GREEN VOLT

Technical Appendix 12.6

Offshore Ornithology Population Viability Analysis

Offshore EIA Report: Volume 2

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Green Volt Offshore Wind Farm

Appendix 12.6 Offshore Ornithology: Population Viability Analysis

Green Volt Offshore Wind Ltd.

APEM Ref: P00008351

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1.0	18/11/22	All	All	APEM first draft	RC

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1. Introduction

1.1 Purpose of this report

This report has been produced for the purpose of describing the methods and presenting the results of population viability analysis (PVA) run for selected species requiring further assessment, which form part of the Environmental Impact Assessment report (EIAR) for the proposed Green Volt offshore wind farm.

1.2 Project Background

Green Volt Offshore Wind Limited (‘the Applicant’) is proposing to develop the Green Volt Offshore Wind Farm (OWF) (from here on referred to as ‘Green Volt’) as a proposed floating offshore wind farm. The proposed site is approximately 75 km northeast of the Aberdeenshire coast in the northern North Sea, Scotland. The proposed array area covers an area of approximately 117 km^2, whilst the survey area included a 4 km buffer surrounding the array area provides a total study area of approximately 391 km^2. Green Volt will comprise both offshore and onshore infrastructure, including an offshore generating station (the wind farm), export cables to the Buzzard platform and landfall and an onshore transmission infrastructure for connection to the electricity network (please see **Chapter 5: Project Description** for full details on the Project Design).

APEM Ltd (hereafter APEM) was commissioned by the Applicant to undertake a study of offshore ornithology that characterises the area that may be influenced by Green Volt. A separate report (**Appendix: 12.1 Offshore and intertidal ornithology baseline technical report**) provides the findings from offshore and intertidal ornithology data to determine the receptors that characterise the baseline and are of relevance to the assessment of potential impacts from Green Volt. This technical appendix has been produced to support **Chapter 12: Offshore and Intertidal Ornithology**.

The consideration of offshore ornithology for Green Volt has been discussed with consultees through the Green Volt Ornithology Working Group meetings; of which NatureScot, Marine Scotland Science (MSS), Marine Scotland Licensing Operations Team (MS-LOT) and the Royal Society for the Protection of Birds (RSPB) are in attendance. Agreements made with consultees within the Green Volt Stakeholder Ornithology meeting process are set out in the consultation table within the **Chapter 12: Offshore and Intertidal Ornithology**.

1.3 Population Viability Analysis

Renewable energy projects in the marine environment, such as 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 and have the potential to affect the productivity or elevate the baseline mortality of a population. The EIA process provides the assessment of such potential effects as a consequence of OWFs at varying population scales.

The population-level consequences from estimated mortalities (such as those from collision risk and displacement) need to be considered for seabirds in relation to their seasonal populations. One method to estimate the effect that developments alone or cumulatively (when the project alone effects are considered alongside any effects from other projects on the same receptor) may have on a population is through 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.

This report provides PVAs modelled on BDMPS population scales for further assessment of the following the species:

- Gannet, *Morus bassanus* (in the breeding season);
- Kittiwake, *Rissa tridactyla* (in the pre-breeding, breeding, post-breeding and non-breeding seasons); and
- Great black-backed gull, *Larus marinus* (in the non-breeding season).

These three species were selected for further assessment due to the predicted impacts at a cumulative scale exceeding a 1% increase relative to the baseline mortality rate at the BDMPS scale, with a 1% increase being the level which has been regarded as the threshold for undertaking further assessments such as PVA. For the project alone, as detailed in **Chapter 12: Offshore and Intertidal Ornithology** the assessments concluded no significant effect in EIA terms. For each species above, PVA has been undertaken for each season that had an increase in baseline mortality of over 1% at the cumulative scale.

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. Methods

2.1 Guidance and Models

2.1.1 Overview

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.

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 1** of this report.

2.2 PVA demographic parameters

2.2.1 Modelling approach

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.

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.

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.

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).

All PVA modelling in this report was undertaken with environmental and demographic stochasticity. To ensure robust results, all simulations were set to run 5,000 times. All models were run for a 35-year time span, representing the likely lifespan of Green Volt.

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 *et al*., 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.

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).

2.2.2 Species demographics

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** summarises the species-specific values selected for the two species that are the focus of this report.

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 national productivity values presented within Horswill and Robinson (2015) were instead used for assessment, due to providing a more representative productivity rate of the populations assessed. The exception to this was great black-backed gull, productivity was taken from the SMP report (JNCC 2022), to provide an average regional productivity representing north and east Scotland between 1991 to 2021.

For all three species, the breeding population sizes are based on colony counts from the Seabird Monitoring Programme database (JNCC, 2022) for all colonies within mean maximum (mean max) plus one Standard Deviation (+1SD) foraging range (Woodward et al, 2019) with exceptions for gannet as described in the **Chapter 12: Offshore and Intertidal Ornithology**. Non-breeding season population sizes inputted into PVAs used BDMPS taken from the review undertaken by Furness (2015).

The survival rates for gannet and kittiwake were kept as the national values presented within the tool, which match the mean estimates presented in Horswill and Robinson (2015).

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).

For age at first breeding and maximum brood size per pair parameters, the pre-formulated values within the tool were selected.

Table 1 BDMPS population demographic parameters selected for gannet, kittiwake and great black-backed gull

Species	Productivity rate + SD	BDMPS population size (all individuals)	Mean adult survival rate + SD	Mean immature age class 0 – 1 survival rate + SD	Mean immature age class 1 – 2 survival rate + SD	Mean immature age class 2 – 3 survival rate + SD	Mean immature age class 3 – 4 survival rate + SD	Mean immature age class 4 – 5 survival rate + SD
Gannet	0.700 ± 0.082	804,425 (breeding season)	0.919 ± 0.042	0.424 ± 0.045	0.829 ± 0.026	0.891 ± 0.019	0.895 ± 0.019	0.895 ± 0.042
Kittiwake	0.690 ± 0.296	627,816 (pre-breeding season)	0.854 ± 0.051	0.790 ± 0.000	0.854 ± 0.051	0.854 ± 0.051	0.854 ± 0.051	0.854 ± 0.051
		357,426 (breeding season)						
		829,937 (post-breeding season)						
		829,937 (non-breeding season)						
Great black-backed gull	1.111 ± 0.637	91,399 (non-breeding season)	0.885 ± 0.022	0.798 ± 0.092	0.834 ± 0.034	0.834 ± 0.034	0.834 ± 0.034	0.834 ± 0.034

2.3 Impact values assessed

For all three species and the relevant seasons, a range of generic impact levels have been modelled based on the cumulative impact values provided in **Chapter 12: Offshore and Intertidal Ornithology**. Using a range accounts for the uncertainty in project totals for developments which have yet to gain consent, future proofing the results. SNCBs also prefer a range-based approach to assessment, over a single impact value.

3. Results

3.1.1 Introduction

The outputs of the Seabird PVA Tool are set out in **Table 2** to **Table 7** below for the three species and the relevant seasons requiring PVA. The metrics used to summarise the PVA results are based on the median of the ratio of impacted to unimpacted counterfactual of population growth and the median counterfactual of population size.

3.1.2 Gannet breeding season

Table 2 presents the PVA results for gannet during the breeding season when considering the relevant breeding population using the latest SMP colony counts.

Table 2 Gannet breeding season PVA results using Seabird PVA Tool

Increase in mortalities above baseline	Mortality relative rate	Density independent counterfactual metric (after 35 years)		Reduction in growth rate	Reduction in population size
		Median Growth Rate (SD)	Median Population size (SD)		
1,670	0.0020	0.997 (0.000)	0.918 (0.003)	-0.23%	-8.94%
1,745	0.0021	0.997 (0.000)	0.914 (0.003)	-0.24%	-9.43%
1,820	0.0022	0.997 (0.000)	0.910 (0.003)	-0.26%	-9.86%
1,895	0.0023	0.997 (0.000)	0.906 (0.003)	-0.27%	-10.23%
1,970	0.0024	0.997 (0.000)	0.902 (0.003)	-0.28%	-10.79%

3.1.3 Kittiwake pre-breeding season

Table 3 presents the PVA results for kittiwake during the pre-breeding season when considering the North Sea and English Channel BDMPS.

Table 3 Kittiwake pre-breeding season PVA results using Seabird PVA Tool

Increase in mortalities above baseline	Mortality relative rate	Density independent counterfactual metric (after 35 years)		Reduction in growth rate	Reduction in population size
		Growth rate (SD)	Population size (SD)		
1,143	0.0018	0.997 (0.000)	0.926 (0.004)	-0.21%	-8.09%
1,218	0.0019	0.997 (0.000)	0.922 (0.004)	-0.22%	-8.45%
1,293	0.0020	0.997 (0.000)	0.918 (0.004)	-0.23%	-9.06%
1,368	0.0021	0.997 (0.000)	0.914 (0.004)	-0.25%	-9.24%
1,443	0.0022	0.997 (0.000)	0.915 (0.004)	-0.26%	-9.82%

3.1.4 Kittiwake breeding season

Table 4 presents the PVA results for kittiwake during the breeding season when considering the relevant breeding population using the latest SMP colony counts.

Table 4 Kittiwake breeding season PVA results using Seabird PVA Tool

Increase in mortalities above baseline	Mortality relative rate	Density independent counterfactual metric (after 35 years)		Reduction in growth rate	Reduction in population size
		Growth rate (SD)	Population size (SD)		
865	0.0024	0.997 (0.000)	0.902 (0.005)	-0.28%	-10.81%
940	0.0026	0.996 (0.000)	0.894 (0.005)	-0.30%	-11.89%
1,015	0.0028	0.996 (0.000)	0.887 (0.005)	-0.33%	-12.57%
1,090	0.0030	0.996 (0.000)	0.879 (0.005)	-0.35%	-13.76%
1,165	0.0032	0.996 (0.000)	0.872 (0.005)	-0.38%	-14.75%

3.1.5 Kittiwake post-breeding season

Table 5 presents the PVA results for kittiwake during the post-breeding season when considering the North Sea and English Channel BDMPS.

Table 5 Kittiwake post-breeding season PVA results using Seabird PVA Tool

Increase in mortalities above baseline	Mortality relative rate	Density independent counterfactual metric (after 35 years)		Reduction in growth rate	Reduction in population size
		Growth rate (SD)	Population size (SD)		
1,517	0.0018	0.997 -(0.000)	0.926 (0.004)	-0.21%	-7.99%
1,592	0.0019	0.997 -(0.000)	0.922 (0.004)	-0.22%	-8.42%
1,667	0.0020	0.997 -(0.000)	0.918 (0.004)	-0.23%	-8.89%
1,752	0.0021	0.997 -(0.000)	0.914 (0.004)	-0.25%	-9.34%
1,837	0.0022	0.997 -(0.000)	0.915 (0.004)	-0.26%	-9.78%

3.1.6 Kittiwake non-breeding season

Table 6 presents the PVA results for kittiwake during the non-breeding season when considering the North Sea and English Channel BDMPS.

Table 6 Kittiwake non-breeding season PVA results using Seabird PVA tool

Increase in mortalities above baseline	Mortality relative rate	Density independent counterfactual metric (after 35 years)		Reduction in growth rate	Reduction in population size
		Growth rate (SD)	Population size (SD)		
2,735	0.0032	0.996 (0.000)	0.872 (0.003)	-0.38%	-14.53%
2,810	0.0033	0.996 (0.000)	0.868 (0.003)	-0.39%	-15.12%
2,885	0.0034	0.995 (0.000)	0.864 (0.004)	-0.40%	-15.62%
2,970	0.0035	0.995 (0.000)	0.861 (0.003)	-0.41%	-16.16%
3,055	0.0036	0.995 (0.000)	0.857 (0.003)	-0.42%	-16.53%

3.1.7 Great black-backed gull non-breeding season

Table 7 presents the PVA results for great black-backed gull during the non-breeding season when considering the North Sea and English Channel BDMPS.

Table 7 Great black-backed gull non-breeding season results using Seabird PVA Tool

Increase in mortalities above baseline	Mortality relative rate	Density independent counterfactual metric (after 35 years)		Reduction in growth rate	Reduction in population size
		Growth rate (SD)	Population size (SD)		
760	0.0083	0.990 (0.000)	0.703 (0.006)	-0.98%	-42.28%
785	0.0085	0.990 (0.000)	0.697 (0.006)	-1.00%	-43.39%
810	0.0088	0.989 (0.000)	0.689 (0.006)	-1.04%	-45.18%
835	0.0091	0.989 (0.000)	0.680 (0.006)	-1.07%	-46.97%
860	0.0094	0.989 (0.000)	0.671 (0.006)	-1.11%	-48.95%

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Appendix 1 Seabird PVA Tool Input Log

Gannet (breeding) parameter log

Set up

The log file was created on: 2022-11-22 01:43:19 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (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 “GV_GX_non.breeding_v2”.

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: 4321.

Years for burn-in: 10.

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 804425 in 2015

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: 0.895 , sd: 0.042 , DD: NA

Impacts

Number of impact scenarios: 5.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

Are impacts specified as a relative value or absolute harvest?: relative

Years in which impacts are assumed to begin and end: 2026 to 2061

Impact on Demographic Rates

Scenario A - Name: 0.0020

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002 , se: NA

Scenario B - Name: 0.0021

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0021 , se: NA

Scenario C - Name: 0.0022

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0022 , se: NA

Scenario D - Name: 0.0023

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0023 , se: NA

Scenario E - Name: 0.0024

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0024 , se: NA

Output:

First year to include in outputs: 2026

Final year to include in outputs: 2061

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

Kittiwake (pre-breeding) parameter log

Set up

The log file was created on: 2022-11-21 15:43:00 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (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 "GV_KI_pre-breeding_RUN1".

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: 43.

Years for burn-in: 10.

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 627816 in 2015

Productivity rate per pair: mean: 0.69 , sd: 0.296

Adult survival rate: mean: 0.854 , sd: 0.051

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 1e-04 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.051 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.051 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.051 , DD: NA

Impacts

Number of impact scenarios: 5.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

Are impacts specified as a relative value or absolute harvest?: relative

Years in which impacts are assumed to begin and end: 2026 to 2061

Impact on Demographic Rates

Scenario A - Name: KI_1143_0.0018

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0018 , se: NA

Scenario B - Name: KI_1218_0.0019

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0019 , se: NA

Scenario C - Name: KI_1293_0.0020

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002 , se: NA

Scenario D - Name: KI_1368_0.0021

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0021 , se: NA

Scenario E - Name: KI_1443_0.0022

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0022 , se: NA

Output:

First year to include in outputs: 2026

Final year to include in outputs: 2061

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

Kittiwake (breeding) parameter log

Set up

The log file was created on: 2022-11-21 15:14:46 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (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 “GV_KI_breeding_RUN1”.

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: 43.

Years for burn-in: 10.

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 357426 in 2021

Productivity rate per pair: mean: 0.69 , sd: 0.296

Adult survival rate: mean: 0.854 , sd: 0.051

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 1e-04 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.051 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.051 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.051 , DD: NA

Impacts

Number of impact scenarios: 5.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

Are impacts specified as a relative value or absolute harvest?: relative

Years in which impacts are assumed to begin and end: 2026 to 2061

Impact on Demographic Rates

Scenario A - Name: KI_865_0.0024

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0024 , se: NA

Scenario B - Name: KI_940_0.0026

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0026 , se: NA

Scenario C - Name: KI_1015_0.0028

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0028 , se: NA

Scenario D - Name: KI_1090_0.0030

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.003 , se: NA

Scenario E - Name: KI_1165_0.0032

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0032 , se: NA

Output:

First year to include in outputs: 2026

Final year to include in outputs: 2061

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

Kittiwake (post-breeding) parameter log

Set up

The log file was created on: 2022-11-21 15:52:03 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (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 “GV_KI_post-breeding_RUN1”.

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: 43.

Years for burn-in: 10.

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 2015

Productivity rate per pair: mean: 0.69 , sd: 0.296

Adult survival rate: mean: 0.854 , sd: 0.051

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 1e-04 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.051 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.051 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.051 , DD: NA

Impacts

Number of impact scenarios: 5.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

Are impacts specified as a relative value or absolute harvest?: relative

Years in which impacts are assumed to begin and end: 2026 to 2061

Impact on Demographic Rates

Scenario A - Name: KI_1517_0.0018

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0018 , se: NA

Scenario B - Name: KI_1592_0.0019

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0019 , se: NA

Scenario C - Name: KI_1667_0.0020

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002 , se: NA

Scenario D - Name: KI_1752_0.0021

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0021 , se: NA

Scenario E - Name: KI_1837_0.0022

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0022 , se: NA

Output:

First year to include in outputs: 2026

Final year to include in outputs: 2061

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

Kittiwake (non-breeding) parameter log

Set up

The log file was created on: 2022-11-21 15:05:05 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (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 “GV_KI_non-breeding_RUN1”.

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: 43.

Years for burn-in: 10.

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 2015

Productivity rate per pair: mean: 0.69 , sd: 0.296

Adult survival rate: mean: 0.854 , sd: 0.051

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 1e-04 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.051 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.051 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.051 , DD: NA

Impacts

Number of impact scenarios: 5.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

Are impacts specified as a relative value or absolute harvest?: relative

Years in which impacts are assumed to begin and end: 2026 to 2061

Impact on Demographic Rates

Scenario A - Name: KI_2735_0.0032

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0032 , se: NA

Scenario B - Name: KI_2810_0.0033

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0033 , se: NA

Scenario C - Name: KI_2885_0.0034

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0034 , se: NA

Scenario D - Name: KI_2970_0.0035

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0035 , se: NA

Scenario E - Name: KI_3055_0.0036

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0036 , se: NA

Output:

First year to include in outputs: 2026

Final year to include in outputs: 2061

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

Great black-backed gull (non-breeding) parameter log

Set up

The log file was created on: 2022-11-22 01:58:57 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (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 “GV_GBBG_non.breeding_v2”.

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: 4321.

Years for burn-in: 10.

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 91339 in 2015

Productivity rate per pair: mean: 1.111 , sd: 0.637

Adult survival rate: mean: 0.885 , sd: 0.022

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: 5.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

Are impacts specified as a relative value or absolute harvest?: relative

Years in which impacts are assumed to begin and end: 2026 to 2061

Impact on Demographic Rates

Scenario A - Name: 0.0083

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0083 , se: NA

Scenario B - Name: 0.0085

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0085 , se: NA

Scenario C - Name: 0.0088

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0088 , se: NA

Scenario D - Name: 0.0091

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0091 , se: NA

Scenario E - Name: 0.0094

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0094 , se: NA

Output:

First year to include in outputs: 2026

Final year to include in outputs: 2061

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

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