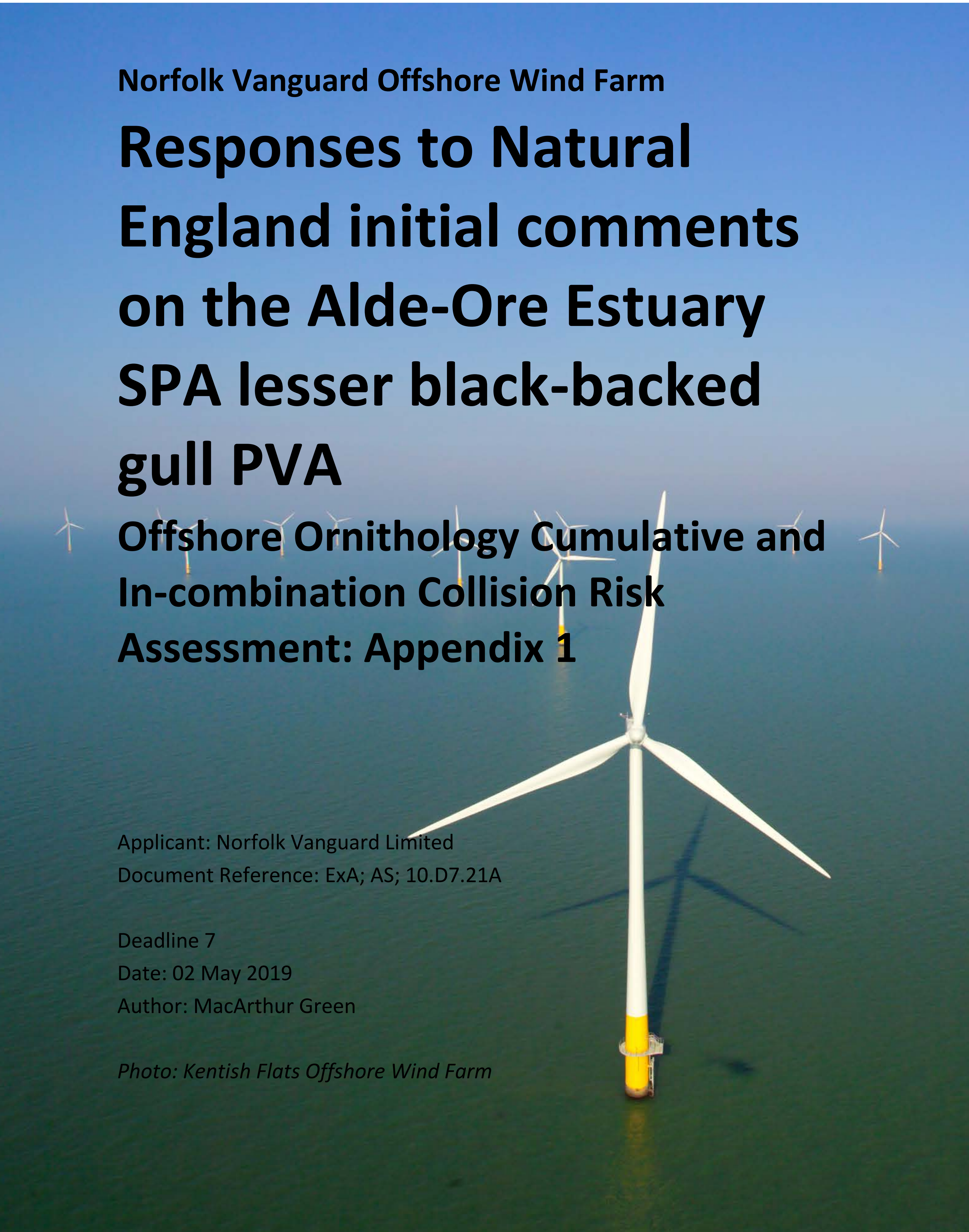

Norfolk Vanguard Offshore Wind Farm

Responses to Natural England initial comments on the Alde-Ore Estuary SPA lesser black-backed gull PVA

Offshore Ornithology Cumulative and In-combination Collision Risk Assessment: Appendix 1

Applicant: Norfolk Vanguard Limited
Document Reference: ExA; AS; 10.D7.21A

Deadline 7
Date: 02 May 2019
Author: MacArthur Green

Photo: Kentish Flats Offshore Wind Farm

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30/04/2019	02D	Minor revisions	MT	EV	
02/05/2019	04	Final for submission	MT	RS	RS

Executive Summary

This note contains responses from the Applicant to interim comments from Natural England on the Alde-Ore Estuary SPA lesser black-backed gull population viability analysis (PVA). This note also provides updated graphs of the counterfactuals of population size and population growth rate, estimated across 5,000 simulations and with the inclusion of 95% confidence intervals as requested by Natural England.

The outputs remain almost exactly the same for the purposes of assessment (i.e. within +/- 0.1% for the median predictions compared with those presented in ExA; AS; 10.D.6.16) and therefore the original interpretation in the Norfolk Vanguard assessment is unaffected by these updates.

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Glossary

CPGR	Counterfactual of Population Growth Rate
CPS	Counterfactual of Population Size
FFC	Flamborough and Filey Coast SPA
GWFL	Galloper Wind Farm Limited
LBBG	Lesser black-backed gull
OWF	Offshore Wind Farm
NE	Natural England
NV	Norfolk Vanguard
PVA	Population Viability Analysis
SMP	Seabird Monitoring Programme
SPA	Special Protection Area

1 INTRODUCTION

1. At Deadline 6, the Applicant submitted a population viability analysis (PVA) for the breeding population of lesser black-backed gulls at the Alde-Ore Estuary Special Protection Area (SPA) (ExA; AS; 10.D6.17) to provide predictions of the consequences of additional mortality from the Project on this population, as requested by Natural England.

2. Natural England provided the Applicant with initial comments on this PVA report via email on the 17th April 2019. Table 1 presents Natural England's comments and the Applicant's responses to these comments.

Table 1. Natural England's initial comments on the Alde-Ore Estuary SPA lesser black-backed gull PVA report (ExA; AS 10.D6.16) and responses from the Applicant.

Natural England's Comment	Applicant's Response
The models have been run using 1,000 simulations. We note that previous PVAs (e.g. MacArthur Green 2015) have used 5,000 simulations for the stochastic models, whereas the LBBG Alde-Ore PVA in REP6-020 undertaken by the Vanguard Applicant has used 1,000. As was advised by Natural England at Hornsea 3 regarding the updated PVAs undertaken for the Flamborough and Filey Coast (FFC) SPA, a larger number of simulations would potentially be needed to generate reliable results (Natural England 2019).	The Applicant acknowledges the point made by Natural England on this matter. While increasing the number of simulations as suggested, particularly when matched run formulations are used, makes virtually no material difference to the reliability of the results, updated outputs from the model with 5,00 simulations are provided in this note (figures 1 to 4 and tables 2 to 5). The median outputs for 5,000 simulations are within +/-0.1% of those produced for 1,000 simulations while the confidence intervals within +/-1% of those produced for 1,000 simulations, which makes no material difference to the conclusions reached from the results.
With regard to the metrics, it is not clear how the median and confidence intervals around the counterfactuals of population size and growth rate metrics have been calculated for the 'matched runs/pairs' approach. Therefore, Natural England suggests that the Applicant sets out how they have calculated the metrics - a worked example would be useful. Natural England advises that with a 'matched runs/pairs' method the metric should be calculated for each of the individual matched pairs and then (as there are 1,000 simulations in the Applicant's	The Applicant can confirm that the method described by Natural England is how these estimates were calculated and this is reflected in the values in the tabulated outputs of the report (ExA; AS; 10.D6.17, Tables A.1 to A.4). However, the confidence intervals were not

models) there will be 1,000 metric calculations from which a median value of the metric and the 95% confidence intervals can be derived.	presented on the counterfactual of population size figures (ExA; AS; 10.D6.17, Figures A.1 and A.3) and those intervals presented on the figures for the counterfactuals of population growth rate (ExA; AS; 10.D6.17, Figures A.2 and A.4) were incorrectly plotted. Updated figures are provided in this note (Figures 1 to 4 below) which present confidence intervals for both counterfactual measures which correspond to those in the tables in the report (A.1 to A.4) and which were estimated as per Natural England's methods. It should be noted that the median estimates in Figures 1 to 4 below are the same as those in the original report (ExA; AS; 10.D6.17).
We note that the final paragraph of Section 4 of REP6-020 states that: '…the demographic rates indicate that under baseline conditions the population growth rate would be in excess of 10%.' Natural England is concerned by this statement as there is no evidence to suggest this is an appropriate assumption. We note that in the original LBBG Alde-Ore PVA undertaken for the Galloper offshore wind farm (OWF) (GWFL 2012) when run in density independent mode and with the "historic" scenario resulted in projected population DECLINE - this was with: juvenile survival rate = 0.82, adult survival rate = 0.90, productivity = 0.45 chicks per pair and proportion of adults breeding = 0.66. These demographic rates are quite similar to the parameters used in this PVA undertaken for Vanguard (juvenile survival = 0.82, adult survival = 0.885, productivity = 0.53 and proportion of adults breeding = 0.663. Natural England does not think the Alde-Ore Estuary SPA colony is growing at all at the moment and therefore considers that its demographic rates must be different to those used here. Further justification for this assumption is needed should it continue to form part of the PVA.	This statement regarding baseline growth was made in error and reflected the results from an earlier draft of the model prior to demographic rate revisions to incorporate the relatively high level of nonbreeding recorded in this species. Following this update the underlying growth rate of the density independent model is negative (-2%). However, this has no bearing on the outputs presented and the counterfactual estimates are unaffected.
We note that the value of 0.351 fledged young per pair is a pretty low value. This figure has been arrived at by multiplying the Horswill & Robinson (2015) value of 0.530 for national mean productivity by 0.663 to take account of the proportion of birds that miss breeding each year (in an average LBBG population). Natural England is not certain about the appropriateness of this and note that in the old LBBG Alde-Ore PVA undertaken for Galloper OWF (GWFL 2012) three productivity rates were	The Applicant agrees this is a precautionary assumption regarding the incidence of nonbreeding, derived from other studies. However, the breeding success data suggested as alternatives by Natural England, only reflect birds which

simulated: 0.45, 0.80 and 1.0 and focused on the result when 0.8 was used. That was on the basis of there having been a good year in 2011. However, the 3 year mean productivity at Orford up to 2011 was 0.256 and in 2012 it was 0.19. We note that there is breeding success data in the Seabird Monitoring Programme (SMP) database for Havergate Island from 2009-11 and 2014-15, but no data for Orfordness.	actually attend the colony and initiate breeding, whereas the 66% figure accounts for birds which simply do not attempt to breed (i.e. do not attend the colony). This figure will not be known for this colony, although the Applicant agrees that given its small size it is possible that assuming such a high rate of nonbreeding rate as this (66%) overestimates the incidence of non-breeding. Thus, this ensures the results are precautionary, as reducing the rate of nonbreeding would improve the population's growth rate.
The last sentence of this paragraph states: 'Population projections produced by such models will either increase to infinity or decrease to extinction.' We note that if survival and productivity are perfectly matched then in theory the population may remain stable, but as the Applicant notes even if slightly out then over time the colony will drift up or down - though if quite closely matched the two stochastic elements may stop the inexorable rise or fall, or slow it considerably.	Natural England's comment on this matter would only be the case in a deterministic model, and even then the precision of the estimates to achieve stability in a density independent model is far beyond anything that could be estimated empirically. In a stochastic model such as the ones presented, the variation in parameter values means the original statement in the report remains correct.
We are not aware of any evidence of density dependence acting on the LBBG colony at the Alde-Ore Estuary SPA. The colony declined significantly in 2001, and although the reasons for the decline are not understood it may be due to external factors. It is now such a small colony that it is hard to imagine density dependence operating much now (unless maybe depensatory). This paragraph states: '…the demographic rate most likely to reflect density dependent effects will be reproduction, with breeding success declining as population approaches the ceiling set by food resources…' We note that density dependence will almost certainly NOT be operating just now at the Alde-Ore LBBG colony with such a depleted colony and will likely remain pretty weak effect until the colony gets much bigger. However, we consider it appropriate that the Applicant has considered modelling density dependent regulation through reproduction rather than survival across multiple rates.	The Applicant acknowledges Natural England's comment on this matter and agrees that modelling density dependence for seabirds is most appropriate through effects on reproduction. The Applicant considers that presenting outputs both with and without density dependence is appropriate in order that the range of potential population projections is available for assessment.
The last sentence of this paragraph states: 'Furthermore, the additional mortality was applied to all age classes in proportion to their presence (i.e. wind farm mortality was not considered	The Applicant can confirm that the mortality was applied using the model age ratios, not the

to target specific age classes).' Clarification is required as to whether this is in the modelled population as a whole or their presence in the OWF survey dataset of age classes recorded at sea. Natural England assumes it is the former, but clarification is required.	survey ones. The Applicant considers this to be appropriate because the modelling is intended to provide a guide for additional mortality in the wider sense (i.e. irrespective of where and when during the year it happens).
The first sentence of this paragraph states: 'Although the trend in the Alde-Ore Estuary population is not well known...' Natural England notes that the Alde-Ore LBBG population trend is well known from 2001 to 2010 at least, as shown in one of the figures in the Alde-Ore LBBG stochastic PVA report undertaken for Galloper OWF (GWFL 2012).	The Applicant stands by this statement: the trend since 2010 (i.e. the last decade) is not known with any confidence and the trend up to 2010 is not considered to provide a reliable guide for the current status of the population, as this is almost 10 years out of date (it is noted that this is a much longer gap than the two year gap when the analysis was undertaken for Galloper).

1.1 Updated outputs

3. Revised counterfactual figures are provided below calculated from 5,000 simulations as requested by Natural England, with 95% confidence intervals included on the figures. These results are within +/-0.1% for the median estimates and +/11% for the confidence intervals (compared with those obtained from 1,000 simulations (i.e. in ExA; AS; 10.D6.16). Therefore, the original interpretation of these results (i.e. in ExA; AS; 10.D6.17) is un affected. The corresponding outputs are tabulated in Tables 2 to 5.

4. The Applicant considers that this note addresses the comments received from Natural England and no further updates to the PVA outputs are therefore required.

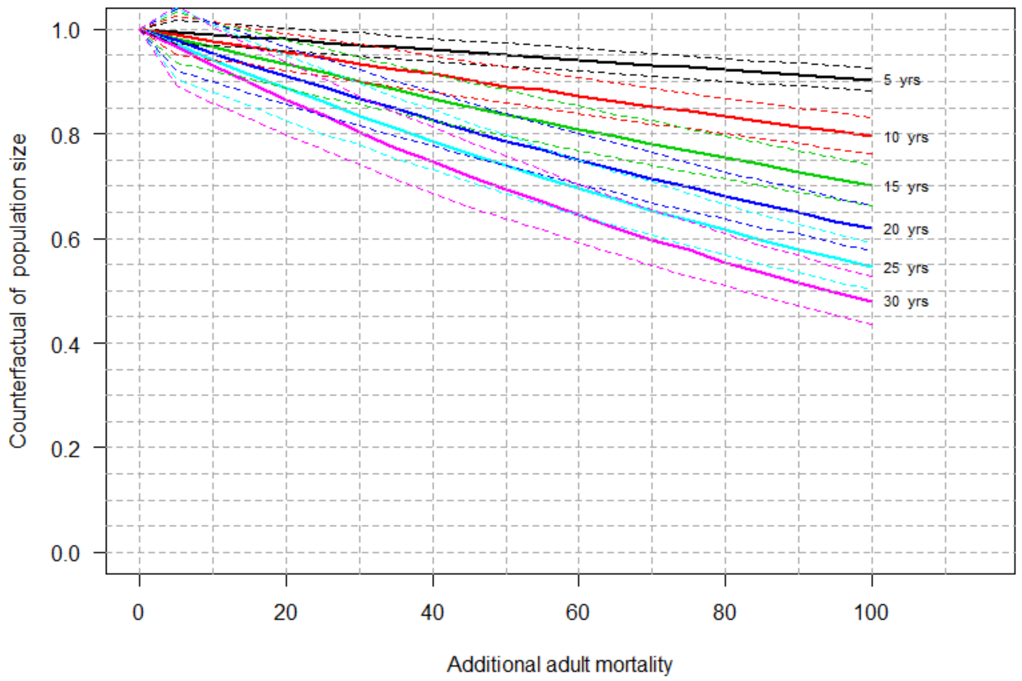

Figure 1. Counterfactual of population size, with 95% confidence intervals (dashed lines). 5,000 Density independent simulations.

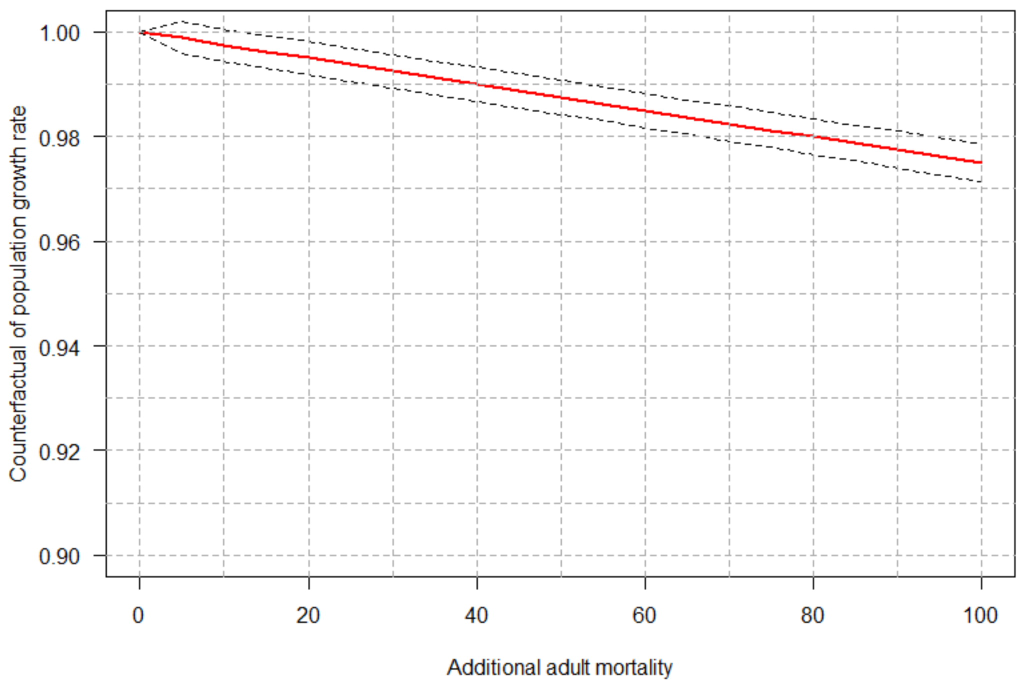

Figure 2. Counterfactual of population growth rate, with 95% confidence intervals (dashed lines). 5,000 Density independent simulations.

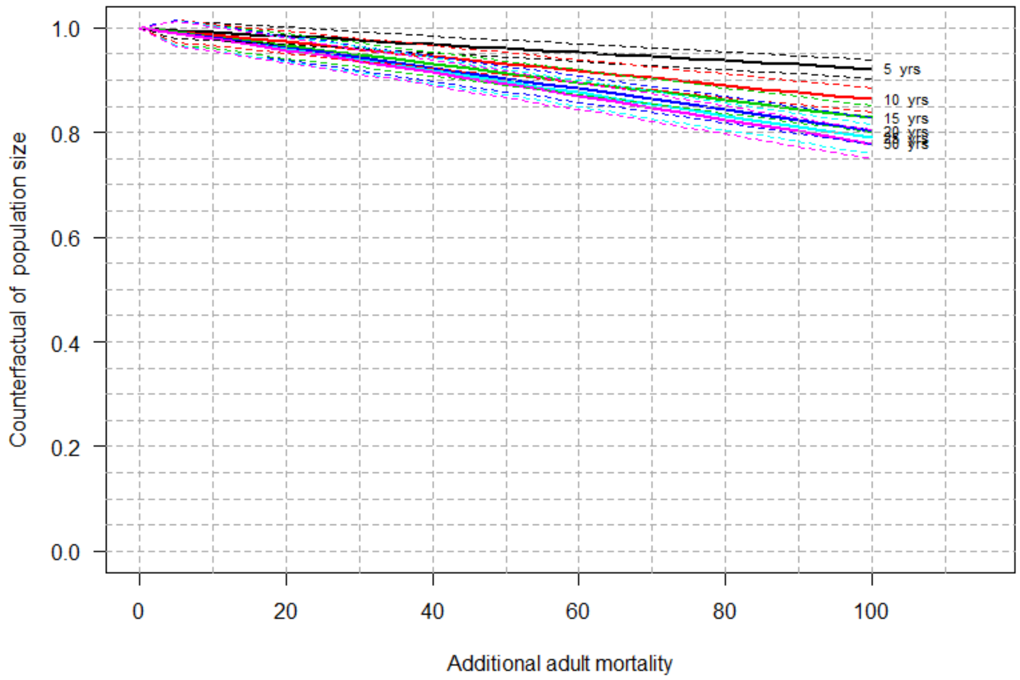

Figure 3. Counterfactual of population size, with 95% confidence intervals (dashed lines). 5,000 Density independent simulations.

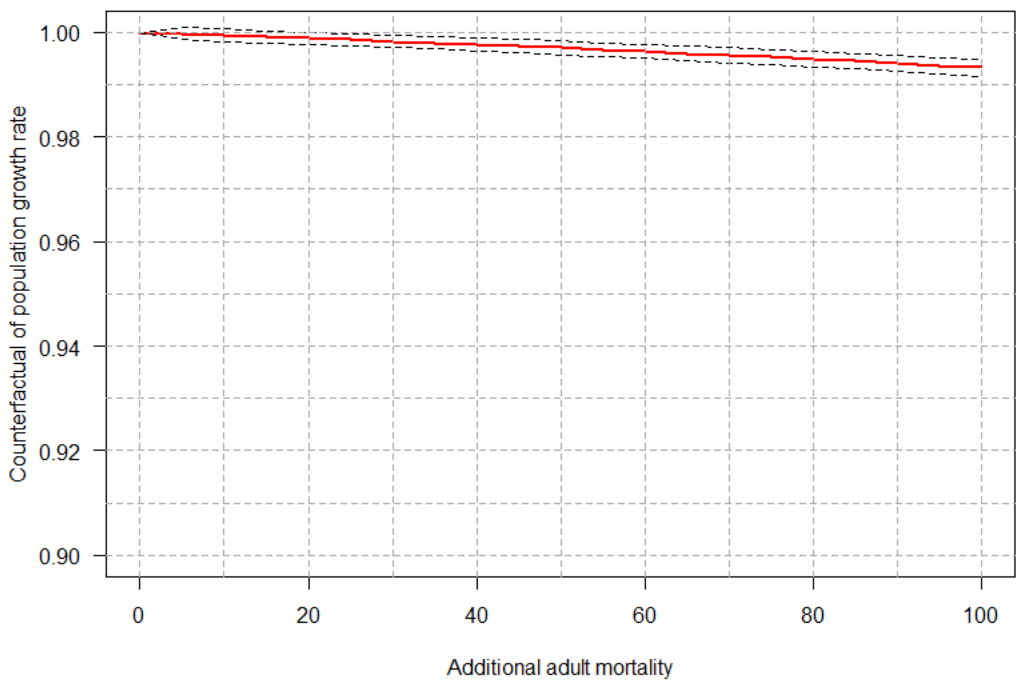

Figure 4. Counterfactual of population growth rate, with 95% confidence intervals (dashed lines). 5,000 Density dependent simulations.

Table 2. Lesser black-backed gull, demographic rate set 1, counterfactuals of population size after 5 to 30 years, estimated using a matched runs method, from 5,000 density independent simulations.

	Counterfactual of population size at 5 year intervals						
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000
	Median	1.000	1.000	1.000	1.000	1.000	1.000
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.972	0.952	0.937	0.922	0.906	0.893
	Median	0.995	0.988	0.983	0.977	0.972	0.966
	Upper 95%	1.017	1.026	1.032	1.038	1.041	1.046
10	Lower 95%	0.968	0.942	0.920	0.899	0.879	0.858
	Median	0.990	0.978	0.966	0.953	0.941	0.930
	Upper 95%	1.014	1.016	1.012	1.012	1.009	1.006
15	Lower 95%	0.963	0.932	0.905	0.878	0.854	0.828
	Median	0.985	0.967	0.949	0.931	0.914	0.897
	Upper 95%	1.007	1.003	0.997	0.989	0.978	0.969
20	Lower 95%	0.959	0.922	0.888	0.857	0.827	0.798
	Median	0.980	0.956	0.932	0.910	0.887	0.865
	Upper 95%	1.002	0.991	0.979	0.966	0.953	0.940
25	Lower 95%	0.953	0.909	0.871	0.835	0.799	0.769
	Median	0.975	0.945	0.916	0.888	0.860	0.833
	Upper 95%	0.998	0.982	0.964	0.944	0.923	0.906
30	Lower 95%	0.948	0.900	0.856	0.815	0.780	0.741
	Median	0.971	0.934	0.900	0.866	0.834	0.804
	Upper 95%	0.994	0.972	0.947	0.923	0.898	0.872
35	Lower 95%	0.943	0.889	0.841	0.795	0.753	0.714
	Median	0.965	0.924	0.884	0.846	0.810	0.775
	Upper 95%	0.988	0.961	0.932	0.901	0.870	0.843
40	Lower 95%	0.940	0.879	0.827	0.778	0.731	0.687
	Median	0.961	0.914	0.869	0.826	0.785	0.748
	Upper 95%	0.982	0.949	0.914	0.881	0.846	0.815
45	Lower 95%	0.935	0.870	0.811	0.758	0.708	0.662
	Median	0.956	0.903	0.854	0.807	0.762	0.719
	Upper 95%	0.978	0.939	0.898	0.859	0.821	0.785
50	Lower 95%	0.929	0.859	0.796	0.740	0.687	0.638
	Median	0.951	0.893	0.838	0.787	0.739	0.694
	Upper 95%	0.974	0.929	0.884	0.840	0.799	0.757
55	Lower 95%	0.925	0.849	0.783	0.721	0.666	0.616
	Median	0.946	0.883	0.824	0.769	0.717	0.669
	Upper 95%	0.968	0.917	0.867	0.820	0.774	0.731
60	Lower 95%	0.920	0.840	0.767	0.704	0.645	0.592
	Median	0.941	0.873	0.809	0.751	0.696	0.645
	Upper 95%	0.963	0.907	0.853	0.800	0.749	0.703
65	Lower 95%	0.915	0.829	0.756	0.687	0.626	0.571

	Median	0.937	0.863	0.795	0.732	0.675	0.622
	Upper 95%	0.959	0.898	0.837	0.782	0.727	0.678
70	Lower 95%	0.910	0.819	0.741	0.669	0.606	0.548
	Median	0.932	0.853	0.780	0.715	0.655	0.599
	Upper 95%	0.954	0.888	0.826	0.765	0.708	0.656
75	Lower 95%	0.905	0.810	0.728	0.653	0.587	0.528
	Median	0.927	0.843	0.767	0.698	0.634	0.577
	Upper 95%	0.949	0.877	0.808	0.744	0.685	0.632
80	Lower 95%	0.901	0.801	0.715	0.637	0.569	0.509
	Median	0.923	0.834	0.753	0.681	0.616	0.557
	Upper 95%	0.944	0.867	0.795	0.727	0.666	0.609
85	Lower 95%	0.896	0.791	0.701	0.621	0.552	0.491
	Median	0.918	0.824	0.740	0.664	0.597	0.536
	Upper 95%	0.939	0.859	0.782	0.711	0.646	0.587
90	Lower 95%	0.891	0.782	0.689	0.608	0.536	0.471
	Median	0.913	0.815	0.727	0.649	0.579	0.517
	Upper 95%	0.935	0.849	0.768	0.695	0.629	0.568
95	Lower 95%	0.886	0.771	0.676	0.592	0.518	0.453
	Median	0.908	0.805	0.714	0.633	0.561	0.498
	Upper 95%	0.931	0.841	0.755	0.679	0.609	0.547
100	Lower 95%	0.882	0.764	0.664	0.577	0.504	0.436
	Median	0.904	0.797	0.702	0.617	0.544	0.479
	Upper 95%	0.926	0.831	0.741	0.663	0.591	0.528

Table 3. Lesser black-backed gull, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 30 using a matched runs method, from 5,000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
5	0.999	0.996	1.002
10	0.997	0.994	1.000
15	0.996	0.993	0.999
20	0.995	0.992	0.998
25	0.994	0.991	0.997
30	0.993	0.989	0.996
35	0.991	0.988	0.994
40	0.990	0.987	0.993
45	0.989	0.986	0.992
50	0.987	0.984	0.991
55	0.986	0.983	0.990
60	0.985	0.982	0.988
65	0.984	0.981	0.987
70	0.982	0.979	0.986
75	0.981	0.978	0.985
80	0.980	0.977	0.983
85	0.979	0.975	0.982
90	0.977	0.974	0.981
95	0.976	0.973	0.980
100	0.975	0.971	0.979

Table 4. Lesser black-backed gull, demographic rate set 1, counterfactuals of population size after 5 to 30 years, estimated using a matched runs method, from 5,000 density dependent simulations.

Counterfactual of population size at 5 year intervals							
Additional adult mortality	Estimate	yr.5	yr.10	yr.15	yr.20	yr.25	yr.30
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000
	Median	1.000	1.000	1.000	1.000	1.000	1.000
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.979	0.972	0.967	0.966	0.965	0.965
	Median	0.996	0.993	0.991	0.990	0.989	0.989
	Upper 95%	1.012	1.015	1.015	1.014	1.014	1.013
10	Lower 95%	0.976	0.966	0.961	0.957	0.955	0.955
	Median	0.992	0.986	0.983	0.981	0.980	0.979
	Upper 95%	1.009	1.008	1.005	1.004	1.004	1.003
15	Lower 95%	0.971	0.958	0.952	0.947	0.945	0.944
	Median	0.988	0.979	0.974	0.971	0.969	0.968
	Upper 95%	1.005	1.001	0.997	0.995	0.993	0.993
20	Lower 95%	0.968	0.952	0.942	0.938	0.935	0.934
	Median	0.984	0.972	0.966	0.961	0.959	0.957
	Upper 95%	1.001	0.995	0.989	0.985	0.983	0.982
25	Lower 95%	0.964	0.944	0.934	0.928	0.924	0.924
	Median	0.980	0.965	0.957	0.952	0.949	0.947
	Upper 95%	0.997	0.987	0.980	0.976	0.973	0.970
30	Lower 95%	0.960	0.937	0.926	0.918	0.915	0.911
	Median	0.976	0.959	0.948	0.942	0.938	0.936
	Upper 95%	0.993	0.981	0.972	0.965	0.963	0.960
35	Lower 95%	0.956	0.931	0.916	0.909	0.904	0.902
	Median	0.972	0.952	0.940	0.933	0.928	0.926
	Upper 95%	0.989	0.974	0.962	0.956	0.953	0.950
40	Lower 95%	0.952	0.924	0.908	0.899	0.892	0.889
	Median	0.969	0.945	0.931	0.923	0.918	0.914
	Upper 95%	0.985	0.966	0.954	0.947	0.943	0.939
45	Lower 95%	0.949	0.916	0.900	0.888	0.882	0.878
	Median	0.965	0.938	0.923	0.913	0.907	0.903
	Upper 95%	0.980	0.960	0.946	0.937	0.932	0.928
50	Lower 95%	0.945	0.910	0.890	0.878	0.871	0.866
	Median	0.961	0.932	0.914	0.903	0.897	0.892
	Upper 95%	0.977	0.953	0.937	0.927	0.921	0.917
55	Lower 95%	0.940	0.903	0.882	0.869	0.861	0.855
	Median	0.957	0.925	0.905	0.893	0.886	0.881
	Upper 95%	0.974	0.946	0.929	0.917	0.910	0.906
60	Lower 95%	0.936	0.896	0.872	0.858	0.849	0.844
	Median	0.953	0.917	0.897	0.883	0.875	0.870
	Upper 95%	0.969	0.940	0.920	0.908	0.899	0.896
65	Lower 95%	0.931	0.888	0.864	0.848	0.838	0.833
	Median	0.949	0.911	0.888	0.874	0.865	0.859
	Upper 95%	0.966	0.933	0.911	0.898	0.890	0.885
70	Lower 95%	0.928	0.882	0.855	0.838	0.828	0.821
	Median	0.945	0.904	0.879	0.864	0.854	0.847
	Upper 95%	0.963	0.925	0.903	0.889	0.880	0.873
75	Lower 95%	0.924	0.875	0.846	0.829	0.816	0.809
	Median	0.941	0.897	0.871	0.854	0.843	0.836

	Upper 95%	0.958	0.919	0.894	0.879	0.868	0.862
80	Lower 95%	0.921	0.868	0.836	0.818	0.805	0.798
	Median	0.937	0.890	0.862	0.844	0.832	0.825
	Upper 95%	0.954	0.912	0.885	0.869	0.857	0.851
85	Lower 95%	0.916	0.861	0.828	0.808	0.795	0.786
	Median	0.933	0.884	0.853	0.834	0.821	0.813
	Upper 95%	0.950	0.906	0.878	0.860	0.848	0.839
90	Lower 95%	0.912	0.854	0.819	0.797	0.783	0.774
	Median	0.930	0.877	0.844	0.824	0.811	0.802
	Upper 95%	0.946	0.899	0.869	0.850	0.836	0.828
95	Lower 95%	0.908	0.846	0.810	0.787	0.771	0.762
	Median	0.926	0.870	0.836	0.814	0.800	0.790
	Upper 95%	0.943	0.893	0.860	0.839	0.826	0.817
100	Lower 95%	0.904	0.840	0.801	0.777	0.760	0.749
	Median	0.922	0.863	0.827	0.804	0.789	0.779
	Upper 95%	0.940	0.886	0.852	0.829	0.815	0.806

Table 5. Lesser black-backed gull, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 30 using a matched runs method, from 5,000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
5	1.000	0.999	1.001
10	0.999	0.998	1.001
15	0.999	0.998	1.000
20	0.999	0.998	1.000
25	0.999	0.997	1.000
30	0.998	0.997	0.999
35	0.998	0.997	0.999
40	0.998	0.996	0.999
45	0.997	0.996	0.999
50	0.997	0.996	0.998
55	0.997	0.995	0.998
60	0.996	0.995	0.998
65	0.996	0.995	0.997
70	0.996	0.994	0.997
75	0.995	0.994	0.997
80	0.995	0.993	0.996
85	0.994	0.993	0.996
90	0.994	0.993	0.996
95	0.994	0.992	0.995
100	0.993	0.992	0.995