.94 , sd: 0.025 , 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: 2021 to 2051

Impact on Demographic Rates

Scenario A - Name: 100

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001201678 , se: NA

Scenario B - Name: 200

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002403355 , se: NA

Scenario C - Name: 1700

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.02042852 , se: NA

Scenario D - Name: 2900

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.03484865 , se: NA

Scenario E - Name: 3050

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.03665116 , se: NA

Output:

First year to include in outputs: 2021
Final year to include in outputs: 2051
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA