Hornsea Project Four: Environmental Statement (ES)

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Volume A5, Annex 5.4: Offshore Ornithology Population Viability Analysis

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Glossary

Term	Definition
All Individuals	The whole population including all adults and juveniles
Bio-Season	Bird behaviour and abundance is recognised to differ across a calendar year, with particular months recognised as being part of different seasons. The biologically defined minimum population scales (BDMPS) bio-seasons used in this report are based on those in Furness (2015), hereafter referred to as bio-seasons. Separate bio-seasons are recognised in this technical report in order to establish the level of importance any seabird species has within the study area during any particular period of time.
Breeding Adults	Adults at breeding age proportion of a population.
Cumulative effects	The combined effect of Hornsea Four in combination with the effects from a number of different projects, on the same single receptor/resource. Cumulative impacts are those that result from changes caused by other past, present or reasonably foreseeable actions together with Hornsea Four.
Demographic Parameter	A factor that determines the population size.
Density Dependence	The influence of population size or density on one or more demographic parameters.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Projects (NSIPs).
Hornsea Project Four Offshore Wind Farm	The term covers all elements of the project (i.e. both the offshore and onshore). Hornsea Four infrastructure will include offshore generating stations (wind turbines), electrical export cables to landfall, and connection to the electricity transmission network. Hereafter referred to as Hornsea Four.
Orsted Hornsea Project Four Ltd	The Applicant for the proposed Hornsea Project Four Offshore Wind Farm Development Consent Order (DCO).
Population Viability Analysis (PVA)	The process of determining the probability that a population will persist over a specified time period.
Probabilistic	Based on a theory of probability involving chance variation.
Productivity	The annual population estimate of number of chicks fledged per pair.
Shiny App	User-friendly graphical user interface accessible via a standard web-browser that uses underlying R code.
Stochasticity	The lack of any predictable order or plan.
Survival Rate	The probability of an individual to survive from one breeding season to the next.

Acronyms

Acronym	Definition
AfL	Agreement for Lease
BDMPS	Biologically Defined Minimum Population Scale
CRM	Collision Risk Modelling
DCO	Development Consent Order
EIA	Environmental Impact Assessment
EP	Evidence Plan
ES	Environmental Statement
JNCC	Joint Nature Conservation Committee
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PVA	Population Viability Analysis
RSPB	Royal Society for the Protection of Birds
SD	Standard Deviation
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
WTG	Wind Turbine Generator

Units

Unit	Definition
km	Kilometre
km^2	Kilometre squared
%	Percentage (proportion)

1 Introduction

1.1 Project Background

1.1.1.1 Orsted Hornsea Project Four Ltd. (hereafter the 'Applicant') is proposing to develop the Hornsea Project Four Offshore Wind Farm (hereafter 'Hornsea Four'). Hornsea Four will be located approximately 69 km offshore from coastline of the East Riding of Yorkshire in the Southern North Sea, with the array area covering an area of approximately 492 km^2 and will be the fourth project to be developed in the former Hornsea Zone. Hornsea Four will include both offshore and onshore infrastructure including an offshore generating station (wind farm), export cables to landfall, and connection to the electricity transmission network (please see **Volume A1, Chapter 4: Project Description** for full details on the Project Design).

1.1.1.2 The Hornsea Four Agreement for Lease (AfL) area was 846 km^2 at the Scoping phase of project development. In the spirit of keeping with Hornsea Four's approach to Proportionate Environmental Impact Assessment (EIA), the project gave due consideration to the size and location (within the existing AfL area of the final project that is being taken forward to Development Consent Order (DCO) application). This consideration is captured internally as the "Developable Area Process", which includes Physical, Biological and Human constraints in refining the developable area, balancing consenting and commercial considerations with technical feasibility for construction.

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

1.1.1.4 APEM Ltd (hereafter APEM) was commissioned by the Applicant to undertake a modelling exercise to assess the potential for impacts from Hornsea Four alone and cumulatively with other projects for specific seabirds at the Biologically Defined Minimum Population Scale (BDMPS) and biogeographic population level through the use of Population Viability Analysis (PVA). This technical annex contains the methodology and results of the PVAs run for the selected of seabirds and was produced to support **Volume A2, Chapter 5: Offshore and Intertidal Ornithology**.

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

1.2 Population Viability Analysis

1.2.1.1 Renewable energy projects in the marine environment, such as Offshore Wind Farms (OWFs), have the potential to impact on seabirds through a number of processes such as collision with turbine blades resulting in mortality, or displacement from an area due to the presence of Wind Turbine Generators (WTGs). These processes affect individuals, but the cumulative effects (when the project alone effects are considered alongside any effects from other projects on the same receptor) have the potential to affect the productivity or elevate the baseline mortality of a population. The EIA process provides for the assessment of such potential effects as a consequence of OWFs at varying population scales, from a single Special Protection Area (SPA) colony, to the wider biogeographic population.

1.2.1.2 One method to estimate the effect that developments alone or cumulatively may have on a population is through Population Viability Analysis (PVA). PVA provides a robust framework using demographic parameters to predict changes in the population, using statistical population models to forecast future changes over a set period. Comparisons are made between 'baseline' conditions whereby conditions remain unimpacted and under 'scenario' conditions where an impact is applied to a population by the alteration of demographic parameters.

1.2.1.3 This report provides PVAs modelled North Sea and English Channel BDMPS and wider biogeographic population scales as agreed with the EP Technical Panel (OFF-ORN-2.27). The six species selected for modelling were:

- Gannet, *Morus bassanus*;
- Kittiwake, *Rissa tridactyla*;
- Great black-backed gull, *Larus marinus*;
- Guillemot, *Uria aalge*;
- Razorbill, *Alca torda*; and
- Puffin, *Fratacula artica*.

1.2.1.4 Other species recorded within the Hornsea Four array area that may be subject to collision risk were deemed to be at lower risk, including lesser black-backed gull (*Larus fuscus*) and herring gull (*Larus argentatus*), with potential impacts from Hornsea Four determined to be negligible and of no material contribution to any cumulative effects for these species.

1.2.1.5 PVA was undertaken using the Seabird PVA Tool developed by Natural England (Searle et al. 2019). The Seabird PVA Tool was accessed via the 'Shiny App' interface, which is a user-friendly graphical user interface accessible via a standard web-browser that uses the nepva R package to perform the modelling and analysis. The advantages of using an online platform for modelling and analysis purposes are that users are not required to use any R code, users are not required to install or maintain R, and updates to the model are made directly to the server. The tool is capable of assessing any type of impact in terms of change to demographic parameters, or as a cull or harvest of a fixed size per year (Searle et al. 2019).

2 Methodology

2.1 Guidance and Models

2.1.1.1 The user guide for the Seabird PVA Tool provided by Natural England (Mobbs et al. 2020) has been followed for modelling and assessment of potential impacts.

2.1.1.2 The demographic parameters used for the PVA are presented in **Section 2.2**, whilst the input log and outputs from the Shiny App are included in **Appendix A** of this report.

2.2 PVA Demographic Parameters

2.2.1 Modelling Approach

Simulation Type

2.2.1.1 All PVA models were undertaken using the 'Simulation' run type, which is used to simulate population trajectories based on the specified demographic parameters, initial population sizes and scenarios the user inputs into the model.

2.2.1.2 The Seabird PVA Tool uses a Leslie matrix to construct a PVA model (Caswell 2000) based on the parameters provided by the user. Users can specify whether they wish the model to include demographic stochasticity, environmental stochasticity, density dependence, density independence or whether they want the model to run an entirely deterministic model.

2.2.1.3 A deterministic model translates the demographic parameters provided into actual numbers and provides a simplistic model, which can be used to generate average trends. Due to the lack of stochasticity, a deterministic model will produce the same result every time the simulation is run. In situations where little is known about how the population size has varied, or how the scale of impact may vary, running a deterministic model might provide a more candid assessment of the population and how it may be impacted.

2.2.1.4 A stochastic model produces probabilistic outputs to account for the impact of environmental and demographic stochasticity. Environmental stochasticity describes the effects random variation in factors such as weather can have on a population and is modelled by the incorporation of randomly generated values for the probability of survival from one-time step to the next. Demographic stochasticity refers to the effect of random variation in population structure on demographic rates and is modelled by generating random numbers of surviving individuals for any given survival probability. Demographic stochasticity can usually be ignored for populations greater than 100 individuals, however including demographic stochasticity will not cause any penalty when simulating larger populations (WWT Consulting 2012).

2.2.1.5 All PVA modelling in this report was undertaken with environmental and deterministic stochasticity. To ensure robust results, all simulations were set to run 5,000 times, as requested by Natural England (OFF-ORN-2.46). All models were run for a 35-year time span, representing the likely lifespan of Hornsea Four.

2.2.1.6 Demographic processes such as growth, survival, productivity and recruitment are density-dependent, as their rates change in relation to the number of individuals in a population. Density dependence can be described as being either compensatory or depensatory (Begon, Townsend & Harper 2005). Compensation is characterised by demographic changes that cause a stabilising effect on a populations long-term average. Depensation acts to further decrease the rate of population growth in declining populations and can delay the rate of recovery. This is typically exhibited in populations that have been significantly depleted in size and is caused by a reduction in the benefits associated with conspecific presence.

2.2.1.7 Density dependence is self-evident in the natural environment, as without density dependence, populations would grow exponentially. For seabird populations, the mechanisms as to how this operates are largely uncertain. If density dependence is mis-specified in an assessment, the modelled predictions may be unreliable. Therefore, it is more typical to use density independent models for seabird assessments, despite the lack of biologically necessary density dependence. As such, density independent models lack any means by which a population can recover once it has been reduced beyond a certain point, they are therefore appropriate for impact assessment purposes on the grounds of precaution (i.e. another source of precaution in the assessment process) (Ridge et al. 2019).

2.2.1.8 Although both the counterfactual of population size and population growth rate are presented within this report, the Applicant considers that the counterfactual of population growth rate only should be used for interpreting the predicted impacts. This is because the counterfactual of population growth rate can be compared against known population trends for a feature / receptor and is relatively insensitive to the baseline rate of growth and direction (positive or negative). Whereas, the counterfactual of population size will predict very large differences in comparison to the baseline population size, especially when density dependent factors allowing for population recovery or preventing exponential growth are not considered within the PVA, as is the case with these assessments.

2.2.2 Species-specific values

2.2.2.1 The Shiny App offers the users the choice of using pre-set demographic parameters or the ability to enter custom values. The pre-set demographic values are available for a total of 15 different species. The values are derived from previously reported national or colony specific demographic parameters sourced from the Joint Nature Conservation Committee (JNCC) Seabird Monitoring Programme (SMP 2020), divided into eight regional classifications (further information on the eight regional classifications can be found in Mobbs et al. (2020)) for breeding success data or Horswill and Robinson (2015) for survival rate. **Table 1** and **Table 2** summarise the species-specific values selected for the six species that are the focus of this report.

2.2.2.2 After reviewing the pre formulated productivity rates within the tool for the eight regional classifications, due to the age of the data (productivity data spanning over 50 years in some instances) feeding into the productivity rates, none of the pre formulated values for productivity were representative of the populations assessed within this report. The productivity values presented within Horswill and Robinson (2015) were instead used for assessment as described in further detail below, due to providing a more representative productivity rate of the populations assessed.

Biogeographic Population Demographic Parameters

2.2.2.3 For all six species the initial population size inputted into all PVAs for the biogeographic scale were taken from the review undertaken by Furness (2015). The survival rates for gannet, kittiwake, guillemot, razorbill and puffin were derived from the national values presented in Horswill and Robinson (2015), which are pre formulated within the Natural England PVA tool.

2.2.2.4 The survival rates for great black-backed gull presented in Horswill and Robinson (2015) are limited and are based on a relatively old study by Glutz von Blotzheim & Bauer (1982). Due to the limited amount of data Horswill and Robinson (2015) recommended using the survival

rates of other large gull species when conducting population modelling for great black-backed gull. Therefore, the survival rates for great black-backed gull used for the PVA are based on adult and juvenile rates for herring gull as presented in Horswill & Robinson (2015).

2.2.2.5 The most appropriate productivity rates to be used at the biogeographic scale were concluded to be the national values for all six species calculated in Horswill and Robinson (2015), as agreed with the EP Technical Panel (OFF-ORN-2.42).

Table 1: Biogeographic population demographic parameters selected for all six species.

Species	Productivity Rate ± Standard Deviation (SD)	Available Colony-Specific Survival Rate	Initial Population Size (all individuals)
Gannet	0.700 ± 0.082	National pre-formulated values	1,180,000
Kittiwake	0.690 ± 0.296	National pre-formulated values	5,100,000
Great black-backed gull	1.139 ± 0.533	National pre-formulated values for herring gull (see paragraph 2.2.2.4)	235,000
Guillemot	0.672 ± 0.147	National pre-formulated values	4,125,000
Razorbill	0.570 ± 0.247	National pre-formulated values	1,707,000
Puffin	0.617 ± 0.151	National pre-formulated values	11,840,000

BDMPS Population Demographic Parameters

2.2.2.6 For all six species, the initial population size inputted into all PVAs for the BDMPS were taken from the review undertaken by Furness (2015) (OFF-ORN-2.1). The survival rates for gannet, kittiwake, guillemot, razorbill and puffin were derived from the national values presented in Horswill and Robinson (2015) as recommended by Natural England (OFF-ORN-2.42).

2.2.2.7 As stated in paragraph 2.2.2.4, due to the limited data on great black-backed gull survival rates, values used for PVA modelling are based on the values specified in Horswill and Robinson (2015) for herring gull instead.

2.2.2.8 For gannet, great black-backed gull, guillemot, razorbill and puffin, the national productivity rate from Horswill and Robinson (2015) were identified as the most representative of the North Sea and English Channel BDMPS due to none of the discrete geographic areas identified in Cook and Robinson (2010) for all five species providing appropriate representation of the whole North Sea population, as recommended by Natural England (OFF-ORN-2.42).

2.2.2.9 For kittiwake, the regional-specific productivity rate for the East region presented in Horswill and Robinson (2015) was selected to be the most representative of the North Sea BDMPS. The East region covers an extensive area of the North Sea, with the exception of the Shetlands, and includes colonies from Orkney to East England (Lowestoft). Kittiwake exhibit marked regional variation in demographic parameters (Frederiksen et al. 2005a; Mavor et al. 2008) which is evident when comparing regional-specific productivity rates;

productivity rates for the Shetland region (0.408) being half that of the East region (0.819) (Horswill and Robinson 2015). Some of the largest colony declines are in Shetland, which have been declining at an average rate of 16.0% per annum, whereas along the east coast of the UK, the average rate of decline is much slower at 2.3% (JNCC 2020). Sandeel abundance can be a major factor influencing kittiwake breeding success, with regional variability in sandeel recruitment attributed to variations in productivity rates between regions (Frederiksen et al. 2005b). This can be particularly pronounced between the Shetland region and East region as sandeel stock around Shetland depends on advection of larvae from the Orkney spawning grounds, which in some years is poor or fails (Frederiksen et al. 2005b). Therefore, productivity rates for the Shetland region are excluded as being unrepresentative of the North Sea region as a whole and the regional-specific productivity rate for the East region selected to be the most representative of the North Sea BDMPS.

Table 2: BDMPS population demographic parameters selected for all six species.

Species	Productivity Rate ± SD	Available Colony-Specific Survival Rate	Initial Population Size (all individuals)
Gannet	0.700 ± 0.082	National pre-formulated values	456,298
Kittiwake	0.819 ± 0.332	National pre-formulated values	829,937
Great black-backed gull	1.139 ± 0.533	National pre-formulated values for herring gull (see paragraph 2.2.2.4)	91,399
Guillemot	0.672 ± 0.147	National pre-formulated values	1,617,306
Razorbill	0.570 ± 0.247	National pre-formulated values	591,874
Puffin	0.617 ± 0.151	National pre-formulated values	260,726

3 Impacts Assessed

3.1 Collision Risk

3.1.1.1 There is potential of collision risk to birds as a result of operational activities associated with Hornsea Four and other projects. The risk to birds is through potential collision with WTGs and associated infrastructure from OWFs, resulting in injury or fatality. This may occur when birds fly through the OWFs whilst foraging for food, commuting between breeding sites and foraging areas, or during migration.

3.1.1.2 Following the results of the collision risk modelling (CRM) described in **Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling**, two species (gannet and kittiwake) were deemed to require further consideration of potential population level effects through the use of PVA. Although predicted collision risk totals for great black-backed gull were considered negligible from Hornsea Four, a precautionary approach has been taken and PVA has been considered for this species also as requested by Natural England.

3.1.1.3 The collision risk values for Hornsea Four alone are based on the multiple assessments presented in **Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling**. The

cumulative values for Hornsea Four in **Table 3**, **Table 5** and **Table 6** below are based on the Band Option 2, Cook et al. (2014) avoidance rates and mean density estimates for gannet and kittiwake, whilst for great black-backed gull the value is based on Band Option 3, Cook et al. (2014) avoidance rates and mean density estimates as calculated in **Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling**.

3.1.1.4 For cumulative assessments, the projects identified for inclusion are those defined as being within Tier 1 (sub-tiers 1a to 1d) and Tier 2, as described in Section **5.12** of **Volume A2, Chapter 5: Offshore and Intertidal Ornithology**. The approach taken to assessing cumulative collision risk is a quantitative one, drawing upon the published information produced by the respective project developers. Such published, quantitative information on predicted collisions is not available at an early stage in the development of a project. The result is that the cumulative collision risk assessment addresses projects in Tiers 1 and 2 but not Tier 3 or below, as these are projects that are at the pre-scoping and scoping stage where no data are currently available with respect to impact assessments.

3.1.1.5 The cumulative collision risk figures for gannet, great black-backed gull and kittiwake for other OWFs included for assessment presented below are based on the values submitted at Deadline XI for EA1N / EA2 (SPR 2021) which are the most up to date cumulative collision risk tables currently available. The following amendments were made to the values published at Deadline XI for EA1N / EA2 (SPR 2021) for assessments included within this report:

- Updated collision risk values for Hornsea Four;
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time Hornsea Four is predicted to be operational; and
- Inclusion of both the Applicant's and Natural England's final values for Hornsea Three as presented in (Orsted 2021).

3.2 Displacement

3.2.1.1 The presence of WTGs has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea where OWFs are located. This in effect represents indirect habitat loss, which would potentially reduce the area available to those seabirds to forage, loaf and / or moult that currently occur within and around OWFs and may be susceptible to displacement from such developments. Displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals. Cumulative displacement therefore has the potential to lead to effects on a wider scale.

3.2.1.2 Following the results of the displacement analysis described in **Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis**, four species (gannet, guillemot, razorbill and puffin) were deemed to require further consideration of potential population level effects through the use of PVA. The displacement impacts assessed for both Hornsea Four alone and cumulatively with other OWF projects follows a range-based approach as advised by Natural England (OFF-ORN-4.8), considering a displacement value of 60 – 80% displacement and 1% mortality for gannet, and 30 to 70% displacement and 1 to 10% mortality for the auk species, with the Applicant's position on auk displacement being 50% displacement and 1% mortality based on an evidence-led approach (rationale for auk displacement evidence-led approach provided in **Volume A2, Chapter 5: Offshore and**

Intertidal Ornithology). The extent of displacement assessed for all four species is the Hornsea Four array area and a 2 km buffer.

3.2.1.3 The projects identified for cumulative assessment are those defined as being within Tier 1 (sub-tiers 1a to 1d) and Tier 2, as described in Section 5.12 of Volume A2, Chapter 5: Offshore and Intertidal Ornithology. The cumulative abundance figures (to which the range of displacement and mortality rates are applied) for gannet, guillemot and razorbill presented below are based on the values submitted at Deadline XI for EA1N / EA2 (SPR 2021) which are the most up to date cumulative disturbance and displacement tables currently available. The following amendments were made to the values published at Deadline XI for EA1N / EA2 (Orsted 2021) for assessments included within this report:

- Updated displacement values for Hornsea Four; and
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time Hornsea Four is predicted to be operational.

3.2.1.4 The cumulative displacement abundance figures for puffin presented below are based on the values submitted at Deadline VIII for Norfolk Vanguard (MacArthur Green 2019), with the addition of Gunfleet Sands, Kentish Flats (and subsequent extension) Methil, Rampion and Scroby Sands at the request of Natural England (OFF-ORN-4.7 and 6.7). For the remaining projects (Norfolk Boreas, Hornsea Three, EA1N, EA2, Sheringham Shoal Extension and Dudgeon Extension projects) the totals were derived from the latest relevant submissions.

3.3 Gannet

3.3.1.1 The bio-season and annual collision risk and displacement mortality estimates for gannet are presented in Table 3 and Table 4. These data represent the potential cumulative displacement for gannet within the array area and a 2 km buffer for all OWFs identified for inclusion in this assessment.

Table 3: Cumulative bio-season and annual collision mortality estimates for gannet for all projects including Hornsea Four at EIA level.

Projects	Migration-Free Breeding	Post-Breeding Migration	Return Migration	Annual Total
Projects cumulatively up to Hornsea Three Applicant's value (all current consented projects)	1,735.9	748.7	306.8	2,790.4
Projects cumulatively up to Hornsea Three consented value (all current consented projects)	1,743.0	751.2	309.1	2,803.3
Norfolk Boreas	14.1	12.7	3.9	30.7
East Anglia ONE North	12.4	11.0	1.1	24.5
East Anglia TWO	12.5	23.1	4.0	39.6
Norfolk Vanguard	8.2	18.6	5.3	32.1
Dudgeon Extension Project	3.6	4.9	0.4	9.0
Sheringham Shoal Extension Project	0.3	1.4	0.0	1.8
Hornsea Four (Applicant's approach)	13.4	4.9	1.8	20.2

Projects	Migration-Free Breeding	Post-Breeding Migration	Return Migration	Annual Total
All Projects (Applicant's approach)	**1,800.4**	**825.4**	**323.3**	**2,948.2**
Hornsea Four (Natural England's approach)	16.1	7.1	2.8	25.9
All Projects (Natural England's approach)	**1,810.3**	**830.0**	**326.6**	**2,966.9**

Table 4: Cumulative bio-season and annual displacement mortality estimates for gannet for all projects including Hornsea Four at EIA level.

Projects	Season	Abundance	60% Disp, 1% Mort	80% Disp, 1% Mort
Projects cumulatively up to Hornsea Three (all current consented projects)	Migration-free Breeding	18,526	111.16	148.21
	Post-breeding migration	15,009	90.05	120.07
	Return Migration	3,812	22.87	30.50
	Annual Total	37,347	224.08	298.78
Norfolk Boreas	Breeding	1,229	7.4	9.8
	Post-breeding migration	1,723	10.3	13.8
	Return Migration	526	3.2	4.2
	Annual Total	3,478	20.9	27.8
EA1N	Breeding	149	0.9	1.2
	Post-breeding migration	468	2.8	3.7
	Return Migration	44	0.3	0.4
	Annual Total	661	4.0	5.3
EA2	Breeding	192	1.2	1.5
	Post-breeding migration	891	5.3	7.1
	Return Migration	192	1.2	1.5
	Annual Total	1,275	7.7	10.2
Norfolk Vanguard	Breeding	271	1.6	2.2
	Post-breeding migration	2,453	14.7	19.6
	Return Migration	437	2.6	3.5
	Annual Total	3,161	19.0	25.3
Dudgeon Extension Project	Breeding	361	2.2	2.9
	Post-breeding migration	343	2.1	2.7
	Return Migration	47	0.3	0.4
	Annual Total	751	4.5	6.0
Sheringham Shoal Extension Project	Breeding	40	0.2	0.3
	Post-breeding migration	295	1.8	2.4
	Return Migration	0	0.0	0.0
	Annual Total	335	2.0	2.7
Hornsea Four	Migration-free Breeding	791	4.7	6.3
	Post-breeding migration	854	5.1	6.8
	Return Migration	235	1.4	1.9
	Annual Total	1,880	11.3	15.0
All projects	**Migration-free Breeding**	**21,559**	**129.4**	**172.5**
	Post-breeding migration	**22,036**	**132.2**	**176.3**
	Return Migration	**5,293**	**31.8**	**42.3**
	Annual Total	**48,888**	**293.3**	**391.1**

3.3.1.2 The cumulative annual total collision and displacement mortality rates for Hornsea Four and all other projects is between 3,242 to 3,358, based on the combined annual displacement and collision mortality estimates presented in Table 3 and Table 4. These totals have been modelled using the Seabird PVA Tool and the results are presented in Table 10 to estimate the potential population level effects of such cumulative collision and displacement mortality rates.

3.4 Kittiwake

3.4.1.1 The bio-season and annual collision risk estimates for kittiwake are presented in Table 5.

Table 5: Cumulative bio-season and annual collision mortality estimates for kittiwake for all projects including Hornsea Four at EIA level.

Projects	Migration-Free Breeding	Post-Breeding Migration	Return Migration	Annual Total
Projects cumulatively up to Hornsea Three Applicant's value (all current consented projects)	1,101.2	1,437.1	1,138.0	3,675.3
Projects cumulatively up to Hornsea Three consented value (all current consented projects)	1,168.4	1,469.6	1,141.1	3,778.1
Norfolk Boreas	13.3	32.2	11.9	57.5
East Anglia ONE North	40.4	8.1	3.5	52.0
East Anglia TWO	29.5	5.4	7.4	42.3
Norfolk Vanguard	21.8	16.4	19.3	57.5
Dudgeon Extension Project	17.2	8.6	2.2	28.0
Sheringham Shoal Extension Project	0.9	1.9	0.0	2.8
Hornsea Four (Applicant's approach	29.8	38.4	25.1	93.3
All Projects (Applicant's approach)	**1,254.1**	**1,548.1**	**1,207.4**	**4,008.7**
Hornsea Four (Natural England's approach)	32.9	44.6	29.2	106.7
All Projects (Natural England's approach)	**1,324.4**	**1,586.7**	**1,214.6**	**4,124.8**

3.4.1.2 The cumulative annual total collisions for Hornsea Four and all other projects is between 4,009 to 4,125, as presented in Table 5. These totals have been modelled using the Seabird PVA Tool and the results are presented in Table 12 below to estimate the potential population level effects of such cumulative collision mortality rates.

3.5 Great black-backed gull

3.5.1.1 The bio-season and annual collision risk estimates for great black-backed gull are presented in Table 6.

Table 6: Cumulative bio-season and annual collision mortality estimates for great black-backed gull for all projects including Hornsea Four at EIA level.

Projects	Breeding	Non-breeding	Annual Total
Projects cumulatively up to Hornsea Three Applicant's value (all current consented projects)	155.6	699.7	855.3
Projects cumulatively up to Hornsea Three consented value (all current consented projects)	160.1	714.8	874.9
Norfolk Boreas	6.9	28.7	35.6
East Anglia ONE North	3.7	1.2	4.9
East Anglia TWO	3.5	3.4	6.9
Norfolk Vanguard	4.5	21.5	26.0
Dudgeon Extension Project	0.3	1.6	1.9
Sheringham Shoal Extension Project	0.0	5.3	5.3
Hornsea Four (Applicant's approach	0.3	4.0	4.3
All Projects (Applicant's approach)	**174.8**	**765.3**	**940.1**
Hornsea Four (Natural England's approach)	0.6	8.3	8.9
All Projects (Natural England's approach)	**179.6**	**784.7**	**964.3**

3.5.1.2 The cumulative annual total collisions for Hornsea Four and all other projects is between 940 to 964, as presented in Table 5. These totals have been modelled using the Seabird PVA Tool and the results are presented in Table 12 below to estimate the potential population level effects of such cumulative collision mortality rates.

3.6 Guillemot

3.6.1.1 The cumulative bio-season and total abundance estimates for guillemot within OWF array areas plus 2 km buffer are presented in Table 7.

Table 7: Cumulative bio-season and annual displacement estimates for guillemot from all projects including Hornsea Four at EIA level.

Projects	Season	Abundance	30% Disp, 1% Mort	50% Disp, 1% Mort	70% Disp, 10% Mort
Projects cumulatively up to Hornsea Three (all current consented projects)	Breeding Season	152,274	456.8	761.4	10,659.2
	Non-Breeding Season	148,758	446.3	743.8	10,413.1
	Annual	301,032	903.1	1,505.2	21,072.2
Norfolk Boreas	Breeding	7,767	23.3	38.8	543.7
	Non-breeding	13,777	41.3	68.9	964.4
	Annual	21,544	64.6	107.7	1,508.1
East Anglia ONE North	Breeding	4,183	12.5	20.9	292.8
	Non-breeding	1,888	5.7	9.4	132.2
	Annual	6,071	18.2	30.4	425.0
East Anglia TWO	Breeding	2,077	6.2	10.4	145.4
	Non-breeding	1,675	5.0	8.4	117.3
	Annual	3,752	11.3	18.8	262.6

Projects	Season	Abundance	30% Disp, 1% Mort	50% Disp, 1% Mort	70% Disp, 10% Mort
Norfolk Vanguard	Breeding	4,320	13.0	21.6	302.4
	Non-breeding	4,776	14.3	23.9	334.3
	Annual	9,096	27.3	45.5	636.7
Dudgeon Extension Project	Breeding	8,061	24.2	40.3	564.3
	Non-breeding	2,977	8.9	14.9	208.4
	Annual	11,038	33.1	55.2	772.7
Sheringham Shoal Extension Project	Breeding	610	1.8	3.1	42.7
	Non-breeding	599	1.8	3.0	41.9
	Annual	1,209	3.6	6.0	84.6
Hornsea Four	Breeding	8,550	25.7	42.8	598.5
	Non-breeding	17,062	51.2	85.3	1,194.3
	Annual	25,612	76.8	128.1	1,792.8
All Projects	**Breeding Season**	**187,842**	**563.5**	**939.2**	**13,148.9**
	Non-Breeding Season	**191,512**	**574.5**	**957.6**	**13,405.8**
	Annual	**379,354**	**1,138.1**	**1,896.8**	**26,554.8**

3.6.1.2 The cumulative total abundance of guillemot at risk of displacement within OWF areas plus 2 km buffer for all projects is 379,354, as presented in Table 7. These totals have been modelled using an evidence-led displacement rate of 50% and a 1% mortality rate, and a displacement rate of between 30% to 70% and mortality rate of between 1% to 10% as requested by Natural England (OFF-ORN-2.43). These increases in mortality have been modelled using the Seabird PVA Tool and the results are presented in Table 17 to estimate the potential population level effects of such cumulative displacement mortality rates.

3.7 Razorbill

3.7.1.1 The cumulative bio-season and total abundance estimates for razorbill within OWF array areas plus 2 km buffer are presented in Table 8.

Table 8: Cumulative bio-season and annual displacement estimates for razorbill from all projects including Hornsea Four at EIA level.

Projects	Season	Abundance	30% Disp, 1% Mort	50% Disp, 1% Mort	70% Disp, 10% Mort
Projects cumulatively up to Hornsea Three (all current consented projects)	Migration-free breeding	29,931	89.8	149.7	2,095.2
	Post-breeding Migration	33,842	101.5	169.2	2,368.9
	Non-migratory Wintering	22,001	66.0	110.0	1,540.1
	Return Migration	30,825	92.5	154.1	2,157.8
	Annual Total	116,597	349.8	583.0	8,161.8
Norfolk Boreas	Migration-free breeding	630	1.9	3.2	44.1
	Post-breeding Migration	263	0.8	1.3	18.4
	Non-migratory Wintering	1,065	3.2	5.3	74.6
	Return Migration	345	1.0	1.7	24.2
	Annual Total	2,303	6.9	11.5	161.2
EA1N	Migration-free breeding	403	1.2	2.0	28.2
	Post-breeding Migration	85	0.3	0.4	6.0

Projects	Season	Abundance	30% Disp, 1% Mort	50% Disp, 1% Mort	70% Disp, 10% Mort
	Non-migratory Wintering	54	0.2	0.3	3.8
	Return Migration	207	0.6	1.0	14.5
	Annual Total	749	2.2	3.7	52.4
EA2	Migration-free breeding	281	0.8	1.4	19.7
	Post-breeding Migration	44	0.1	0.2	3.1
	Non-migratory Wintering	136	0.4	0.7	9.5
	Return Migration	230	0.7	1.2	16.1
	Annual Total	692	2.1	3.5	48.4
Norfolk Vanguard	Migration-free breeding	879	2.6	4.4	61.5
	Post-breeding Migration	866	2.6	4.3	60.6
	Non-migratory Wintering	839	2.5	4.2	58.7
	Return Migration	924	2.8	4.6	64.7
	Annual Total	3,508	10.5	17.5	245.6
Dudgeon Extension Project	Migration-free breeding	824	2.5	4.1	57.7
	Post-breeding Migration	3,649	10.9	18.2	255.4
	Non-migratory Wintering	576	1.7	2.9	40.3
	Return Migration	272	0.8	1.4	19.0
	Annual Total	5,321	16.0	26.6	372.5
Sheringham Shoal Extension Project	Migration-free breeding	240	0.7	1.2	16.8
	Post-breeding Migration	646	1.9	3.2	45.2
	Non-migratory Wintering	590	1.8	3.0	41.3
	Return Migration	148	0.4	0.7	10.4
	Annual Total	1,624	4.9	8.1	113.7
Hornsea Four	Migration-free breeding	276	0.8	1.4	19.3
	Post-breeding Migration	3,590	10.8	18.0	251.3
	Non-migratory Wintering	474	1.4	2.4	33.2
	Return Migration	371	1.1	1.9	26.0
	Annual Total	4,711	14.1	23.6	329.8
All Projects	**Migration-free breeding**	**33,464**	**100.4**	**167.3**	**2,342.5**
	Post-breeding Migration	**42,985**	**129.0**	**214.9**	**3,009.0**
	Non-migratory Wintering	**25,735**	**77.2**	**128.7**	**1,801.5**
	Return Migration	**33,322**	**100.0**	**166.6**	**2,332.5**
	Annual Total	**135,505**	**406.5**	**677.5**	**9,485.3**

3.7.1.2 The cumulative total abundance of razorbills at risk of displacement within OWF areas plus 2 km buffer for all projects is 135,505 as presented in **Table 8**. These totals have been modelled using an evidence-led displacement rate of 50% and a 1% mortality rate, and a displacement rate of between 30% to 70% and mortality rate of between 1% to 10% as requested by Natural England (OFF-ORN-2.43). These estimated increases in mortality have been modelled using the Seabird PVA Tool and the results are presented in **Table 18** to estimate the potential population level effects of such cumulative displacement mortality rates.

3.8 Puffin

3.8.1.1 The cumulative bio-season and total abundance estimates for puffin within OWF array areas plus 2 km buffer are presented in Table 9.

Table 9: Cumulative bio-season and annual displacement estimates for puffin from all projects including Hornsea Four at EIA level.

Projects	Season	Abundance	30% Disp, 1% Mort	50% Disp, 1% Mort	70% Disp, 10% Mort
Projects in-combination up to Hornsea Three (all current consented projects)	Breeding	21,212	63.6	106.1	1,484.8
	Non-Breeding	23,055	69.2	115.3	1,613.9
	Annual total	44,267	132.8	221.3	3,098.7
Norfolk Boreas	Breeding	0	0.0	0.0	0.0
	Non-Breeding	23	0.1	0.1	1.6
	Annual total	23	0.1	0.1	1.6
EA1N	Breeding	0	0.0	0.0	0.0
	Non-Breeding	0	0.0	0.0	0.0
	Annual total	0	0.0	0.0	0.0
EA2	Breeding	15	0.0	0.1	1.0
	Non-Breeding	0	0.0	0.0	0.0
	Annual total	15	0.0	0.1	1.0
Norfolk Vanguard	Breeding	67	0.2	0.3	4.7
	Non-Breeding	112	0.3	0.6	7.8
	Annual total	179	0.5	0.9	12.5
Dudgeon Extension Project	Breeding	0	0.0	0.0	0.0
	Non-Breeding	17	0.0	0.1	1.2
	Annual total	17	0.0	0.1	1.2
Sheringham Shoal Extension Project	Breeding	0	0.0	0.0	0.0
	Non-Breeding	11	0.0	0.1	0.7
	Annual total	11	0.0	0.1	0.7
Hornsea Four	Breeding	153	0.5	0.8	10.7
	Non-Breeding	353	1.1	1.8	24.7
	Annual total	506	1.5	2.5	35.4
All Projects	**Breeding**	**21,446.6**	**64.3**	**107.2**	**1,501.3**
	Non-Breeding	**23,570.2**	**70.7**	**117.9**	**1,649.9**
	Annual total	**45,016.8**	**135.1**	**225.1**	**3,151.2**

3.8.1.2 The cumulative total abundance of puffins at risk of displacement within OWF areas plus 2km buffer for all projects is 45,017 as presented in Table 9. These totals have been modelled using an evidence-led displacement rate of 50% and a 1% mortality rate, and a displacement rate of between 30% to 70% and mortality rate of between 1% to 10% as requested by Natural England (OFF-ORN-2.43). These increases in mortality have been modelled using the Seabird PVA Tool and the results are presented in Table 20 to estimate the potential population level effects of such cumulative displacement mortality rates.

4 PVA Results

4.1 Introduction

4.1.1.1 The outputs of the Seabird PVA Tool are set out in Table 10 to Table 21 below for all six species. The metrics used to summarise the PVA results are based on the counterfactual of population growth calculated as the median of the ratio of the annual growth rate of the impacted to un-impacted population, expressed as a proportion.

4.2 Gannet

4.2.1 Hornsea Four alone

4.2.1.1 The results of the PVA runs for impacts from Hornsea Four alone on gannet at the biogeographic and North Sea and English Channel BDMPS are presented in Table 10 below.

Table 10: Gannet population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Predicted mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. Displacement 60% 1% mortality estimate	11.3	1.000	0.00%
	2. Displacement 80% 1% mortality estimate	15.0	1.000	0.00%
	3. Collision mortality estimate (Option 2 Cook et al. 2014, mean density values[1])	20.1	1.000	0.00%
	4. Collision mortality estimate (Option 2 Cook et al. 2014, max density estimate[1])	42.9	1.000	0.00%
	5. Collision mortality estimate (Option 2 Cook et al. 2014, min density estimate[1])	8.8	1.000	0.00%
	6. Collision mortality estimate (Option 2 Statutory Nature Conservation Body (SNCB), mean density estimate[2])	25.9	1.000	0.00%
	7. Combined collision and displacement mortality estimate (scenario 1+3)	31.4	1.000	0.00%
	8. Combined collision and displacement mortality estimate (scenario 2+3)	35.2	1.000	0.00%
BDMPS	1. Displacement 60% 1% mortality estimate	11.3	1.000	0.00%

[1] Based on the annual collision result values presented in Table 11 of Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling.
[2] Based on the annual collision result values presented in Table A2 of Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling.

Population Scale	Scenario	Predicted mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	2. Displacement 80% 1% mortality estimate	15.0	1.000	0.00%
	3. Collision mortality estimate (Option 2 Cook et al. 2014, mean density values[1])	20.1	1.000	0.00%
	4. Collision mortality estimate (Option 2 Cook et al. 2014, max density estimate[1])	42.9	1.000	0.01%
	5. Collision mortality estimate (Option 2 Cook et al. 2014, min density estimate[1])	8.8	1.000	0.00%
	6. Collision mortality estimate (Option 2 SNCB, mean density estimate[2])	25.9	1.000	0.01%
	7. Combined collision and displacement mortality estimate (scenario 1+3)	31.4	1.000	0.01%
	8. Combined collision and displacement mortality estimate (scenario 2+3)	35.2	1.000	0.01%

4.2.2 Hornsea Four cumulatively

4.2.2.1 The results of the PVA runs for gannet for impacts from Hornsea Four cumulatively with other OWFs are presented in **Table 11** below for both the biogeographic and North Sea BDMPS population scales.

Table 11: Gannet cumulative population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. Cumulative displacement 60% 1% mortality estimate	293.3	1.000	0.03%
	2. Cumulative displacement 80% 1% mortality estimate	391.1	1.000	0.04%
	3. Cumulative Collision mortality estimate (Applicant's approach for HOW03 + HOW04)	2,948.2	0.997	0.28%
	4. Cumulative collision mortality estimate (Applicant's approach for HOW04 only)	2,961.1	0.997	0.28%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	5. Cumulative collision mortality estimate (Natural England's Approach for HOW03 + HOW04)	2,966.9	0.997	0.28%
	6. Cumulative combined collision and displacement mortality estimate (scenario 1 + 3)	3,241.5	0.997	0.31%
	7. Cumulative combined collision and displacement mortality estimate (scenario 1 + 4)	3,254.5	0.997	0.31%
	8. Cumulative combined collision and displacement mortality estimate (scenario 1 + 5)	3,358.0	0.997	0.32%
	9. Cumulative combined collision and displacement mortality estimate (scenario 2 + 3)	3,339.3	0.997	0.32%
	10. Cumulative combined collision and displacement mortality estimate (scenario 2 + 4)	3,352.2	0.997	0.32%
	11. Cumulative combined collision and displacement mortality estimate (scenario 2 + 5)	3,358.0	0.997	0.34%
BDMPS	1. Cumulative displacement 60% 1% mortality estimate	293.3	0.999	0.07%
	2. Cumulative displacement 80% 1% mortality estimate	391.1	0.999	0.10%
	3. Cumulative Collision mortality estimate (Applicant's approach for HOW03 + HOW04)	2,948.2	0.992	0.73%
	4. Cumulative collision mortality estimate (Applicant's approach for HOW04 only)	2,961.1	0.992	0.73%
	5. Cumulative collision mortality estimate (Natural England's Approach for HOW03 + HOW04)	2,966.9	0.992	0.74%
	6. Cumulative combined collision and displacement mortality estimate (scenario 1 + 3)	3,241.5	0.992	0.80%
	7. Cumulative combined collision and displacement mortality estimate (scenario 1 + 4)	3,254.5	0.992	0.81%
	8. Cumulative combined collision and displacement mortality estimate (scenario 1 + 5)	3,358.0	0.991	0.83%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	9. Cumulative combined collision and displacement mortality estimate (scenario 2 + 3)	3,339.3	0.991	0.83%
	10. Cumulative combined collision and displacement mortality estimate (scenario 2 + 4)	3,352.2	0.991	0.83%
	11. Cumulative combined collision and displacement mortality estimate (scenario 2 + 5)	3,358.0	0.991	0.87%

4.3 Kittiwake

4.3.1 Hornsea Four alone

4.3.1.1 The results of the PVA runs for impacts from Hornsea Four alone on kittiwake at the biogeographic and North Sea BDMPS are presented in Table 12 below.

Table 12: Kittiwake population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. Collision mortality estimate (Option 2 Cook et al. 2014, mean density values[3])	93.3	1.000	0.00%
	2. Collision mortality estimate (Option 2 Cook et al. 2014, max density values[3])	208.9	1.000	0.00%
	3. Collision mortality estimate (Option 2 Cook et al. 2014, min density values[3])	27.2	1.000	0.00%
	4. Collision mortality estimate (Option 2 Bowgen & Cook 2018, mean density values[3])	84.8	1.000	0.00%
	5. Collision mortality estimate (Option 3 Bowgen & Cook 2018, mean density values[3])	23.8	1.000	0.00%
	6. Collision mortality estimate (Option 2 SNCB, mean density estimate[4])	106.7	1.000	0.00%
BDMPS	1. Collision mortality estimate (Option 2 Cook et al. 2014, mean density values[3])	93.3	1.000	0.01%

[3] Based on the annual collision result values presented in Table 12 of Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling.
[4] Based on the annual collision result values presented in Table A 3 of Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	2. Collision mortality estimate (Option 2 Cook et al. 2014, max density values[3])	208.9	1.000	0.03%
	3. Collision mortality estimate (Option 2 Cook et al. 2014, min density values[3])	27.2	1.000	0.00%
	4. Collision mortality estimate (Option 2 Bowgen & Cook 2018, mean density values[3])	84.8	1.000	0.01%
	5. Collision mortality estimate (Option 3 Bowgen & Cook 2018, mean density values[3])	23.8	1.000	0.00%
	6. Collision mortality estimate (Option 2 SNCB, mean density estimate[4])	106.7	1.000	0.02%

4.3.2 Hornsea Four cumulatively

4.3.2.1 The results of the PVA runs for kittiwake for impacts from Hornsea Four cumulatively with other OWFs are presented in Table 13 below for both the biogeographic and North Sea BDMPS population scales.

Table 13: Kittiwake cumulative population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. Cumulative Collision mortality estimate (Applicant's approach for HOW03 + HOW04)	4,008.7	0.999	0.10%
	2. Cumulative collision mortality estimate (Applicant's approach for HOW04 only)	4,111.4	0.999	0.10%
	3. Cumulative collision mortality estimate (Natural England's Approach for HOW03 + HOW04)	4,124.8	0.999	0.10%
BDMPS	1. Cumulative Collision mortality estimate (Applicant's approach for HOW03 + HOW04)	4,008.7	0.994	0.60%
	2. Cumulative collision mortality estimate (Applicant's approach for HOW04 only)	4,111.4	0.994	0.62%
	3. Cumulative collision mortality estimate (Natural England's Approach for HOW03 + HOW04)	4,124.8	0.994	0.62%

4.4 Great black-backed gull

4.4.1 Hornsea Four alone

4.4.1.1 The results of the PVA runs for impacts from Hornsea Four alone on great black-backed gull at the biogeographic and North Sea BDMPS population scales are presented in Table 14 below.

Table 14: Great black-backed gull population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. Collision mortality estimate (Option 2 Cook et al. 2014, mean density values[5])	7.2	1.000	0.00%
	2. Collision mortality estimate (Option 2 Cook et al. 2014, max density estimate[5])	31.8	1.000	0.02%
	3. Collision mortality estimate (Option 2 Cook et al. 2014, min density estimate[5])	0.2	1.000	0.00%
	4. Collision mortality estimate (Option 3 Cook et al. 2014, mean density values[5])	4.2	1.000	0.00%
	5. Collision mortality estimate (Option 3 Cook et al. 2014, max density estimate[5])	18.7	1.000	0.01%
	6. Collision mortality estimate (Option 3 Cook et al. 2014, min density estimate[5])	0.1	1.000	0.00%
	7. Collision mortality estimate (Option 3 Bowgen & Cook 2018, mean density values[5])	2.7	1.000	0.00%
	8. Collision mortality estimate (Option 2 SNCB, mean density estimate[6])	8.9	1.000	0.00%
BDMPS	1. Collision mortality estimate (Option 2 Cook et al. 2014, mean density values[5])	7.2	1.000	0.01%
	2. Collision mortality estimate (Option 2 Cook et al. 2014, max density estimate[5])	31.8	1.000	0.04%

[5] Based on the annual collision result values presented in Table 15 of Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling.
[6] Based on the annual collision result values presented in Table A 6 of Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	3. Collision mortality estimate (Option 2 Cook et al. 2014, min density estimate[5])	0.2	1.000	0.00%
	4. Collision mortality estimate (Option 3 Cook et al. 2014, mean density values[5])	4.2	1.000	0.01%
	5. Collision mortality estimate (Option 3 Cook et al. 2014, max density estimate[5])	18.7	1.000	0.03%
	6. Collision mortality estimate (Option 3 Cook et al. 2014, min density estimate[5])	0.1	1.000	0.00%
	7. Collision mortality estimate (Option 3 Bowgen & Cook 2018, mean density values[5])	2.7	1.000	0.01%
	8. Collision mortality estimate (Option 2 SNCB, mean density estimate[6])	8.9	0.999	0.08%

4.4.2 Hornsea Four cumulatively

4.4.2.1 The results of the PVA runs for great black-backed for impacts from Hornsea Four cumulatively with other OWFs are presented in Table 15 below for both the biogeographic and North Sea BDMPS population scales.

Table 15: Great black-backed gull cumulative population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. Cumulative Collision mortality estimate (Applicant's approach for HOW03 + HOW04)	940.1	0.995	0.48%
	2. Cumulative collision mortality estimate (Applicant's approach for HOW04 only)	959.7	0.995	0.49%
	3. Cumulative collision mortality estimate (Natural England's Approach for HOW03 + HOW04)	964.3	0.995	0.50%
BDMPS	1. Cumulative Collision mortality estimate (Applicant's approach for HOW03 + HOW04)	940.1	0.988	1.24%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	2. Cumulative collision mortality estimate (Applicant's approach for HOW04 only)	959.7	0.987	1.27%
	3. Cumulative collision mortality estimate (Natural England's Approach for HOW03 + HOW04)	964.3	0.987	1.27%

4.5 Guillemot

4.5.1 Hornsea Four alone

4.5.1.1 The results of the PVA runs for impacts from Hornsea Four alone on guillemot at the biogeographic and North Sea and English Channel BDMPS population scales are presented in Table 16 below.

Table 16: Guillemot population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. 30% displacement, 1% mortality estimate	76.8	1.000	0.00%
	2. 50% displacement, 1% mortality estimate	128.1	1.000	0.00%
	3. 60% displacement, 1% mortality estimate (Forth of Tay Consented Values)	153.7	1.000	0.00%
	4. 70% displacement, 1% mortality estimate	179.3	1.000	0.00%
	5. 30% displacement, 2% mortality estimate	153.7	1.000	0.00%
	6. 50% displacement, 2% mortality estimate	256.1	1.000	0.01%
	7. 70% displacement, 2% mortality estimate	358.6	1.000	0.01%
	8. 30% displacement, 5% mortality estimate	384.2	1.000	0.01%
	9. 50% displacement, 5% mortality estimate	640.4	1.000	0.02%
	10. 70% displacement, 5% mortality estimate	896.5	1.000	0.02%
	11. 30% displacement, 10% mortality estimate	768.4	1.000	0.02%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	12. 50% displacement, 10% mortality estimate	1,280.7	1.000	0.03%
	13. 70% displacement, 10% mortality estimate	1,793.0	1.000	0.05%
BDMPS	1. 30% displacement, 1% mortality estimate	76.8	1.000	0.01%
	2. 50% displacement, 1% mortality estimate	128.1	1.000	0.01%
	3. 60% displacement, 1% mortality estimate (Forth of Tay Consented Values)	153.7	1.000	0.01%
	4. 70% displacement, 1% mortality estimate	179.3	1.000	0.01%
	5. 30% displacement, 2% mortality estimate	153.7	1.000	0.01%
	6. 50% displacement, 2% mortality estimate	256.1	1.000	0.02%
	7. 70% displacement, 2% mortality estimate	358.6	1.000	0.02%
	8. 30% displacement, 5% mortality estimate	384.2	1.000	0.03%
	9. 50% displacement, 5% mortality estimate	640.4	1.000	0.04%
	10. 70% displacement, 5% mortality estimate	896.5	0.999	0.06%
	11. 30% displacement, 10% mortality estimate	768.4	0.999	0.05%
	12. 50% displacement, 10% mortality estimate	1,280.7	0.999	0.09%
	13. 70% displacement, 10% mortality estimate	1,793.0	0.999	0.12%

4.5.2 Hornsea Four cumulatively

4.5.2.1 The results of the PVA runs for guillemot for impacts from Hornsea Four cumulatively with other OWFs are presented in **Table 17** below for both the biogeographic and North Sea and English Channel BDMPS population scales.

Table 17: Guillemot cumulative population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. In-combination 30% displacement, 1% mortality estimate	1,138.1	1.000	0.03%
	2. In-combination 50% displacement, 1% mortality estimate	1,896.8	0.999	0.05%
	3. In-combination 70% displacement, 1% mortality estimate	2,655.5	0.999	0.07%
	4. In-combination 30% displacement, 2% mortality estimate	2,276.1	0.999	0.06%
	5. In-combination 50% displacement, 2% mortality estimate	3,793.5	0.999	0.10%
	6. In-combination 70% displacement, 2% mortality estimate	5,311.0	0.999	0.14%
	7. In-combination 30% displacement, 5% mortality estimate	5,690.3	0.998	0.16%
	8. In-combination 50% displacement, 5% mortality estimate	9,483.9	0.997	0.26%
	9. In-combination 70% displacement, 5% mortality estimate	13,277.4	0.996	0.36%
	10. In-combination 30% displacement, 10% mortality estimate	11,380.6	0.997	0.31%
	11. In-combination 50% displacement, 10% mortality estimate	18,967.7	0.995	0.52%
	12. In-combination 70% displacement, 10% mortality estimate	26,554.8	0.993	0.72%
BDMPS	1. In-combination 30% displacement, 1% mortality estimate	1,138.1	0.999	0.08%
	2. In-combination 50% displacement, 1% mortality estimate	1,896.8	0.999	0.13%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	3. In-combination 70% displacement, 1% mortality estimate	2,655.5	0.998	0.18%
	4. In-combination 30% displacement, 2% mortality estimate	2,276.1	0.998	0.16%
	5. In-combination 50% displacement, 2% mortality estimate	3,793.5	0.997	0.26%
	6. In-combination 70% displacement, 2% mortality estimate	5,311.0	0.996	0.37%
	7. In-combination 30% displacement, 5% mortality estimate	5,690.3	0.996	0.40%
	8. In-combination 50% displacement, 5% mortality estimate	9,483.9	0.993	0.66%
	9. In-combination 70% displacement, 5% mortality estimate	13,277.4	0.991	0.92%
	10. In-combination 30% displacement, 10% mortality estimate	11,380.6	0.992	0.79%
	11. In-combination 50% displacement, 10% mortality estimate	18,967.7	0.987	1.32%
	12. In-combination 70% displacement, 10% mortality estimate	26,554.8	0.982	1.85%

4.6 Razorbill

4.6.1 Hornsea Four alone

4.6.1.1 The results of the PVA runs for impacts from Hornsea Four alone on razorbill at the biogeographic and North Sea and English Channel BDMPS population scales are presented in Table 18 below.

Table 18: Razorbill population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. 30% displacement, 1% mortality estimate	14.1	1.000	0.00%
	2. 50% displacement, 1% mortality estimate	23.6	1.000	0.00%
	3. 60% displacement, 1% mortality estimate (Forth of Tay Consented Values)	28.3	1.000	0.00%
	4. 70% displacement, 1% mortality estimate	33.0	1.000	0.00%
	5. 30% displacement, 2% mortality estimate	28.3	1.000	0.00%
	6. 50% displacement, 2% mortality estimate	47.1	1.000	0.00%
	7. 70% displacement, 2% mortality estimate	66.0	1.000	0.00%
	8. 30% displacement, 5% mortality estimate	70.7	1.000	0.00%
	9. 50% displacement, 5% mortality estimate	117.8	1.000	0.01%
	10. 70% displacement, 5% mortality estimate	164.9	1.000	0.01%
	11. 30% displacement, 10% mortality estimate	141.3	1.000	0.01%
	12. 50% displacement, 10% mortality estimate	235.6	1.000	0.02%
	13. 70% displacement, 10% mortality estimate	329.8	1.000	0.02%
BDMPS	1. 30% displacement, 1% mortality estimate	14.1	1.000	0.00%
	2. 50% displacement, 1% mortality estimate	23.6	1.000	0.00%
	3. 60% displacement, 1% mortality estimate (Forth of Tay Consented Values)	28.3	1.000	0.01%
	4. 70% displacement, 1% mortality estimate	33.0	1.000	0.01%
	5. 30% displacement, 2% mortality estimate	28.3	1.000	0.01%
	6. 50% displacement, 2% mortality estimate	47.1	1.000	0.01%
	7. 70% displacement, 2% mortality estimate	66.0	1.000	0.01%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	8. 30% displacement, 5% mortality estimate	70.7	1.000	0.01%
	9. 50% displacement, 5% mortality estimate	117.8	1.000	0.02%
	10. 70% displacement, 5% mortality estimate	164.9	1.000	0.03%
	11. 30% displacement, 10% mortality estimate	141.3	1.000	0.03%
	12. 50% displacement, 10% mortality estimate	235.6	1.000	0.05%
	13. 70% displacement, 10% mortality estimate	329.8	0.999	0.07%

4.6.2 Hornsea Four cumulatively

4.6.2.1 The results of the PVA runs for razorbill for impacts from Hornsea Four cumulatively with other OWFs are presented in Table 19 below for both the biogeographic and North Sea and English Channel BDMPS population scales.

Table 19: Razorbill cumulative population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. In-combination 30% displacement, 1% mortality estimate	406.5	1.000	0.03%
	2. In-combination 50% displacement, 1% mortality estimate	677.5	1.000	0.05%
	3. In-combination 70% displacement, 1% mortality estimate	948.5	0.999	0.07%
	4. In-combination 30% displacement, 2% mortality estimate	813.0	0.999	0.06%
	5. In-combination 50% displacement, 2% mortality estimate	1,355.0	0.999	0.09%
	6. In-combination 70% displacement, 2% mortality estimate	1,897.1	0.999	0.13%
	7. In-combination 30% displacement, 5% mortality estimate	2,032.6	0.999	0.14%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	8. In-combination 50% displacement, 5% mortality estimate	3,387.6	0.998	0.23%
	9. In-combination 70% displacement, 5% mortality estimate	4,742.7	0.997	0.33%
	10. In-combination 30% displacement, 10% mortality estimate	4,065.1	0.997	0.28%
	11. In-combination 50% displacement, 10% mortality estimate	6,775.2	0.995	0.47%
	12. In-combination 70% displacement, 10% mortality estimate	9,485.3	0.993	0.66%
BDMPS	1. In-combination 30% displacement, 1% mortality estimate	406.5	0.999	0.08%
	2. In-combination 50% displacement, 1% mortality estimate	677.5	0.999	0.14%
	3. In-combination 70% displacement, 1% mortality estimate	948.5	0.998	0.19%
	4. In-combination 30% displacement, 2% mortality estimate	813.0	0.998	0.16%
	5. In-combination 50% displacement, 2% mortality estimate	1,355.0	0.997	0.27%
	6. In-combination 70% displacement, 2% mortality estimate	1,897.1	0.996	0.38%
	7. In-combination 30% displacement, 5% mortality estimate	2,032.6	0.996	0.41%
	8. In-combination 50% displacement, 5% mortality estimate	3,387.6	0.993	0.68%
	9. In-combination 70% displacement, 5% mortality estimate	4,742.7	0.991	0.95%
	10. In-combination 30% displacement, 10% mortality estimate	4,065.1	0.992	0.81%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	11. In-combination 50% displacement, 10% mortality estimate	6,775.2	0.986	1.35%
	12. In-combination 70% displacement, 10% mortality estimate	9,485.3	0.981	1.90%

4.7 Puffin

4.7.1 Hornsea Four alone

4.7.1.1 The results of the PVA runs for impacts from Hornsea Four alone on puffin at the biogeographic and North Sea and English Channel BDMPS population scales are presented in Table 20 below.

Table 20: Puffin population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. 30% displacement, 1% mortality estimate	1.5	No discernible increase in baseline mortality	0.00%
	2. 50% displacement, 1% mortality estimate	2.5	No discernible increase in baseline mortality	0.00%
	3. 60% displacement, 1% mortality estimate (Forth of Tay Consented Values)	3.0	No discernible increase in baseline mortality	0.00%
	4. 70% displacement, 1% mortality estimate	3.5	No discernible increase in baseline mortality	0.00%
	5. 30% displacement, 2% mortality estimate	3.0	No discernible increase in baseline mortality	0.00%
	6. 50% displacement, 2% mortality estimate	5.1	1.000	0.00%
	7. 70% displacement, 2% mortality estimate	7.1	1.000	0.00%
	8. 30% displacement, 5% mortality estimate	7.6	1.000	0.00%
	9. 50% displacement, 5% mortality estimate	12.7	1.000	0.00%
	10. 70% displacement, 5% mortality estimate	17.7	1.000	0.00%
	11. 30% displacement, 10% mortality estimate	15.2	1.000	0.00%
	12. 50% displacement, 10% mortality estimate	25.3	1.000	0.00%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	13. 70% displacement, 10% mortality estimate	35.4	1.000	0.00%
BDMPS	1. 30% displacement, 1% mortality estimate	1.5	1.000	0.00%
	2. 50% displacement, 1% mortality estimate	2.5	1.000	0.00%
	3. 60% displacement, 1% mortality estimate (Forth of Tay Consented Values)	3.0	1.000	0.00%
	4. 70% displacement, 1% mortality estimate	3.5	1.000	0.00%
	5. 30% displacement, 2% mortality estimate	3.0	1.000	0.00%
	6. 50% displacement, 2% mortality estimate	5.1	1.000	0.00%
	7. 70% displacement, 2% mortality estimate	7.1	1.000	0.00%
	8. 30% displacement, 5% mortality estimate	7.6	1.000	0.00%
	9. 50% displacement, 5% mortality estimate	12.7	1.000	0.01%
	10. 70% displacement, 5% mortality estimate	17.7	1.000	0.01%
	11. 30% displacement, 10% mortality estimate	15.2	1.000	0.01%
	12. 50% displacement, 10% mortality estimate	25.3	1.000	0.01%
	13. 70% displacement, 10% mortality estimate	35.4	1.000	0.02%

4.7.2 Hornsea Four cumulatively

4.7.2.1 The results of the PVA runs for puffin for impacts from Hornsea Four cumulatively with other OWFs are presented in Table 21 below for both the biogeographic and North Sea and English Channel BDMPS population scales.

Table 21: Puffin cumulative population modelling results using the Seabird PVA Tool.

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
Biogeographic	1. In-combination 30% displacement, 1% mortality estimate	135.1	1.000	0.00%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	2. In-combination 50% displacement, 1% mortality estimate	225.1	1.000	0.00%
	3. In-combination 70% displacement, 1% mortality estimate	315.1	1.000	0.00%
	4. In-combination 30% displacement, 2% mortality estimate	270.1	1.000	0.00%
	5. In-combination 50% displacement, 2% mortality estimate	450.2	1.000	0.00%
	6. In-combination 70% displacement, 2% mortality estimate	630.2	1.000	0.01%
	7. In-combination 30% displacement, 5% mortality estimate	675.3	1.000	0.01%
	8. In-combination 50% displacement, 5% mortality estimate	1,125.4	1.000	0.01%
	9. In-combination 70% displacement, 5% mortality estimate	1,575.6	1.000	0.02%
	10. In-combination 30% displacement, 10% mortality estimate	1,350.5	1.000	0.01%
	11. In-combination 50% displacement, 10% mortality estimate	2,250.8	1.000	0.02%
	12. In-combination 70% displacement, 10% mortality estimate	3,151.2	1.000	0.03%
BDMPS	1. In-combination 30% displacement, 1% mortality estimate	135.1	0.999	0.07%
	2. In-combination 50% displacement, 1% mortality estimate	225.1	0.999	0.11%
	3. In-combination 70% displacement, 1% mortality estimate	315.1	0.998	0.16%
	4. In-combination 30% displacement, 2% mortality estimate	270.1	0.999	0.14%

Population Scale	Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (After 35 Years)	Reduction in growth rate (per annum)
	5. In-combination 50% displacement, 2% mortality estimate	450.2	0.998	0.23%
	6. In-combination 70% displacement, 2% mortality estimate	630.2	0.997	0.32%
	7. In-combination 30% displacement, 5% mortality estimate	675.3	0.997	0.34%
	8. In-combination 50% displacement, 5% mortality estimate	1,125.4	0.994	0.57%
	9. In-combination 70% displacement, 5% mortality estimate	1,575.6	0.992	0.80%
	10. In-combination 30% displacement, 10% mortality estimate	1,350.5	0.993	0.69%
	11. In-combination 50% displacement, 10% mortality estimate	2,250.8	0.989	1.15%
	12. In-combination 70% displacement, 10% mortality estimate	3,151.2	0.984	1.61%

5 References

Begon, M., Townsend, C. R. and Harper John L. (2005) Ecology: From Individuals to Ecosystems. 4th Edition. Hoboken, New Jersey, USA: Wiley-Blackwell.

Caswell, H. (2000). Matrix Population Models. Sinauer Associates Inc., Sunderland.

Cook, A.S.C.P. & Robinson, R.A. (2010). How Representative Is the Current Monitoring of Breeding Seabirds in the UK. BTO, Thetford.

Cook, A.S.C.P., Humphries, E.M., Masden, E.A. Burton, N.H.K. (2014) The avoidance rates of collision between birds and offshore turbines. BTO Research Report No 656 to Marine Scotland Science.

Frederiksen, M., Harris, M. P. and Wanless, S. (2005a). Inter-Population Variation in Demographic Parameters: A Neglected Subject? Oikos Vol. 111, No. 2 (2005), pp. 209-214.

Frederiksen, M., Wright, P. J., Harris, M. P., Mavor, R. A, Heubeck, M. and Wanless, S. (2005b). Regional patterns of Kittiwake Rissa tridactyla breeding success are related to variability in sandeel recruitment. Marine Ecology Progress Series. 300. 201-211.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters; Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

Glutz von Blotzheim, U.N. & Bauer, K.M. (1982) Handbuchder Vögel Mitteleuropas. Band 8. Charadriiformes (3. Teil).Akademische Verlagsgesellschaft, Wiesbaden, Germany.

Horswill, C. & Robinson R. A. (2015). Review of seabird demographic rates and density dependence. JNCC Report No. 552. Joint Nature Conservation Committee, Peterborough.

JNCC, (2020), Seabird Population Trends and Causes of Change: 1986-2018 Report (https://jncc.gov.uk/our-work/smp-report-1986-2018) Joint Nature Conservation Committee. Updated 10 March 2020.

MacArthur Green (2019). Norfolk Vanguard Offshore Wind Farm Offshore Ornithology Auk Displacement Assessment Update for Deadline 8. Document Reference: ExA; AS; 10.D8.10

Mavor, R.A., Heubeck, M., Schmitt, S. and Parsons, M. (2008). Seabird numbers and breeding success in Britain and Ireland, 2006. Peterborough, Joint Nature Conservation Committee. (UK Nature Conservation, No. 31.).

Mobbs, D., Searle, K., Daunt, F. & Butler, A. (2020). A Population Viability Analysis Modelling Tool for Seabird Species: Guide for using the PVA tool (v2.0) user interface. Available at: https://github.com/naturalengland/Seabird_PVA_Tool/blob/master/Documentation/PVA_Tool_UI_Guidance.pdf (Downloaded: 11 June 2020).

Ørsted (2021). Hornsea Three Calculation of effect estimates.

Ridge, K., Jones, C., Jones, G. & Kean, G. (2019). Norfolk Vanguard Offshore Wind Farm Examing Authority's Report of Findings and Conclusions and Recommendations to the Secretary of State for Business, Energy and Industrial Strategy.

Scottish Power Renewables (2021). East Anglia Two and East Anglia One North Offshore Windfarms Deadline 11 Offshore Ornithology Cumulative and In-Combination Collision Risk and Displacement Update. [Online] Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010077/EN010077-005243-ExA.AS-3.D11.V1%20EA1N&EA2%20D11%20Offshore%20Ornithology%20Cumulative%20and%20In%20Combination%20Collision%20Risk%20and%20Displacement%20Update.pdf

SMP (2020). JNCC UK Seabird Monitoring Programme. https://jncc.gov.uk/news/smp-database-launch/ and https://app.bto.org/seabirds/public/index.jsp

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

WWT Consulting (2012). SOSS-04 Gannet Population Viability Analysis: Developing guidelines on the use of Population Viability Analysis for investigating bird impacts due to offshore wind farms. Report to The Crown Estate.

Appendix A : Seabird PVA Tool Input Log

Hornsea Four alone gannet biogeographic

Set up

The log file was created on: 2021-05-17 15:10:05 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

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: 8316.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Northern Gannet.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1180000 in 2022
Productivity rate per pair: mean: 0.7 , sd: 0.082
Adult survival rate: mean: 0.919 , sd: 0.042
Immatures survival rates:
Age class 0 to 1 - mean: 0.424 , sd: 0.045 , DD: NA
Age class 1 to 2 - mean: 0.829 , sd: 0.026 , DD: NA

Age class 2 to 3 - mean: 0.891 , sd: 0.019 , DD: NA
Age class 3 to 4 - mean: 0.895 , sd: 0.019 , DD: NA
Age class 4 to 5 - mean: 0.919 , sd: 0.042 , DD: NA

Impacts

Number of impact scenarios: 8.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2e-05 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3e-05 , se: NA

Scenario 8

All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3e-05 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively gannet biogeographic

Set up

The log file was created on: 2021-06-14 14:32:26 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

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: 7445.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Northern Gannet.
Region type to use for breeding success data: .
Available colony-specific survival rate: . Sector to use within breeding success region: .
Age at first breeding: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1180000 in 2022
Productivity rate per pair: mean: 0.7 , sd: 0.082
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

Impacts

Number of impact scenarios: 10.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00025 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00033 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.0025 , se: NA

Scenario 4 & 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00251 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00275 , se: NA

Scenario F - Name: 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00276 , se: NA

Scenario G - Name: 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00285 , se: NA

Scenario H - Name: 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00283 , se: NA

Scenario I - Name: 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00284 , se: NA

Scenario J - Name: 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00285 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone gannet BDMPS

Set up

The log file was created on: 2021-05-18 07:25:06 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

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: 2548.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Northern Gannet.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 456298 in 2022
Productivity rate per pair: mean: 0.7 , sd: 0.082
Adult survival rate: mean: 0.919 , sd: 0.042
Immatures survival rates:
Age class 0 to 1 - mean: 0.424 , sd: 0.045 , DD: NA
Age class 1 to 2 - mean: 0.829 , sd: 0.026 , DD: NA
Age class 2 to 3 - mean: 0.891 , sd: 0.019 , DD: NA
Age class 3 to 4 - mean: 0.895 , sd: 0.019 , DD: NA

Age class 4 to 5 - mean: 0.919 , sd: 0.042 , DD: NA

Impacts

Number of impact scenarios: 8.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 9e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 6e-05 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 7e-05 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 8e-05 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively gannet BDMPS

Set up

The log file was created on: 2021-06-15 12:27:10 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

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: 4596.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Northern Gannet.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 456298 in 2022
Productivity rate per pair: mean: 0.7 , sd: 0.082
Adult survival rate: mean: 0.919 , sd: 0.042
Immatures survival rates:
Age class 0 to 1 - mean: 0.424 , sd: 0.045 , DD: NA
Age class 1 to 2 - mean: 0.829 , sd: 0.026 , DD: NA
Age class 2 to 3 - mean: 0.891 , sd: 0.019 , DD: NA
Age class 3 to 4 - mean: 0.895 , sd: 0.019 , DD: NA

Age class 4 to 5 - mean: 0.919 , sd: 0.042 , DD: NA

Impacts

Number of impact scenarios: 11.
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: 2023 to 2058

Impact on Demographic Rates

Scenario - Name: 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000643 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000857 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.006461 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.006489 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.006502 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.007104 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.007132 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.007359 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.007318 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.007347 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.007359 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone kittiwake biogeographic

Set up

The log file was created on: 2021-05-18 08:11:24 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

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: 5502.
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 2022
Productivity rate per pair: mean: 0.69 , sd: 0.296
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0 , 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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.8e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4.1e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 5e-06 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.7e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 5e-06 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2.1e-05 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively kittiwake biogeographic

Set up

The log file was created on: 2021-06-14 14:57:52 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

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: 7445.
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 2022
Productivity rate per pair: mean: 0.69 , sd: 0.296
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0 , 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: 3.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000786 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000806 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000809 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone kittiwake BDMPS

Set up

The log file was created on: 2021-05-18 08:24:53 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

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: 4670.
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 2022
Productivity rate per pair: mean: 0.819 , sd: 0.332
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0 , 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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000112 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000252 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.3e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000102 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2.9e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000129 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively kittiwake BDMPS

Set up

The log file was created on: 2021-06-14 15:03:35 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 "KI BDMPS 1-10".
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: 7445.
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 2022
Productivity rate per pair: mean: 0.69 , sd: 0.296
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0 , 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: 3.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00483 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.004954 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00497 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone great black-backed gull biogeographic

Set up

The log file was created on: 2021-05-18 10:53:02 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

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: 747.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Great Black-Backed Gull.
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: 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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 235000 in 2022
Productivity rate per pair: mean: 1.139 , sd: 0.533
Adult survival rate: mean: 0.834 , sd: 0.034
Immatures survival rates:
Age class 0 to 1 - mean: 0.798 , sd: 0.092 , DD: NA
Age class 1 to 2 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 2 to 3 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 3 to 4 - mean: 0.834 , sd: 0.034 , DD: NA

Age class 4 to 5 - mean: 0.834 , sd: 0.034 , DD: NA

Impacts

Number of impact scenarios: 8.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.1e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000135 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1e-06 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.8e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 8e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.1e-05 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 3.8e-05 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively great black-backed gull biogeographic

Set up

The log file was created on: 2021-06-14 15:20:31 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

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: 7445.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Great Black-Backed Gull.
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: 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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 235000 in 2022
Productivity rate per pair: mean: 1.139 , sd: 0.533
Adult survival rate: mean: 0.834 , sd: 0.034
Immatures survival rates:
Age class 0 to 1 - mean: 0.798 , sd: 0.092 , DD: NA
Age class 1 to 2 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 2 to 3 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 3 to 4 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 4 to 5 - mean: 0.834 , sd: 0.034 , DD: NA

Impacts

Number of impact scenarios: 3.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.004 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.004084 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.004103 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone great black-backed gull BDMPS

Set up

The log file was created on: 2021-05-19 07:25:42 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

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: 9115.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Great Black-Backed Gull.
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: 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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 91399 in 2022
Productivity rate per pair: mean: 1.139 , sd: 0.533
Adult survival rate: mean: 0.834 , sd: 0.034
Immatures survival rates:
Age class 0 to 1 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 1 to 2 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 2 to 3 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 3 to 4 - mean: 0.834 , sd: 0.034 , DD: NA

Age class 4 to 5 - mean: 0.798 , sd: 0.092 , DD: NA

Impacts

Number of impact scenarios: 8.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 7.9e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000347 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2e-06 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4.6e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000205 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1e-06 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3e-05 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 9.7e-05 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively great black-backed gull BDMPS

Set up

The log file was created on: 2021-06-14 15:27:05 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

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: 7445.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Great Black-Backed Gull.
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: 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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 91399 in 2022
Productivity rate per pair: mean: 1.139 , sd: 0.533
Adult survival rate: mean: 0.834 , sd: 0.034
Immatures survival rates:
Age class 0 to 1 - mean: 0.798 , sd: 0.092 , DD: NA
Age class 1 to 2 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 2 to 3 - mean: 0.834 , sd: 0.034 , DD: NA
Age class 3 to 4 - mean: 0.834 , sd: 0.034 , DD: NA

Age class 4 to 5 - mean: 0.834 , sd: 0.034 , DD: NA

Impacts

Number of impact scenarios: 3.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.010285 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.0105 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.01055 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone guillemot biogeographic

Set up

The log file was created on: 2021-05-18 11:31:00 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

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: 3871.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 4125000 in 2022
Productivity rate per pair: mean: 0.672 , sd: 0.147
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: 13.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.9e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.1e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.7e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4.3e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.7e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 6.2e-05 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 8.7e-05 , se: NA

Scenario 8
All subpopulations

Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 9.3e-05 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000155 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000217 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000186 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00031 , se: NA

Scenario 13
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000435 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively guillemot biogeographic

Set up

The log file was created on: 2021-06-14 13:05:12 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

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: 7445.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 4125000 in 2022
Productivity rate per pair: mean: 0.672 , sd: 0.147
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: 12.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000276 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00046 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000644 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000552 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00092 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001288 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001379 , se: NA

Scenario 8
All subpopulations

Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002299 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.003219 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002759 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.004598 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.006438 , se: NA
Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone guillemot BDMPS

Set up

The log file was created on: 2021-05-18 12:45:00 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

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: 5418.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1617306 in 2022
Productivity rate per pair: mean: 0.672 , sd: 0.147
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: 13.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4.8e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 7.9e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 9.5e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000111 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 9.5e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000158 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000222 , se: NA

Scenario 8
All subpopulations

Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000238 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000396 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000554 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000475 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000792 , se: NA

Scenario 13
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001109 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively guillemot BDMPS

Set up

The log file was created on: 2021-06-14 13:48:14 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

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: 7445.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.
Population 1
Initial population values: Initial population 1617306 in 2022
Productivity rate per pair: mean: 0.672 , sd: 0.147
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: 12.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000704 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001173 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001642 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001407 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002346 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.003284 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.003518 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005864 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00821 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.007037 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.011728 , se: NA
Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.016419 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone razorbill biogeographic

Set up

The log file was created on: 2021-05-18 14:10:48 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

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: 9654.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Razorbill.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1707000 in 2022
Productivity rate per pair: mean: 0.57 , sd: 0.247
Adult survival rate: mean: 0.895 , sd: 0.067
Immatures survival rates:
Age class 0 to 1 - mean: 0.63 , sd: 0.209 , DD: NA
Age class 1 to 2 - mean: 0.63 , sd: 0.209 , DD: NA
Age class 2 to 3 - mean: 0.895 , sd: 0.067 , DD: NA
Age class 3 to 4 - mean: 0.895 , sd: 0.067 , DD: NA

Age class 4 to 5 - mean: 0.895 , sd: 0.067 , DD: NA

Impacts

Number of impact scenarios: 13.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 8e-06 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.4e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.7e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.9e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.7e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2.8e-05 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.9e-05 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 4.1e-05 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 6.9e-05 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 9.7e-05 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 8.3e-05 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000138 , se: NA

Scenario 13
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000193 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively razorbill biogeographic

Set up

The log file was created on: 2021-06-15 07:26:52 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

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: 5028.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Razorbill.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1707000 in 2022
Productivity rate per pair: mean: 0.57 , sd: 0.247
Adult survival rate: mean: 0.895 , sd: 0.067
Immatures survival rates:
Age class 0 to 1 - mean: 0.63 , sd: 0.209 , DD: NA
Age class 1 to 2 - mean: 0.63 , sd: 0.209 , DD: NA
Age class 2 to 3 - mean: 0.895 , sd: 0.067 , DD: NA
Age class 3 to 4 - mean: 0.895 , sd: 0.067 , DD: NA

Age class 4 to 5 - mean: 0.895 , sd: 0.067 , DD: NA

Impacts

Number of impact scenarios: 12.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000238 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000397 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000556 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000476 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000794 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001111 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001191 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001985 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002778 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002381 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.003969 , se: NA
Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.005557 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone razorbill BDMPS

Set up

The log file was created on: 2021-05-18 14:31:29 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

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: 714.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Razorbill.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 591874 in 2022
Productivity rate per pair: mean: 0.57 , sd: 0.247
Adult survival rate: mean: 0.895 , sd: 0.067
Immatures survival rates:
Age class 0 to 1 - mean: 0.63 , sd: 0.209 , DD: NA
Age class 1 to 2 - mean: 0.63 , sd: 0.209 , DD: NA
Age class 2 to 3 - mean: 0.895 , sd: 0.067 , DD: NA
Age class 3 to 4 - mean: 0.895 , sd: 0.067 , DD: NA

Age class 4 to 5 - mean: 0.895 , sd: 0.067 , DD: NA

Impacts

Number of impact scenarios: 13.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2.4e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4.8e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 5.6e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 4.8e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 8e-05 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000111 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000119 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000199 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000279 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000239 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000398 , se: NA

Scenario 13
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000557 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively razorbill BDMPS

Set up

The log file was created on: 2021-06-15 07:46:56 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

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: 5028.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Razorbill.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 591874 in 2022
Productivity rate per pair: mean: 0.57 , sd: 0.247
Adult survival rate: mean: 0.895 , sd: 0.067
Immatures survival rates:
Age class 0 to 1 - mean: 0.63 , sd: 0.209 , DD: NA
Age class 1 to 2 - mean: 0.63 , sd: 0.209 , DD: NA
Age class 2 to 3 - mean: 0.895 , sd: 0.067 , DD: NA
Age class 3 to 4 - mean: 0.895 , sd: 0.067 , DD: NA

Age class 4 to 5 - mean: 0.895 , sd: 0.067 , DD: NA

Impacts

Number of impact scenarios: 12.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000687 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001145 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001603 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001374 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002289 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.003205 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.003434 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005724 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.008013 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.006868 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.011447 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.016026 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone puffin biogeographic

Set up

The log file was created on: 2021-07-09 14:16:59 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

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: 4085.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Atlantic Puffin.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 11840000 in 2022
Productivity rate per pair: mean: 0.617 , sd: 0.151
Adult survival rate: mean: 0.907 , sd: 0.083
Immatures survival rates:
Age class 0 to 1 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 1 to 2 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 2 to 3 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 3 to 4 - mean: 0.76 , sd: 0.093 , DD: NA

Age class 4 to 5 - mean: 0.805 , sd: 0.083 , DD: NA

Impacts

Number of impact scenarios: 3.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 7, 8, 9, 10 and 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1e-06 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2e-06 , se: NA

Scenario 13
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3e-06 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively puffin biogeographic

Set up

The log file was created on: 2021-06-15 08:12:29 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

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: 5028.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Atlantic Puffin.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 11840000 in 2022
Productivity rate per pair: mean: 0.617 , sd: 0.151
Adult survival rate: mean: 0.907 , sd: 0.083
Immatures survival rates:
Age class 0 to 1 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 1 to 2 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 2 to 3 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 3 to 4 - mean: 0.76 , sd: 0.093 , DD: NA

Age class 4 to 5 - mean: 0.805 , sd: 0.083 , DD: NA

Impacts

Number of impact scenarios: 12.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.1e-05 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.9e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2.7e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2.3e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.8e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 5.3e-05 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 5.7e-05 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 9.5e-05 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000133 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000114 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00019 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000266 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four alone puffin BDMPS

Set up

The log file was created on: 2021-05-19 07:44:22 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 "PU EIA Alone BDMPS".
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: 7307.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Atlantic Puffin.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 231957 in 2022
Productivity rate per pair: mean: 0.617 , sd: 0.151
Adult survival rate: mean: 0.907 , sd: 0.083
Immatures survival rates:
Age class 0 to 1 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 1 to 2 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 2 to 3 - mean: 0.709 , sd: 0.108 , DD: NA

Age class 3 to 4 - mean: 0.76 , sd: 0.093 , DD: NA
Age class 4 to 5 - mean: 0.805 , sd: 0.083 , DD: NA

Impacts

Number of impact scenarios: 13.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 7e-06 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.1e-05 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.3e-05 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.5e-05 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 1.3e-05 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 2.2e-05 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.1e-05 , se: NA

Scenario 8
All subpopulations

Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 3.3e-05 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 5.5e-05 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 7.6e-05 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 6.5e-05 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000109 , se: NA

Scenario 13
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000153 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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

Hornsea Four cumulatively puffin BDMPS

Set up

The log file was created on: 2021-06-15 08:35:56 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

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: 5028.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Atlantic Puffin.
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: 5.
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: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 231957 in 2022
Productivity rate per pair: mean: 0.617 , sd: 0.151
Adult survival rate: mean: 0.907 , sd: 0.083
Immatures survival rates:
Age class 0 to 1 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 1 to 2 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 2 to 3 - mean: 0.709 , sd: 0.108 , DD: NA
Age class 3 to 4 - mean: 0.76 , sd: 0.093 , DD: NA

Age class 4 to 5 - mean: 0.805 , sd: 0.083 , DD: NA

Impacts

Number of impact scenarios: 12.
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: 2023 to 2058

Impact on Demographic Rates

Scenario 1
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.000582 , se: NA

Scenario 2
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00097 , se: NA

Scenario 3
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001359 , se: NA

Scenario 4
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001164 , se: NA

Scenario 5
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.001941 , se: NA

Scenario 6
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002717 , se: NA

Scenario 7
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.002911 , se: NA

Scenario 8
All subpopulations
Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004852 , se: NA

Scenario 9
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.006793 , se: NA

Scenario 10
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.005822 , se: NA

Scenario 11
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.009704 , se: NA

Scenario 12
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.013585 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2058
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