Muir Mhòr Offshore Wind Farm

Environmental Impact Assessment Report

Volume 3, Appendix 11.5: Population Viability Analysis Report

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Muir Mhòr Offshore Wind Farm

Technical Appendix 11.5: Offshore Ornithology Population Viability Analysis Report

7 November 2024

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Document history

Author	Dr Gillian Vallejo, Principal Ecological Modeller	7 November 2024
Checked	Dr James Robbins, Principal Ecological Modeller	7 November 2024
	Graeme Cook, Principal Ornithologist	
Approved	Dr Chris Pendlebury, Director of Offshore Planning and Environment	7 November 2024

Client Details	
Contact	Martha Lovatt
Client Name	
Address	

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Local Office:

Ochil House
Springkerse Business Park
Stirling
FK7 7XE
SCOTLAND
UK
Tel: +44 (0) 1786 542 300

Reg No: SC177881

Registered Office:

The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, Kirkcudbrightshire
DG7 3XS

VAT No: GB 243 6926 48

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Glossary

Term	Definition
Array Area	The area in which the generation infrastructure (including Wind Turbine Generators and associated foundations, and inter-array cables) and Offshore Electrical Platforms will be located.
Counterfactual growth rate	A metric comparing the growth rate in baseline PVA simulations to the growth rate in impact PVA simulations, calculated as the population growth rate in the impacted scenario divided by the population growth rate in the baseline scenario.
Counterfactual population size	A metric comparing the population size in baseline PVA simulations to the population size in impact PVA simulations, calculated as the population size rate in the impacted scenario divided by the population size in the baseline scenario.
Demographic rates	Rates determining population growth such as survival and productivity.
Demographic stochasticity	Variation in population growth attributable to individual-level stochasticity in survival and/or productivity.
Density-dependence	Changes in population growth rates dependent upon population density.
Displacement matrix approach	Industry standard approach to estimating the number of mortalities arising from distributional responses to wind farm developments (Statutory Nature Conservation Bodies, 2022).
Distributional responses	The behavioural responses of birds arising from barrier effects and/or distributional response as they show an avoidance reaction to development
Environmental stochasticity	Variation in population growth attributable to variability in environmental conditions.
Leslie matrix	A matrix used in Population Viability Analysis modelling to describe the contribution of individuals belonging to different age classes within a population to each age class in the subsequent year.
Population viability analysis	A method of predicting changes in population sizes over time based upon demographic rates.
Proposed Development	The offshore Muir Mhòr Offshore Wind Farm project elements to which this Offshore EIA Report relates
Stochastic collision risk model	Industry standard model used to predict number of mortalities arising from collision with wind turbine rotors, while incorporating uncertainty and variation around parameter estimates.

Term	Definition
SeabORD	A tool that uses individual-based simulations to predict impacts of distributional responses (distributional response and barrier effects) to offshore wind farm developments on adult annual survival rate and chick survival rate during the chick-rearing period (Searle *et al.*, 2018).

Acronyms

Term	Definition
AA	Array Area
BB	Berwick Bank
CGR	Counterfactual growth rate
CPS	Counterfactual population size
EIA	Environmental Impact Assessment
GV	Green Volt
OSPAR	Oslo and Paris regional sea convention
PVA	Population Viability Analysis
NEPVA	Natural England Population Viability Analysis tool
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Bodies
SPA	Special Protection Area

Species names

Common name	Scientific name
Kittiwake	*Rissa tridactyla*
Herring gull	*Larus argentatus*
Guillemot	*Uria aalge*
Razorbill	*Alca torda*
Puffin	*Fratercula arctica*
Gannet	*Morus bassanus*

1. Introduction

Population viability analysis (PVA) is a method to predict the trajectory of a population based on different life history parameters relevant to population growth (e.g., survival rates and reproductive rates). This technique can be used to make predictions regarding baseline population growth or decline over time. Predicted anthropogenic impact levels can then be incorporated and the models re-run to understand how the course of the population over time might be affected by the predicted level of impact. In an Environmental Impact Assessment (EIA) context, PVA can be used to assess the potential effects of mortality associated with a development upon local populations at varying population scales.

This document provides details of PVA carried out to predict population level impacts of the Proposed Development on key seabird populations, both individually (hereafter referred to as project-only scenarios) and in combination with other developments (hereafter referred to as cumulative impact scenarios).

2. Methods

PVA was carried out in accordance with guidance presented in NatureScot, 2023a.

2.1. Tool used

Models were run using the Natural England PVA tool (NEPVA, Tool v 2 (Code: v 4.18 Interface: v 1.7), Searle *et al.*, 2019).

The NEPVA tool is based around a simple age-class based model in which individuals in a simulated population progress from a chick age class, through annual immature age classes to an adult age class, with individuals that have reached the adult stage contributing to productivity (i.e., the measure of successful reproduction in a breeding season). These relationships among age classes are captured in a population projection matrix, also known as a Leslie matrix (Caswell, 2001).

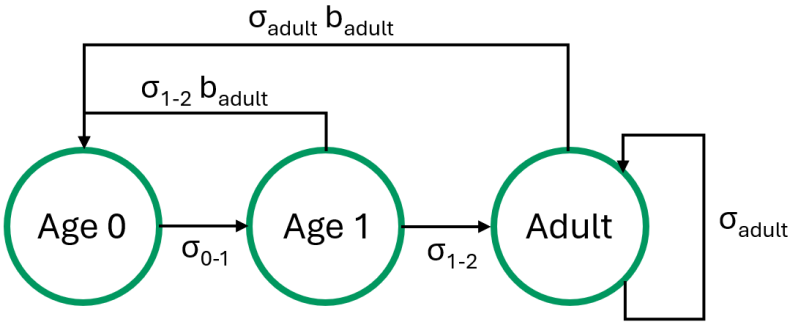
The value of each cell in the Leslie matrix is constructed from demographic parameters (survival and productivity rates) that determine the contribution of individuals within each age class in a given year, to the number of individuals within each age class in the subsequent year (either as a result of survival of existing individuals, or addition of new individuals as a result of reproduction).

When multiplied by a population vector, which reflects the number of animals within each age class in a given year, the Leslie matrix generates a prediction of the number of individuals in each age-class in the subsequent year and can thereby be used to create a predicted population projection.

A simple diagram illustrating the relationships between age-classes as determined by the demographic rates in a hypothetical model, as well as the associated population vector and Leslie matrix, is presented in Figure 2.1.

The NEPVA model is based on a so-called post-breeding census, meaning that the simulated annual population count (comprising the population vector) is carried out immediately following reproduction (i.e., all individuals in the first age class are newborn, all individuals in the second age class are exactly 1 year old etc.). This results in age-class relationships as shown in Figure 2.1.

(a)



(b)

$$\begin{bmatrix} N_{0[t]} \\ N_{1[t]} \\ N_{adult[t]} \end{bmatrix} \times \begin{bmatrix} 0 & \sigma_{1-2} \times b_{adult} & \sigma_{adult} \times b_{adult} \\ \sigma_{0-1} & 0 & 0 \\ 0 & \sigma_{1-2} & \sigma_{adult} \end{bmatrix} = \begin{bmatrix} N_{0[t+1]} \\ N_{1[t+1]} \\ N_{adult[t+1]} \end{bmatrix}$$

Figure 2.1:Diagrammatic structure (a) and population vector and matrix (b) for an example post-breeding census PVA model for a hypothetical species that reaches reproductive maturity after 2 years (i.e., age at first breeding is 2). *σ* represents a survival rate, *b* is a productivity rate, *N* is the number of birds in a given age class and *t* represents the year in the PVA simulations. Adapted from Kendall et al., 2019.

The NEPVA model allows the incorporation of environmental stochasticity, annual variation in demographic parameters such as survival, and productivity rates due to variability in environmental conditions. This is achieved by allowing demographic rates to vary in each simulated year, by sampling from distributions of demographic parameters defined by a mean and a standard deviation.

The tool also allows for the incorporation of demographic stochasticity, reflecting stochasticity in mortality and reproduction events at the individual level. This is achieved by simulating the number of birds of each age-class surviving and the number of chicks fledged each simulated year from a binomial distribution rather than directly from the survival and productivity rates simulated for that year.

When running the tool with stochasticity, a large number of baseline realisations are simulated to generate predicted population trajectories and associated uncertainty in the absence of additional anthropogenic perturbation. Predicted anthropogenic impacts are then incorporated, in this case, as proportionate reductions to the demographic rates used to construct the Leslie matrix, and the simulations are re-run. Comparing among the scenarios with and without impacts can then be used as a basis to draw conclusions regarding the significance of the predicted impacts at the population level.

The NEPVA also includes the option to incorporate density-dependence (changes in population growth rates dependent upon the population density) into PVA models, which are implemented through a suite of functions linking population size to one or more of the demographic parameters used to construct the population projection matrix.

2.2. Species and populations modelled

Predicted collision and distributional response impacts from the Proposed Development were apportioned for six key species (kittiwake, herring gull, guillemot, razorbill, puffin and gannet - see Volume 3, Appendix 11.4, Ornithology Apportionment Technical Report). For each of these species, PVA modelling was considered for both project-only impacts, and cumulative impacts at both the regional population level and for individual Special Protection Areas (SPAs) for which that species is designated, either individually or as part of an assemblage. The regional population was defined as the sum of all the SPA and non-SPA colonies with connectivity to the AA during the breeding season (i.e., those within the species-specific mean maximum foraging range plus one standard deviation, as defined in Woodward *et al*., 2019).

2.2.1. Project-only

In accordance with NatureScot guidance (NatureScot, 2023a), population viability analysis was run for any species and population (SPA or regional) combination for which the apportioned additional mortality rate to breeding adult birds in the higher displacement mortality scenario increased baseline mortality for that species and population by 0.02 percentage points or more. (See section 2.6.1.1 for an explanation of the scenarios modelled.) This can also be calculated directly as the predicted additional annual adult mortality as a percentage of the total number of adult birds in the population.

Final species-population combinations brought forward for assessment are presented in Table 2.1. A detailed description of the methods and calculations used to derive these values is provided in Section 2.6.1.2 and Annex A.

Table 2.1: Species-SPA combinations brought forward for project-only PVA analysis. Calculation of the percentage point change in mortality is presented in Annex A.

Species	Population	Percentage point change in mortality (higher distributional response mortality rate scenario)
Kittiwake	Buchan Ness to Collieston Coast SPA	0.051
	Troup, Pennan and Lion's Heads SPA	0.034
	Regional	0.021
Guillemot	Buchan Ness to Collieston Coast SPA	0.153
	Troup, Pennan and Lion's Heads SPA	0.079
	Regional	0.118
Razorbill	Regional	0.029

See Annex A for the derivation of these numbers.

2.2.2. Cumulative impacts

As advised by NatureScot (email communication from Jenna Lane, Marine Sustainability Advisor, NatureScot, 5th June 2024), cumulative impacts were considered for any species and SPA or regional combinations for which the apportioned project-only impacts to the breeding adult population in a given year were predicted to be equal to or greater than 0.2 birds in the higher distributional response mortality rate scenario. Of these species-SPA or regional combinations, PVA was only run for those for which the apportioned cumulative additional mortality rate to breeding adult birds in the higher displacement mortality rate scenario increased baseline mortality for that species and population by 0.02 percentage points or more, per NatureScot guidance (NatureScot, 2023a).

Final species-population combinations brought forward for assessment are presented in Table 2.2. A detailed description of the methods and calculations used to derive these values is provided in Section 2.6.2 and Annex B.

Table 2.2: Species-SPA combinations brought forward for cumulative PVA analysis. The project-only mortalities are based on all impacts across both the breeding and non-breeding seasons and the higher distributional response mortality rate scenario. The cumulative percentage point change is based on a scenario assuming higher distributional response mortality rates and including fatalities associated with Green Volt and Berwick Bank. (Scenarios run are described in Section 2.6.2). Annual mortalities are presented in the "Annual predicted impact mortality rates" tables in Annex A and percentage changes in mortality are calculated as 100 * the PVA rates presented in tables in Annex B.

Species	Population	Project-only predicted annual mortality of breeding adults (higher distributional response scenario)	Percentage point change in mortality (higher distributional response mortality project-only scenario + cumulative impacts)
Kittiwake	Buchan Ness to Collieston Coast SPA	13.91	0.47
	Cape Wrath SPA	0.20	0.08
	East Caithness Cliffs SPA	7.22	0.96
	Farne Islands SPA	0.60	0.77
	Forth Islands SPA	1.81	0.73
	Fowlsheugh SPA	4.95	0.93
	North Caithness Cliffs SPA	0.82	0.76
	St Abbs Head to Fast Castle SPA	0.62	4.27
	Troup, Pennan and Lion's Heads SPA	9.35	0.42
	West Westray SPA	0.50	1.60
	Regional	47.95	0.76
Herring gull	Buchan Ness to Collieston Coast SPA	0.50	0.11
	Regional	0.51	0.11
Guillemot	Buchan Ness to Collieston Coast SPA	62.24	0.47
	Troup, Pennan and Lion's Heads SPA	37.80	0.34
	Regional	107.30	0.35
Razorbill	Fowlsheugh SPA	0.95	0.99
	Troup, Pennan and Lion's Heads SPA	0.91	0.33
	Regional	12.51	0.56
Puffin	Coquet Island SPA	1.80	0.05

Species	Population	Project-only predicted annual mortality of breeding adults (higher distributional response scenario)	Percentage point change in mortality (higher distributional response mortality project-only scenario + cumulative impacts)
	Farne Island SPA	4.20	0.07
	Forth Islands SPA	10.20	0.33
	North Caithness Cliffs SPA	0.39	0.93
	Regional	18.75	0.17
Gannet	Fair Isle SPA	0.46	0.24
	Flamborough Head and Filey Coast SPA	1.19	1.36
	Forth Islands SPA	10.60	0.68
	Hermaness, Saxa Vord and Valla Field SPA	1.93	0.16
	North Rona and Sula Sgeir SPA	0.25	0.04
	Noss SPA	0.93	0.23
	Sule Skerry and Sule Stack SPA	0.34	0.28
	Regional	18.48	0.37

2.3. Basic run parameters

For each species-population combination modelled, a 'simulation' PVA run was carried out using the NEPVA tool. The simulation model is used to simulate population trajectories over time, based upon user-specified demographic rates, initial population sizes, and scenarios of impact. The basic run parameters that were used are summarised in Table 2.3.

Density-dependence was not included in the modelling, even though it is widely acknowledged to play a role in regulating seabird population sizes (Horswill *et al*., 2017). Density-dependence can represent either a negative relationship between population growth rates at large population sizes due to factors such as increased competition for resources at higher population densities (compensatory density-dependence), or, accelerating declines at low population density due to factors such as increased predation rate (depensatory density-dependence). The exact nature of density dependence is known to vary from colony to colony (Horswill and Robinson, 2015; Cook and Robinson, 2015) and sufficient data relating to the exact nature of density dependent relationships in seabirds is rarely available. Due to a lack of data on these processes in the populations being considered, density-dependence was not included in the modelling. This approach is currently standard industry practice (e.g., APEM, 2023, HWL, 2023, SSE Renewables, 2022a) and is generally assumed to be precautionary since compensatory density dependence is expected to be able to compensate for negative effects of impacts associated with the wind farm, to some degree (WWT, 2012; Cook and Robinson 2015; Green *et al*., 2016; Horswill *et al*., 2017). However, it should be noted that if depensatory compensation is occurring, this could also exacerbate negative impacts (Horswill and Robinson, 2015; Horswill *et al*., 2017; Horswill *et al*., 2022; Jitlal *et al*., 2017).

Population sizes used in the PVA modelling are defined in terms of breeding adults, however the model relates to the entire population i.e. birds within chick and juvenile age classes are also simulated. For a given set of demographic parameters there will be a stable population structure (the proportion of individuals in each age class) which is expected to be reflected within the population (albeit with fluctuations resulting from stochastic processes). The NEPVA model uses an initial assumption that the population structure is well represented by that associated with the deterministic Leslie matrix constructed from the input demographic parameters. However, when stochasticity is incorporated, this structure will be slightly different. A burn-in (a number of "pseudo-years" which are simulated using the full stochastic model) can be used to derive a more appropriate stable population structure for the stochastic model. A burn-in of 10 years was therefore applied, as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May 2024).

Table 2.3: Basic run parameters used for density-dependent PVA modelling

Environmental stochasticity	Demographic stochasticity	Density dependence	Number of simulations	Starting seed	Years for burn-in
Beta/gamma	Yes	No	5000	52	10

2.4. Demographic parameters

Demographic parameters used for the PVA modelling are presented in Table 2.4 and Table 2.5. Demographic parameters used to calculate the change in mortality rate associated with predicted impacts for those species-site or regional combinations not taken forward to PVA are presented in Annex C.

All demographic parameters were taken from Horswill and Robinson, 2015, as per NatureScot guidance (NatureScot, 2023a). For several species, Horswill and Robinson, 2015, present a range of site- or region-specific productivity rates as well as a national average value. Where possible, population or region-specific productivity rates were used. The productivity values selected for each species and the justification for the selection is presented in Table 2.5.

Table 2.4: **Adult and immature mean survival rates, age at first breeding and maximum brood size used in the PVA modelling. Numbers in brackets represent the standard deviations used. All values are taken from Horswill and Robinson, 2015, in line with NatureScot guidance (NatureScot, 2023a).**

Species	Adult survival rate	Immature survival rates						Age at first breeding	Maximum brood size
		0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6		
Kittiwake	0.854 (0.051)	0.790 (0.051*)	0.854 (0.051)	0.854 (0.051)	0.854 (0.051)	-	-	4	2
Herring gull	0.834 (0.034)	0.798 (0.092)	0.834 (0.034)	0.834 (0.034)	0.834 (0.034)	0.834 (0.034)	-	5	3
Guillemot	0.939 (0.015)	0.560 (0.013)	0.792 (0.034)	0.917 (0.022)	0.939 (0.015)	0.939 (0.015)	0.939 (0.015)	6	1
Razorbill	0.895 (0.067)	0.630 (0.209)	0.630 (0.209)	0.895 (0.067)	0.895 (0.067)	0.895 (0.067)	-	5	1
Puffin	0.906 (0.083)	0.709 (0.022)	0.709 (0.022)	0.709 (0.022)	0.760 (0.019)	0.805 (0.017)	-	5	1
Gannet	0.919 (0.042)	0.424 (0.007)	0.829 (0.004)	0.891 (0.003)	0.895 (0.003)	0.919 (0.042)	-	5	1

**No standard deviation is provided in Horswill and Robinson, 2015 so the standard deviation was assumed to be the same as that for the adult survival rate*

Table 2.5: Productivity rates used in the PVA modelling and an explanation for their selection. Values are means, and numbers in brackets represent the standard deviations used. All values are taken from Horswill and Robinson, 2015, in line with NatureScot guidance (NatureScot, 2023a)

Species	Population	Productivity Rate	Rate used	Explanation
Kittiwake	Buchan Ness to Collieston Coast SPA	0.819 (0.332)	East	SPA lies to the East of the line separating the Celtic Sea and Greater North Sea OSPAR regions (Horswill and Robinson, 2015, Appendix S4)
	East Caithness Cliffs SPA			
	Farne Islands SPA			
	Forth Islands SPA			
	Fowlsheugh SPA			
	North Caithness Cliffs SPA			
	St Abb's Head to Fast Castle SPA			
	Troup, Pennan and Lion's Heads SPA			
	West Westray SPA			
	Cape Wrath SPA	0.643 (0.313)	West	SPA extends east and west of the line separating the Celtic Sea and Greater North Sea OSPAR regions, so the more precautionary west value was used (Horswill and Robinson, 2015, Appendix S4)
	Regional	0.690 (0.296)	National average	Intermediate between the East, West and Shetland clusters within which the individual regional colonies fall. Precautionary compared to the East rates where most colonies are located.
Herring gull	Buchan Ness to Collieston Coast SPA	0.920 (0.477)	National average	No region/colony specific estimate provided for this SPA population
	Regional			

Species	Population	Productivity Rate	Rate used	Explanation
Guillemot	Buchan Ness to Collieston Coast SPA Troup, Pennan and Lion's Heads SPA	0.629 (0.174)	North	It is unclear if these SPAs belong to the North or the East clusters (Horswill and Robinson, 2015, Appendix S6) so the North value, rather than East (0.659), was taken as a precautionary approach.
	Regional	0.629 (0.174)	North	This is the more precautionary of the North and East clusters to which the colonies may belong.
Razorbill	Fowlsheugh SPA Troup, Pennan and Lion's Heads SPA Regional	0.570 (0.247)	National average	It is unclear whether these SPA populations belong to the North or the Mid clusters (Horswill and Robinson, 2015, Appendix S7) so the intermediate National average value was used rather than those of the North (0.459) or the Mid (0.643) clusters
Puffin	Coquet Island SPA Forth Islands SPA North Caithness Cliffs SPA	0.617 (0.151)	National average	No region/colony specific estimates are provided for these SPA populations
	Farne Islands SPA	0.415 (0.219)	Farne Islands	Colony-specific estimate is available
	Regional	0.617 (0.151)	National average	No region specific estimates are provided
Gannet	Fair Isle SPA Flamborough and Filey Coast SPA Forth Islands SPA Hermaness, Saxa Vord and Sula Sgeir SPA Noss SPA	0.698 (0.071)	East	SPA lies to the East of the line separating the Celtic Sea and Greater North Sea OSPAR regions (Horswill and Robinson, 2015, Appendix S1)

Species	Population	Productivity Rate	Rate used	Explanation
	Sule Skerry and Sule Stack SPA			
	North Rona and Sula Sgeir SPA	0.710 (0.105)	West	SPA lies to the West of the line separating the Celtic Sea and Greater North Sea OSPAR regions (Horswill and Robinson, 2015, Appendix S1)
	Regional	0.700 (0.082)	National average	The national average is intermediate between the East and West clusters within which the individual colonies within the region fall

Source: Horswill and Robinson, 2015

2.5. Population size data

The population sizes used in the PVA modelling represent the most recently available population counts at the time of writing and are presented in Table 2.6. Details of the origin of these counts are presented in Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report).

Table 2.6: Population sizes and the associated year of the count used in the PVA modelling, by species and SPA. Superscript numbers demonstrate whether the population count was derived from [1]Burnell *et al*., 2023, [2]SMP, 2024, or [3] a combination of Burnell et al., 2023 and SMP, 2024. Details as to why the counts were derived in this way are provided in Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report). Where counts were collected over several years, the midpoint (rounded up) of the range of years was used for PVA modelling. Where this is the case, years are marked with an asterisk.

Species	SPA	Initial population size (breeding adults)	Year of population count
Kittiwake	Buchan Ness to Collieston Coast[2]	27094	2023
	Cape Wrath[1]	7244	2017
	East Caithness Cliffs[1]	48958	2017*
	Farne Islands[1]	7166	2023
	Forth Islands[3]	13244	2022*
	Fowlsheugh[3]	30966	2021*
	North Caithness Cliffs[1]	11142	2016*
	St Abb's Head to Fast Castle[2]	9158	2023
	Troup, Pennan and Lion's Heads[3]	27344	2022*
	West Westray[3]	4838	2020*
	Regional	233139	2023*
Herring Gull	Buchan Ness to Collieston Coast[2]	4536	2023
	Regional	4660	2023*
Guillemot	Buchan Ness to Collieston Coast[2]	40762.80**	2023
	Troup, Pennan and Lion's Head[2]	47718.74**	2023
	Regional	90866.74**	2023*
Razorbill	Fowlsheugh[2]	20869.16**	2023
	Troup, Pennan and Lion's Heads[2]	8801.12**	2023
	Regional	43662.56**	2023*
Puffin	Coquet Island[1]	50058	2019
	Farne Islands[1]	87504	2019
	Forth Islands[3]	90291	2020*
	North Caithness Cliffs[3]	5438	2019*

Species	SPA	Initial population size (breeding adults)	Year of population count
	Regional	262629	2019*
Gannet	Fair Isle[2]	9654	2023
	Flamborough and Filey Coast[2]	30466	2023
	Forth Islands[1]	150518	2014
	Hermaness, Saxa Vord and Valla Field[1]	59124	2021
	North Rona and Sula Sgeir[2]	18990	2023
	Noss[2]	24670	2023
	Sule Skerry and Sule Stack[1]	18130	2018
	Regional	458578	2023*

*Source: Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report). *Single asterisks indicate where counts were taken over several years and the year used for the modelling is the midpoint of the range of years spanned, or where an indicative year is taken for a regional population count. **Guillemot and razorbill counts have been multiplied by 1.34, a widely applied correction factor to get from counted individuals to breeding adults in these species (e.g. SSE Renewables, 2022b) - Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report). [1]Count from Burnell et al., (2023), [2]More recent count than Burnell et al., (2023) for all colonies in SPA taken from SMP, [3]More recent count than Burnell et al., (2023) for 1 or more colonies in SPA taken from SMP, but not all.*

2.6. Impact parameters

2.6.1. Project-only

2.6.1.1. Scenarios modelled

Two types of impacts to seabirds are being assessed in association with the Proposed Development. These are 1) direct mortality associated with bird collisions with the turbine rotors, and 2) indirect mortality arising from distributional responses of birds (distributional response and/or barrier effects) to the Proposed Development. Details of the modelling used to derive the expected mortality associated with these two impact types for the project-only analysis are presented in Volume 3, Appendix 11.2 (Ornithology Collision Risk Modelling Technical Report) and Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) respectively. Not all species are associated with both collision and distributional response impacts, but where they are, these impacts were combined to derive a total annual impact for PVA analysis.

A maximum of two scenarios were modelled to assess the effect of project-only impacts.

For collision risk modelling, NatureScot guidance (NatureScot 2023b) specifies that a worst-case scenario and a most-likely scenario should be modelled based on windfarm design options under consideration. However, in this case, the most likely scenario is also the worst-case scenario so only a single collision scenario need be considered (see Volume 3, Appendix 11.2, Ornithology Collision Risk Modelling Technical Report for details). Whilst the guidance also indicates the use of both the Band Option 2 and the Band Option 3 collision risk models, it was agreed with NatureScot during the scoping consultation that assessment based on Band Option 2 alone would be acceptable (Volume 2, Chapter 12 (Offshore Ornithology), Table 12-4). Therefore, only a single scenario for collision mortality was incorporated into the PVA modelling.

NatureScot guidance also provides a range of mortality rates associated with distributional response that should be considered for each species when applying displacement matrices (NatureScot 2023c). PVA modelling for species predicted to experience distributional response impacts has been carried out for scenarios incorporating both the

lowest and the highest distributional response mortality rates. For some species-population combinations, the SeabORD tool (Searle *et al.*, 2018, Volume 3, Appendix 11.3, Ornithology Distributional Responses Technical Report), rather than displacement matrices, was used to predict mortality associated with distributional responses during the breeding season. In these cases, the same values are used for the higher and lower distributional response mortality rate scenarios (see Table 2.7).

Table 2.7: Scenarios included in PVA modelling

Species	Population	Scenario	Breeding season	Non-breeding season
Kittiwake	Buchan Ness to Collieston Coast SPA	Higher distributional response mortality rate	Collision + SeabORD distributional response	Collision + Displacement matrices, 3% mortality rate, 30% distributional response rate
		Lower distributional response mortality rate	Collision + SeabORD distributional response	Collision + Displacement matrices, 1% mortality rate, 30% distributional response rate
	Troup, Pennan and Lion's Heads SPA	Higher distributional response mortality rate	Collision + SeabORD distributional response	Collision + Displacement matrices, 3% mortality rate, 30% distributional response rate
		Lower displacement mortality	Collision + SeabORD distributional response	Collision + Displacement matrices, 1% mortality rate, 30% distributional response rate
	Regional	Higher distributional response mortality rate	Collision + SeabORD distributional response	Collision + Displacement matrices, 3% mortality rate, 30% distributional response rate
		Lower displacement mortality	Collision + SeabORD distributional response	Collision + Displacement matrices, 1% mortality rate, 30% distributional response rate

Species	Population	Scenario	Breeding season	Non-breeding season
Guillemot	Buchan Ness to Collieston Coast SPA	Higher distributional response mortality rate	SeabORD distributional response	Displacement matrices, 3% mortality rate, 60% distributional response rate
		Lower displacement mortality	SeabORD distributional response	Displacement matrices, 1% mortality rate, 60% distributional response rate
	Troup, Pennan and Lion's Heads SPA	Higher distributional response mortality rate	SeabORD distributional response	Displacement matrices, 3% mortality rate, 60% distributional response rate
		Lower displacement mortality	SeabORD distributional response	Displacement matrices, 1% mortality rate, 60% distributional response rate
	Regional	Higher distributional response mortality rate	SeabORD + matrices, 5 % mortality rate	Displacement matrices, 3% mortality rate, 60% distributional response rate
		Lower displacement mortality	SeabORD + matrices, 3 % mortality rate	Displacement matrices, 1% mortality rate, 60% distributional response rate
Razorbill	Regional	Higher distributional response mortality rate	SeabORD + matrices, 5 % mortality rate	Displacement matrices, 3% mortality rate, 60% distributional response rate
		Lower displacement mortality	SeabORD + matrices, 3 % mortality rate	Displacement matrices, 1% mortality rate, 60% distributional response rate

2.6.1.2. Preparation of predicted impacts for population viability analysis

Collision and distributional response impacts predicted for the Proposed Development were apportioned among relevant SPA and non-SPA populations for key species in Volume 3, Chapter 11.4 (Offshore Ornithology Apportionment Report).

These values are presented in absolute numbers, whilst the required format for the PVAs applied here are proportions relative to total population sizes. In addition, many of the apportioned values, particularly those for the breeding season, refer to the entire population, whilst impacts to adults and immatures are incorporated into the PVA modelling separately. Finally, differences in population counts (breeding adults) versus birds using the AA (breeding adults, non-breeding 'sabbatical' adult birds and immature birds) must also be accounted for. These considerations were incorporated to derive final values for use in PVA as described below.

For the breeding season, distributional response modelling was carried out using the SeabORD tool (Searle *et al.*, 2018, Volume 3, Appendix 11.3, Ornithology Distributional Responses Technical Report) where possible. Since SeabORD provides impacts relative to the total population size, no further manipulation, except for conversion of the output, expressed as a percentage, into a proportion, was required to prepare breeding season impacts for population viability analysis. Species-population combinations for which SeabORD was run are indicated in Annex A.

Breeding season collision impacts were modelled using the stochastic collision risk model (Volume 3, Appendix 11.2, Ornithology Collision Risk Modelling Technical Report) and distributional responses for those species-population combinations for which SeabORD was not run were assessed using the distributional response matrix approach (Volume 3, Appendix 11.3, Ornithology Distributional Responses Technical Report). These predicted impacts were then apportioned to individual colonies with connectivity to the site using a weighting calculated as a function of the population size, its distance from the AA and the proportion of the colony's foraging range which is at sea (Volume 3, Chapter 11.4, Offshore Ornithology Apportionment Report). The final apportioned impacts relate to the whole population of birds using the wind farm (i.e. breeding adults, non-breeding sabbatical adult birds and immature birds), whilst breeding season population counts relate only to breeding adults. It was therefore necessary to divide these impacts into adult birds and immature birds. Predicted mortality of adult birds was also adjusted to account for the proportion of adults expected to be non-breeding sabbatical birds, since the PVAs are based on counts of breeding adults only. This was achieved using methods described in Sections 0 and 0 below. Once impacts had been corrected, breeding season mortality rates relative to the population size were calculated by dividing the predicted mortalities by the population sizes of breeding adults (for adult rates), and immatures (for immature rates).

For the non-breeding season, apportioning ratios calculated from Furness (2015) were used to apportion collision and distributional response impacts where appropriate (Volume 3, Chapter 11.4, Offshore Ornithology Apportionment Report). This approach results in impacts that are already split among adult and immature age classes. However, the non-breeding season is divided into several species-specific sub-seasons among which impacts are apportioned so it was necessary to sum impacts across the non-breeding sub-seasons prior to calculating non-breeding season mortality rates. As above, non-breeding season predicted impacts to adults were adjusted to account for sabbatical rates since the predicted impacts relate to the whole population whilst the PVAs relate to breeding adults only. As for the non-SeabORD breeding season impacts, non-breeding season mortality rates were calculated by dividing the predicted mortalities by the relevant population sizes. It should be noted that impacts applied to non-SPA populations were calculated based upon all colonies within the relevant Furness regions (see Volume 3, Chapter 11.4, Offshore Ornithology Apportionment Report), but were applied to those colonies with connectivity to the AA when PVA rates were calculated. This means that some impacts that should be attributed to colonies without connectivity to the site are attributed to colonies with connectivity when PVA rates are calculated, potentially meaning that non-SPA and regional impact rates used in PVA are precautionary. However, where species have large foraging ranges, there may also be non-SPA populations with connectivity that are outside of the relevant Furness region. Overall, it is expected that this approach is precautionary.

Furness (2015) was not used to apportion non-breeding season impacts for guillemot, herring gull, and puffin (Volume 3, Chapter 11.4, Offshore Ornithology Apportionment Report), following the advice provided by NatureScot during the scoping consultation (Volume 2, Chapter 12, Offshore Ornithology, Table 12-4; Volume 3, Chapter 11.4, Offshore Ornithology Apportionment Report). For puffin, no non-breeding season impacts were apportioned due to their extremely wide-ranging habits during the non-breeding season. Conversely, for guillemot, the same apportionment ratios were assumed as for the breeding season due to low dispersal of this species during the non-breeding season. Similarly for herring gull, breeding season apportionment ratios were also used, but in this case, a correction factor was used to account for a significant influx of birds from Western UK and overseas expected to contribute to the regional non-breeding season herring gull population (assumed to make up 32.5% of the total regional population). In these cases, non-breeding season impact rates were treated the same way as breeding season impacts (as described above).

Finally, breeding and non-breeding season mortality rates are summed to give the overall rates required for the PVA analysis. The adult rate calculated was converted into a percentage to determine whether PVA was required according to the threshold set by NatureScot (2023a) (see Section 2.2).

All calculations and working used to derive final impact inputs for PVA are presented in Annex A.

Apportioning of impacts to adults versus immatures

Where apportioned impacts were not yet assigned to adult versus immature age classes, deterministic population viability analysis was used to indicate the expected ratio of adult to immature birds.

In a deterministic model, the right eigenvector associated with the largest eigenvalue of a Leslie matrix represents the stable population structure (the ratio of individuals expected to be within each age class in a stable population) (Caswell, 2001). The Leslie matrices underpinning the NEPVA tool were constructed for each species and population combination using the demographic parameters presented in Table 2.4 and Table 2.5, and Annex B. The right eigenvector associated with the largest eigenvalue was calculated and scaled to sum to 1 in order to calculate the relative proportions of birds expected to be in each age class. These were used to calculate the expected proportion of adults versus immature individuals in the population. Whilst these ratios are expected to change slightly for stochastic models (Searle *et al.*, 2019), comparisons with ratios derived from models including environmental and demographic stochasticity run through the NEPVA tool for a subset of species and populations were within 2% of the deterministic estimates. As such, the deterministic estimates were deemed suitable for this purpose (see Annex D). This approach was approved by NatureScot during consultation (email communication from Caitlin Cunningham, Marine Sustainability Advisor at NatureScot, dated 17th May 2024).

Accounting for sabbatical birds

Adult breeding season impacts that were not derived from SeabORD were also adjusted to account for the proportion of individuals expected to be non-breeding sabbatical birds in any given year. Sabbatical rates were assumed to be 7% for auk, 10% kittiwake, 10% for gannet and 35% for herring gull and lesser black-backed gull following the values agreed with NatureScot for Berwick Bank (SSE Renewables, 2022a), as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May 2024). Impacts to adult birds once immatures and sabbatical birds were removed are presented in Annex G.

2.6.1.3. Impact parameters used for PVA modelling

For each species-population combination, the higher and lower distributional response mortality rate scenarios were modelled simultaneously within a single PVA run using the NEPVA tool, specified as Scenarios A (higher distributional response mortality rate) and B (lower distributional response mortality rate). Collision impacts were the same among both scenarios since the worst-case proposed wind farm parameters are also the most likely (see Section 2.6.1.1).

Impacts were applied separately for adults and immatures, and chick mortality estimated using SeabORD was incorporated as an impact on productivity per pair, i.e., the percent additional chick mortality predicted using SeabORD was applied as a reduction of the same proportion to the simulated productivity rate, since the NEPVA tool does not allow incorporation of impacts to specific immature age-classes. Standard errors for impacts were not included due to the complexity of propagating and partitioning uncertainty appropriately when combining outputs of different model types (SeabORD, matrix models, and stochastic collision risk models) and during post-processing when, for example, splitting impacts among colonies and age-classes. This approach follows that applied in other assessments including Berwick Bank (SSE Renewables, 2022a), Greenvolt (APEM, 2023) and Pentland (in which SeabORD output uncertainty was not included when combined with deterministic CRM outputs for kittiwake) (HWL, 2023) and was agreed in consultation with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May 2024). Since no standard errors were included, the option to match random seeds for impact scenarios within the tool was also turned off.

Impacts were specified as relative impacts on demographic rates, i.e., rates are adjusted by a proportion such that mortality rate scales with population size. The final impact values used in the PVA modelling are summarised in Table 2.8 and calculations used to derive these are presented in Annex A.

Table 2.8: Relative proportion by which demographic rates are decreased as a result of predicted impacts of the proposed development, used in the PVA modelling

Species	Population	Scenario (distributional response mortality rate)	Predicted reduction in		
			Adult survival rate	Immature survival rate	Productivity rate
Kittiwake	Buchan Ness to Collieston Coast	Higher	0.000513	0.000348	0.000945
		Lower	0.000510	0.000347	0.000945
	Troup, Pennan and Lion's Heads	Higher	0.000342	0.000175	0.000600
		Lower	0.000338	0.000173	0.000600
	Regional	Higher	0.000206	0.000144	0.000566
		Lower	0.000192	0.000134	0.000566
Guillemot	Buchan Ness to Collieston Coast	Higher	0.001527	0.001642	0*
		Lower	0.000509	0.000547	0*
	Troup, Pennan and Lion's Heads	Higher	0.000792	0.000849	0.000096
		Lower	0.000265	0.000283	0.000096
	Regional	Higher	0.001181	0.001269	0.000052
		Lower	0.000408	0.000438	0.000052
Razorbill	Regional	Higher	0.000287	0.000268	0.000216
		Lower	0.000177	0.000154	0.000216

**SeabORD predicted a positive impact upon chick survival (see Volume 3, Appendix 11.3, Ornithology Distributional Responses Technical Report), so this impact was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May 2024)*

2.6.2. Cumulative impacts

For cumulative impacts, PVA modelling was carried out for higher and lower distributional response mortality rate scenarios as described above. All collision and distributional response impacts from other developments were taken from Royal HaskoningDHV (2024) with the exception of those for Muir Mhor, which were taken from this assessment, and Ossian (see explanation below). It should be noted that the version of the Royal HaskoningDHV report used is the latest version available as of 29th August 2024 but is yet to be finalised at this time.

Numbers used represented numbers of breeding adult mortalities and numbers of immature mortalities predicted for each SPA population during the breeding and non-breeding seasons. For collision, the values used were those updated to reflect more recent advice on avoidance rates for collision (Royal HaskoningDHV, 2024). For distributional responses, estimates were corrected from those provided within the report such that assumed mortality rates reflected those used for the project-only analysis (see Table 2.7). Where numbers were provided for both as "consented" and "as-built", the as-built numbers were used since these are considered to provide a more accurate representation of realised cumulative effects. For collision estimates for Berwick Bank, values from both the "scoping approach" and the "developer approach" were presented (Royal HaskoningDHV, 2024). The scoping approach was used as this is the more conservative of the two estimates. For puffin, recent NatureScot advice suggests that non-breeding season impacts do not need to be apportioned due to the wide-ranging nature of puffins during the non-breeding season. Therefore, only breeding season impacts were considered during the cumulative impact assessment for puffin. The process for deriving cumulative impacts from those presented by Royal HaskoningDHV is laid out in Annex H.

For Ossian, the total seasonal collision and/or displacement impacts estimated to occur for each relevant species were extracted from Ossian's Offshore Ornithology Collision Risk Model Technical Report (Volume 3, Appendix 11.2) (Ossian OWFL, 2024a) and Offshore Ornithology Displacement Technical Report (Volume 3, Appendix 11.3) (Ossian OWFL, 2024b) respectively. Breeding season apportioning factors were then extracted from Ossian's Offshore Ornithology Special Protection Area Apportioning Technical Report (Part 3, Appendix 3A) (Ossian OWFL, 2024c). For each relevant species and SPA combination, total breeding season impacts were calculated by multiplying the appropriate apportioning factor by the impact for the relevant SPA and species combination. Finally, for each species, the proportion of adults to immatures (Table 2.2 and Table 2.4) and the sabbatical rates (Table 2.5) were also extracted from Ossian's Offshore Ornithology Special Protection Area Apportioning Technical Report (Part 3, Appendix 3A) (Ossian OWFL, 2024c). Each SPA's estimated impact was then multiplied by the immature rate to provide the impact attributed to immatures at that SPA for that species and by the adult ratio and the sabbatical rate to provide the impact attributed to breeding adults at that SPA for that species. For the non-breeding season, apportioning factors for each relevant species and SPA combination were calculated directly from Furness (2015) for adults and immatures separately. This was done for each non-breeding sub-period which made up that species' non-breeding season and was achieved by dividing the number of birds of each age class (adults or immatures) by the total number of birds in the BDMPS region (the appropriate BDMPS region was selected as that in which Ossian lies). The immature apportioning factor(s) for each non-breeding period were then multiplied by the total estimated collision and/or displacement impact for that same non-breeding period to provide the impact attributed to immatures at that SPA for that species. The same was done for adults, and these impacts were also multiplied by the same sabbatical rates as in the breeding season (Ossian, 2024c – Table 2.5) to provide the estimated impact to breeding adults.

For each species, the total number of mortalities per SPA per age class were summed, and then divided by population size to derive cumulative relative impacts on demographic rates for use in the PVA analysis. Separate PVAs were run both including and excluding the numbers for Berwick Bank (hereafter referred to as BB) and Green Volt (hereafter referred to as GV), since these projects will be implementing compensation measures in order to offset the predicted impacts. The impact values used in the models are presented in Table 2.10, and calculations used to derive these are presented in Annex B.

Cumulative impact numbers presented in the Royal Haskoning dataset were not broken down to individual colonies for non-SPA populations, so it was not possible to directly derive cumulative impact numbers for the Proposed Development's regional population as defined in this assessment. It was therefore necessary to make an assumption as to how the number of fatalities to SPAs within the regional population relates to the total number of fatalities. This was achieved by assuming that the cumulative impacts to SPAs and non-SPAs within the regional population are proportionate to the split between the number of birds in the regional population belonging to SPA populations versus non-SPA populations. The total cumulative number of fatalities assigned to SPAs within the region from all developments other than the Proposed Development were therefore extrapolated up based on the ratio of SPA to non-SPA populations to give an estimate of the total cumulative mortalities to the regional population. Predicted numbers of fatalities for the Proposed Development were then added to provide the final predicted cumulative number of fatalities to the regional population.

Table 2.9: Relative proportion by which demographic rates are decreased as a result of predicted impacts of the developments, used in the cumulative PVA modelling. BB and GV relate to Berwick Bank and Green Volt respectively.

Species	Population	Scenario (distributional response mortality rate)	Predicted reduction in		
			Adult survival rate	Immature survival rate	Productivity rate
Kittiwake	Buchan Ness to Collieston Coast	Higher (no BB/GV)	0.0043523	0.0016215	0.0009448
		Higher (with BB/GV)	0.0046933	0.0017078	0.0009448
		Lower (no BB/GV)	0.0033079	0.0012152	0.0009448
		Lower (with BB/GV)	0.0035845	0.0012475	0.0009448
	Cape Wrath*	Higher	0.0008241	0.0009410	0
		Lower	0.0006050	0.0006186	0
	East Caithness Cliffs	Higher (no BB/GV)	0.0095372	0.0044441	0.0002206
		Higher (with BB/GV)	0.0095683	0.0044506	0.0002206
		Lower (no BB/GV)	0.0062282	0.0023864	0.0002206
		Lower (with BB/GV)	0.0062541	0.0023885	0.0002206
	Farne Islands	Higher (no BB/GV)	0.0035642	0.0013906	0
		Higher (with BB/GV)	0.0077426	0.0025162	0
		Lower (no BB/GV)	0.0024428	0.0009535	0
		Lower	0.0057910	0.0013827	0

Species	Population	Scenario (distributional response mortality rate)	Predicted reduction in		
			Adult survival rate	Immature survival rate	Productivity rate
		(with BB/GV)			
	Forth Islands	Higher (no BB/GV)	0.0044251	0.0020969	0.0001208
		Higher (with BB/GV)	0.0072850	0.0028693	0.0001208
		Lower (no BB/GV)	0.0029041	0.0010346	0.0001208
		Lower (with BB/GV)	0.0051979	0.0013322	0.0001208
	Fowlsheugh	Higher (no BB/GV)	0.0055670	0.0021678	0.0009042
		Higher (with BB/GV)	0.0092672	0.0031642	0.0009042
		Lower (no BB/GV)	0.0040300	0.0012285	0.0009042
		Lower (with BB/GV)	0.0069978	0.0016106	0.0009042
	North Caithness Cliffs	Higher (no BB/GV)	0.0076049	0.0031112	0
		Higher (with BB/GV)	0.0076183	0.0031134	0
		Lower (no BB/GV)	0.0053945	0.0020279	0
		Lower (with BB/GV)	0.0054060	0.0020287	0
	St Abb's Head to Fast Castle	Higher (no BB/GV)	0.0049245	0.0021378	0.0006987
		Higher (with BB/GV)	0.0426677	0.0123273	0.0006987
		Lower (no BB/GV)	0.0033006	0.0011420	0.0006987
		Lower (with BB/GV)	0.0335493	0.0050448	0.0006987
	Troup, Pennan and Lion's Heads	Higher (no BB/GV)	0.0047055	0.0020468	0.0005998
		Higher (with BB/GV)	0.0048598	0.0020836	0.0005998

Species	Population	Scenario (distributional response mortality rate)	Predicted reduction in		
			Adult survival rate	Immature survival rate	Productivity rate
		Lower (no BB/GV)	0.0032419	0.0013151	0.0005998
		Lower (with BB/GV)	0.0033690	0.0013292	0.0005998
	West Westray*	Higher	0.0160369	0.0067962	0
		Lower	0.0109241	0.0046025	0
	Regional	Higher (no BB/GV)	0.0052812	0.0023890	0.0005664
		Higher (with BB/GV)	0.0076110	0.0030387	0.0005664
		Lower (no BB/GV)	0.0036268	0.0014185	0.0005664
		Lower (with BB/GV)	0.0054955	0.0016672	0.0005664
Herring gull	Buchan Ness to Collieston Coast	No BB/GV	0.0009700	0.0001683	0
		With BB/GV	0.0010878	0.0001683	0
	Regional	No BB/GV	0.0009468	0.0001677	0
		With BB/GV	0.0010614	0.0001677	0
Guillemot	Buchan Ness to Collieston Coast	Higher (no BB/GV)	0.0019544	0.0020789	0
		Higher (with BB/GV)	0.0047016	0.0037634	0
		Lower (no BB/GV)	0.0007301	0.0007754	0
		Lower (with BB/GV)	0.0018942	0.0014988	0
	Troup, Pennan and Lion's Heads	Higher (no BB/GV)	0.0014344	0.0013737	0.0000964
		Higher (with BB/GV)	0.0023733	0.0019664	0.0000964
		Lower (no BB/GV)	0.0005852	0.0005421	0.0000964
		Lower (with BB/GV)	0.0009889	0.0008018	0.0000964
	Regional	Higher (no BB/GV)	0.0017100	0.0017399	0.0000520
		Higher (with BB/GV)	0.0034354	0.0028069	0.0000520

Species	Population	Scenario (distributional response mortality rate)	Predicted reduction in		
			Adult survival rate	Immature survival rate	Productivity rate
		Lower (no BB/GV)	0.0006753	0.0006760	0.0000520
		Lower (with BB/GV)	0.0014095	0.0011369	0.0000520
Razorbill	Fowlsheugh	Higher (no BB/GV)	0.0085571	0.0081857	0.0002683
		Higher (with BB/GV)	0.0099086	0.0095257	0.0002683
		Lower (no BB/GV)	0.0044450	0.0044553	0.0002683
		Lower (with BB/GV)	0.0052560	0.0052594	0.0002683
	Troup, Pennan and Lion's Heads	Higher (no BB/GV)	0.0028971	0.0022878	0.0000909
		Higher (with BB/GV)	0.0033200	0.0026890	0.0000909
		Lower (no BB/GV)	0.0010897	0.0008332	0.0000909
		Lower (with BB/GV)	0.0013434	0.0010739	0.0000909
	Regional	Higher (no BB/GV)	0.0049089	0.0046236	0.0002157
		Higher (with BB/GV)	0.0056401	0.0053450	0.0002157
		Lower (no BB/GV)	0.0024822	0.0024450	0.0002157
		Lower (with BB/GV)	0.0029210	0.0028778	0.0002157
Puffin	Coquet Island	Higher (no BB/GV)	0.0003286	0.0003215	0
		Higher (with BB/GV)	0.0004558	0.0005119	0
		Lower (no BB/GV)	0.0002041	0.0001932	0
		Lower (with BB/GV)	0.0002804	0.0003075	0
	Farne Islands	Higher	0.0004536	0.0007037	0.0000183

Species	Population	Scenario (distributional response mortality rate)	Predicted reduction in		
			Adult survival rate	Immature survival rate	Productivity rate
		(no BB/GV)			
		Higher (with BB/GV)	0.0007131	0.0012652	0.0000183
		Lower (no BB/GV)	0.0002918	0.0004230	0.0000183
		Lower (with BB/GV)	0.0004476	0.0007598	0.0000183
	Forth Islands	Higher (no BB/GV)	0.0028657	0.0036626	0.0001285
		Higher (with BB/GV)	0.0032657	0.0041301	0.0001285
		Lower (no BB/GV)	0.0017651	0.0021980	0.0001285
		Lower (with BB/GV)	0.0020051	0.0024785	0.0001285
	North Caithness Cliffs	Higher (no BB/GV)	0.0092770	0.0110673	0
		Higher (with BB/GV)	0.0093349	0.0110918	0
		Lower (no BB/GV)	0.0057067	0.0066404	0
		Lower (with BB/GV)	0.0057415	0.0066551	0
	Regional	Higher (no BB/GV)	0.0014000	0.0019248	0.0000579
		Higher (with BB/GV)	0.0016501	0.0022907	0.0000579
		Lower (no BB/GV)	0.0008665	0.0011553	0.0000579
		Lower (with BB/GV)	0.0010166	0.0013749	0.0000579
Gannet	Fair Isle	Higher (no BB/GV)	0.0020512	0.0011218	0
		Higher (with BB/GV)	0.0023967	0.0011772	0
		Lower (no BB/GV)	0.0008964	0.0007927	0

Species	Population	Scenario (distributional response mortality rate)	Predicted reduction in		
			Adult survival rate	Immature survival rate	Productivity rate
		Lower (with BB/GV)	0.0010021	0.0008194	0
	Flamborough and Filey coast	Higher (no BB/GV)	0.0134026	0.0012220	0
		Higher (with BB/GV)	0.0135822	0.0015419	0
		Lower (no BB/GV)	0.0083990	0.0009027	0
		Lower (with BB/GV)	0.0084960	0.0010176	0
	Forth Islands	Higher (no BB/GV)	0.0053279	0.0016318	0
		Higher (with BB/GV)	0.0068444	0.0016998	0
		Lower (no BB/GV)	0.0039092	0.0012138	0
		Lower (with BB/GV)	0.0049669	0.0012884	0
	Hermaness, Saxa Vord and Valla Field	Higher (no BB/GV)	0.0014725	0.0014454	0
		Higher (with BB/GV)	0.0015706	0.0014809	0
		Lower (no BB/GV)	0.0010227	0.0010056	0
		Lower (with BB/GV)	0.0010865	0.0010460	0
	North Rona and Sula Sgeir	Higher (no BB/GV)	0.0003763	0.0003298	0
		Higher (with BB/GV)	0.0004229	0.0003470	0
		Lower (no BB/GV)	0.0002196	0.0001938	0
		Lower (with BB/GV)	0.0002457	0.0002025	0
	Noss	Higher (no BB/GV)	0.0021223	0.0020776	0
		Higher	0.0022616	0.0021173	0

Species	Population	Scenario (distributional response mortality rate)	Predicted reduction in		
			Adult survival rate	Immature survival rate	Productivity rate
		(with BB/GV)			
		Lower (no BB/GV)	0.0013063	0.0012939	0
		Lower (with BB/GV)	0.0013969	0.0013391	0
	Sule Skerry and Sule Stack	Higher (no BB/GV)	0.0027485	0.0012946	0
		Higher (with BB/GV)	0.0028194	0.0013045	0
		Lower (no BB/GV)	0.0019264	0.0011921	0
		Lower (with BB/GV)	0.0019777	0.0011977	0
	Regional	Higher (no BB/GV)	0.0031209	0.0010065	0
		Higher (with BB/GV)	0.0036645	0.0010591	0
		Lower (no BB/GV)	0.0021534	0.0007303	0
		Lower (with BB/GV)	0.0025270	0.0007711	0

**Cape Wrath and West Westray have no apportioned impacts from Berwick Bank or Green Volt for kittiwake.*

2.7. Years simulated

The first year of the simulation was selected to be the same as the year of the population count used in the model. Where counts were collected over several years, the midpoint of the range of years was used (see Table 2.6).

Impacts were simulated to begin in 2032, the proposed first year of operation according to current planned project timelines, and to end in 2082.

In accordance with NatureScot guidance, output metrics were generated for 2057 (25 years of operation), 2082 (50 years of operation) and 2067 (35 years of operation, representing the end of the intended lease period). The input parameters relating to years simulated used in the NEPVA tool are presented in Table 2.10.

Table 2.10: PVA inputs relating to years simulated

Parameter	Year
Starting year	Year of population count
Start of impacts	2032
End of impacts	2081
Final year included in outputs	2082

2.7.1. Indication of possible consequences of construction phase impacts

It is acknowledged that impacts upon seabirds will not be restricted to the operational phase of the project. However, there is very little information available on the extent or magnitude of impacts during the construction phase and no way within the current publicly-available version of the NEPVA tool to apply different rates of impact in different years of simulations. In order to provide context as to potential consequences of impacts during the construction phase, PVAs have also been run in which the onset of impacts is set to begin in 2029 since this is when offshore construction is currently planned to commence. It should be noted that these models include collision impacts where these were assessed, which would not be expected during the construction phase, and also that there is currently no data as to whether distributional responses during the construction phase are likely to be greater (due to the novelty of the presence of infrastructure at the site and/or construction activity) or lesser (due to the reduced amount of infrastructure and lack of moving turbine blades) than during the operational phase.

Results of these additional analyses are presented in Annex E.

2.8. Metrics assessed

In accordance with NatureScot guidance (NatureScot, 2023a), counterfactual growth rate (the ratio of the impacted population growth rate to the baseline population growth rate) and counterfactual population size (the ratio of the impacted population size to the baseline population size) were generated to inform EIA conclusions. These metrics, particularly the former, are generally used in this context as they are relatively insensitive to misspecification of input parameters (Cook and Robinson, 2016). A counterfactual growth rate of 1 would mean that there was no difference in the population growth rate between the baseline and impact scenarios, whilst a counterfactual population growth rate of 0.998 would mean that the population growth rate in the impact scenario is 99.8% that of the baseline scenario.

For each run, the counterfactual population size and the counterfactual growth rate based on comparing the last year prior to impact (2031) with years of interest (2057, 2067 and 2082) were calculated for each impact scenario. These are presented alongside absolute predicted population sizes, population growth rates, and figures showing the predicted population trajectories.

3. Results

3.1. Kittiwake

3.1.1. Project-only

Simulated population sizes and counterfactual population sizes for project-only kittiwake scenarios after 25, 35, and 50 years of operation are presented in Table 3.1. Growth rates and counterfactual growth rates for the same years are presented in Table 3.2. Visual representations of the population projections from the PVA modelling are presented in Annex F. It should be noted that population trajectories predicted in the kittiwake PVAs suggest a trend of population increase whilst trends from survey data indicate that kittiwake populations have been declining across Scotland (a 57% decline between the Seabird 2000 census and the latest census - Burnell et al., 2023 – which, based on an average count interval of 18 years, translates to a population growth rate of 0.954). However, these models have been constructed using the demographic parameters agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor at NatureScot, 17th May, 2024) and we also note that the key metrics used to assess the difference among scenarios (the counterfactual growth rate and the counterfactual population size) are relative, and, as noted previously, are therefore relatively insensitive to deviations in population trend (Cook and Robinson, 2016).

Table 3.1: Median simulated population sizes (breeding pairs) and counterfactual population sizes for kittiwake. Values are median values with 95% confidence intervals in brackets.

Population	Scenario (distributional response mortality rate)	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Buchan Ness to Collieston Coast SPA	Baseline	17509 (12564 - 23607)	41546 (21393 - 78666)	-	57257 (26853 - 119948)	-	95098 (39316 - 220307)	-
	Higher	17506 (12520 - 23590)	40802 (20958 - 77012)	0.981 (0.957 - 1.010)	55740 (26120 - 117111)	0.973 (0.948 - 1.000)	91227 (38027 - 213023)	0.962 (0.935 - 0.990)
	Lower	17506 (12572 - 23621)	40740 (20926 - 76888)	0.981 (0.957 - 1.010)	55790 (25975 - 117209)	0.973 (0.948 - 1.000)	91483 (37586 - 212289)	0.962 (0.936 - 0.990)
Troup, Pennan and Lion's Heads SPA	Baseline	18286 (12891 - 25066)	43443 (21698 - 83286)	-	60317 (27446 - 127119)	-	99428 (39356 - 234693)	-
	Higher	18293 (12898 - 25088)	42858 (21485 - 81909)	0.988 (0.963 - 1.010)	59250 (26797 - 125517)	0.983 (0.957 - 1.010)	96988 (38657 - 229660)	0.977 (0.949 - 1.000)
	Lower	18295 (12853 - 25061)	42885 (21436 - 82245)	0.988 (0.963 - 1.010)	59312 (26748 - 125112)	0.983 (0.957 - 1.010)	96899 (38430 - 229383)	0.977 (0.949 - 1.000)
Regional	Baseline	130250 (93551 - 175969)	188157 (96540 - 357325)	-	214713 (100560 - 454783)	-	266725 (109984 - 625845)	-
	Higher	130221 (93758 - 175986)	185981 (95821 - 353828)	0.991 (0.981 - 1.001)	211906 (98587 - 448442)	0.987 (0.976 - 0.998)	260991 (108091 - 615216)	0.981 (0.969 - 0.993)
	Lower	130262 (93365 - 176004)	186074 (95856 - 354163)	0.991 (0.981 - 1.001)	211763 (98466 - 447386)	0.987 (0.976 - 0.998)	260994 (107801 - 614403)	0.982 (0.969 - 0.994)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.2: Simulated growth rates and counterfactual growth rates for kittiwake. Values are median values with 95% confidence intervals in brackets.

Population	Scenario (distributional response mortality rate)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Buchan Ness to Collieston Coast SPA	Baseline	1.034 (1.010 - 1.057)	-	1.034 (1.013 - 1.054)	-	1.034 (1.017 - 1.050)	-
	Higher	1.033 (1.009 - 1.057)	0.999 (0.998 - 1.000)	1.033 (1.012 - 1.053)	0.999 (0.999 - 1.000)	1.033 (1.016 - 1.050)	0.999 (0.999 - 1.000)
	Lower	1.033 (1.009 - 1.057)	0.999 (0.998 - 1.000)	1.033 (1.012 - 1.053)	0.999 (0.999 - 1.000)	1.033 (1.016 - 1.050)	0.999 (0.999 - 1.000)
Troup, Pennan and Lion's Heads SPA	Baseline	1.034 (1.009 - 1.058)	-	1.034 (1.012 - 1.054)	-	1.034 (1.016 - 1.051)	-
	Higher	1.034 (1.008 - 1.057)	1.000 (0.999 - 1.000)	1.034 (1.012 - 1.054)	1.000 (0.999 - 1.000)	1.033 (1.015 - 1.050)	1.000 (0.999 - 1.000)

Population	Scenario (distributional response mortality rate)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
	Lower	1.034 (1.008 - 1.057)	1.000 (0.999 - 1.000)	1.034 (1.012 - 1.054)	1.000 (0.999 - 1.000)	1.033 (1.016 - 1.050)	1.000 (0.999 - 1.000)
Regional	Baseline	1.014 (0.991 - 1.038)	-	1.014 (0.994 - 1.034)	-	1.014 (0.998 - 1.031)	-
	Higher	1.014 (0.990 - 1.037)	1.000 (0.999 - 1.000)	1.014 (0.993 - 1.034)	1.000 (0.999 - 1.000)	1.014 (0.997 - 1.030)	1.000 (0.999 - 1.000)
	Lower	1.014 (0.990 - 1.037)	1.000 (0.999 - 1.000)	1.014 (0.993 - 1.034)	1.000 (0.999 - 1.000)	1.014 (0.997 - 1.030)	1.000 (0.999 - 1.000)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

3.1.2. Cumulative impacts

Simulated population sizes and counterfactual population sizes for cumulative kittiwake scenarios after 25, 35, and 50 years of operation are presented in Table 3.3. Growth rates and counterfactual growth rates for the same years are presented in Table 3.4. Visual representations of the population projections from the PVA modelling are presented in Annex F. As above, it should be noted that baseline population trajectories predicted in the kittiwake PVAs suggest a trend of population increase whilst trends from survey data indicate that kittiwake populations have been declining across Scotland. For the Cape Wrath population, this discrepancy is smaller, since the population has only declined by 6% according to Burnell *et al.*, 2023, translating into a population growth rate of 0.997 for that population. Also as noted before, these models have been constructed using the demographic parameters agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor at NatureScot, 17th May, 2024) and relative metrics which are relatively insensitive to deviation in population trends (Cook and Robinson, 2016) have been used to assess the difference among scenarios.

Table 3.3: Median simulated population sizes (breeding pairs) and counterfactual population sizes for kittiwake. Values are median values with 95% confidence intervals in brackets.

Population	Scenario (distributional response mortality rate)	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Buchan Ness to Collieston Coast SPA	Baseline	17513 (12552 - 23631)	41606 (21367 - 78518)	-	57316 (26858 - 119987)	-	94958 (39519 - 220589)	-
	Higher (no BB/GV)	17514 (12570 - 23644)	37920 (19398 - 71918)	0.912 (0.888 - 0.936)	50537 (23577 - 105725)	0.880 (0.857 - 0.905)	79542 (33140 - 186137)	0.838 (0.815 - 0.864)
	Higher (with BB/GV)	17490 (12534 - 23601)	37755 (19236 - 71413)	0.908 (0.884 - 0.930)	50130 (23397 - 104383)	0.875 (0.850 - 0.898)	79043 (32528 - 183851)	0.831 (0.806 - 0.854)
	Lower displacement (no BB/GV)	17484 (12548 - 23585)	38678 (19735 - 73233)	0.930 (0.907 - 0.954)	51970 (24175 - 108988)	0.905 (0.881 - 0.930)	82917 (34261 - 192572)	0.870 (0.845 - 0.896)
	Lower (with BB/GV)	17511 (12527 - 23606)	38474 (19834 - 72992)	0.927 (0.904 - 0.950)	51558 (24169 - 108207)	0.900 (0.875 - 0.924)	82236 (33897 - 191342)	0.864 (0.839 - 0.889)
Cape Wrath SPA	Baseline	5742 (3726 - 8348)	13460 (6455 - 26898)	-	18667 (8133 - 40508)	-	30875 (11951 - 74467)	-
	Higher	5746 (3744 - 8347)	13156 (6399 - 26139)	0.978 (0.929 - 1.030)	18168 (8000 - 39471)	0.971 (0.918 - 1.024)	29462 (11414 - 71998)	0.960 (0.906 - 1.015)
	Lower	5745 (3740 - 8343)	13250 (6372 - 26506)	0.984 (0.936 - 1.037)	18298 (8048 - 39969)	0.978 (0.928 - 1.033)	29866 (11440 - 72390)	0.969 (0.917 - 1.026)

Population	Scenario (distributional response mortality rate)	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
East Caithness Cliffs SPA	Baseline	38855 (25263 - 56449)	90997 (43862 - 181335)	-	126195 (55377 - 275276)	-	208258 (80438 - 506252)	-
	Higher (no BB/GV)	38814 (25313 - 56463)	76678 (36754 - 152875)	0.842 (0.824 - 0.859)	99637 (43603 - 217443)	0.789 (0.771 - 0.806)	149874 (57676 - 366518)	0.721 (0.703 - 0.738)
	Higher (with BB/GV)	38804 (25315 - 56475)	76577 (36882 - 153112)	0.841 (0.823 - 0.859)	99467 (43524 - 218217)	0.788 (0.771 - 0.806)	149587 (57540 - 365898)	0.721 (0.703 - 0.737)
	Lower (no BB/GV)	38842 (25319 - 56450)	81192 (38946 - 161809)	0.892 (0.873 - 0.909)	107868 (47312 - 235365)	0.854 (0.835 - 0.872)	167284 (64666 - 405894)	0.804 (0.785 - 0.822)
	Lower (with BB/GV)	38812 (25287 - 56456)	81162 (39237 - 161534)	0.891 (0.873 - 0.909)	107834 (47233 - 235580)	0.853 (0.835 - 0.871)	167022 (64026 - 406729)	0.804 (0.785 - 0.822)
Farne Islands	Baseline	4629 (3315 - 6263)	10984 (5674 - 20797)	-	15170 (7137 - 31720)	-	25154 (10491 - 58275)	-
	Higher (no BB/GV)	4625 (3312 - 6258)	10249 (5246 - 19434)	0.933 (0.889 - 0.981)	13766 (6511 - 28711)	0.908 (0.862 - 0.960)	21914 (9071 - 51002)	0.876 (0.828 - 0.928)
	Higher (with BB/GV)	4632 (3317 - 6253)	9644 (4961 - 18384)	0.877 (0.834 - 0.923)	12659 (5926 - 26672)	0.835 (0.792 - 0.881)	19629 (8007 - 45963)	0.781 (0.737 - 0.826)
	Lower (no BB/GV)	4634 (3317 - 6251)	10465 (5364 - 19766)	0.953 (0.908 - 1.002)	14194 (6627 - 29591)	0.936 (0.888 - 0.988)	22993 (9505 - 53914)	0.913 (0.862 - 0.965)
	Lower (with BB/GV)	4630 (3321 - 6250)	9958 (5090 - 18887)	0.907 (0.864 - 0.953)	13256 (6140 - 27853)	0.874 (0.829 - 0.922)	20908 (8594 - 48720)	0.831 (0.786 - 0.880)
Forth Islands	Baseline	8852 (6225 - 12151)	21010 (10560 - 40515)	-	29184 (13245 - 61599)	-	48037 (19158 - 114199)	-
	Higher (no BB/GV)	8868 (6229 - 12111)	19446 (9695 - 37320)	0.926 (0.891 - 0.959)	26216 (11854 - 55412)	0.898 (0.863 - 0.934)	41406 (16550 - 98390)	0.863 (0.826 - 0.899)
	Higher (with BB/GV)	8861 (6251 - 12129)	18656 (9275 - 35853)	0.887 (0.854 - 0.921)	24735 (11182 - 52512)	0.848 (0.814 - 0.882)	38302 (15187 - 91405)	0.797 (0.764 - 0.832)
	Lower (no BB/GV)	8859 (6237 - 12140)	19945 (9881 - 38265)	0.949 (0.914 - 0.985)	27188 (12259 - 57158)	0.931 (0.894 - 0.968)	43496 (17270 - 103233)	0.906 (0.867 - 0.943)
	Lower (with BB/GV)	8860 (6240 - 12108)	19298 (9604 - 37198)	0.918 (0.884 - 0.952)	25954 (11754 - 54444)	0.888 (0.853 - 0.924)	40815 (16127 - 96858)	0.850 (0.815 - 0.887)
Fowlsheugh	Baseline	21486 (14689 - 30210)	50752 (25083 - 98297)	-	70814 (32038 - 150074)	-	115748 (46798 - 281746)	-
	Higher (no BB/GV)	21460 (14714 - 30237)	45862 (22552 - 89099)	0.902 (0.880 - 0.924)	61309 (27804 - 130943)	0.868 (0.845 - 0.890)	94999 (38297 - 231649)	0.822 (0.799 - 0.845)
	Higher (with BB/GV)	21475 (14678 - 30241)	43395 (21300 - 84229)	0.854 (0.834 - 0.876)	56846 (25788 - 121278)	0.805 (0.783 - 0.827)	85703 (34428 - 210004)	0.742 (0.720 - 0.764)

Population	Scenario (distributional response mortality rate)	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
	Lower (no BB/GV)	21468 (14743 - 30171)	47036 (23183 - 91219)	0.926 (0.903 - 0.949)	63664 (28718 - 135336)	0.899 (0.876 - 0.923)	99780 (40224 - 243668)	0.864 (0.839 - 0.888)
	Lower (with BB/GV)	21464 (14716 - 30205)	45018 (22182 - 87467)	0.887 (0.865 - 0.908)	59806 (27085 - 128671)	0.847 (0.825 - 0.869)	91894 (37199 - 225360)	0.796 (0.774 - 0.818)
North Caithness Cliffs	Baseline	9179 (5869 - 13603)	21459 (10422 - 44381)	-	29893 (13168 - 66000)	-	49000 (19241 - 123049)	-
	Higher (no BB/GV)	9196 (5870 - 13522)	18566 (8978 - 38418)	0.865 (0.829 - 0.901)	24477 (10798 - 54179)	0.818 (0.784 - 0.855)	37170 (14489 - 94599)	0.759 (0.724 - 0.793)
	Higher (with BB/GV)	9181 (5859 - 13493)	18547 (8977 - 38391)	0.864 (0.830 - 0.900)	24429 (10842 - 54178)	0.817 (0.782 - 0.855)	37079 (14556 - 93754)	0.758 (0.724 - 0.794)
	Lower (no BB/GV)	9192 (5844 - 13570)	19322 (9427 - 39864)	0.902 (0.864 - 0.940)	25909 (11441 - 57231)	0.867 (0.830 - 0.906)	40210 (15672 - 101469)	0.821 (0.784 - 0.860)
	Lower (with BB/GV)	9196 (5840 - 13561)	19340 (9438 - 40041)	0.902 (0.863 - 0.940)	25909 (11495 - 57248)	0.867 (0.828 - 0.906)	40322 (15579 - 101904)	0.821 (0.783 - 0.859)
St Abb's Head to Fast Castle	Baseline	5919 (4232 - 8010)	14040 (7215 - 26662)	-	19399 (9133 - 40469)	-	32082 (13226 - 74792)	-
	Higher (no BB/GV)	5915 (4241 - 7985)	12866 (6590 - 24273)	0.916 (0.876 - 0.957)	17134 (7995 - 35896)	0.885 (0.845 - 0.926)	27148 (11160 - 63402)	0.845 (0.804 - 0.887)
	Higher (with BB/GV)	5921 (4229 - 8000)	7406 (3716 - 14347)	0.527 (0.498 - 0.557)	8026 (3684 - 17307)	0.414 (0.388 - 0.439)	9614 (3832 - 22919)	0.299 (0.278 - 0.319)
	Lower (no BB/GV)	5914 (4246 - 7981)	13234 (6792 - 25263)	0.942 (0.903 - 0.985)	17850 (8311 - 37440)	0.920 (0.881 - 0.965)	28644 (11948 - 66856)	0.893 (0.849 - 0.936)
	Lower (with BB/GV)	5911 (4240 - 7973)	8500 (4316 - 16395)	0.605 (0.573 - 0.636)	9724 (4473 - 20724)	0.501 (0.471 - 0.529)	12492 (4994 - 29718)	0.388 (0.362 - 0.412)
Troup, Pennan and Lion's Heads	Baseline	18299 (12892 - 25113)	43404 (21638 - 82802)	-	60319 (27356 - 126858)	-	99204 (39510 - 234860)	-
	Higher (no BB/GV)	18294 (12875 - 25052)	39530 (19630 - 75889)	0.910 (0.887 - 0.933)	53003 (23830 - 111824)	0.878 (0.854 - 0.902)	82828 (32738 - 197258)	0.835 (0.811 - 0.860)
	Higher (with BB/GV)	18299 (12908 - 25038)	39412 (19715 - 75828)	0.908 (0.885 - 0.931)	52822 (23914 - 111335)	0.875 (0.851 - 0.899)	82505 (32749 - 195485)	0.832 (0.807 - 0.856)
	Lower (no BB/GV)	18287 (12890 - 25022)	40578 (20328 - 78231)	0.935 (0.911 - 0.959)	54879 (24898 - 115977)	0.911 (0.887 - 0.936)	87344 (34521 - 206950)	0.879 (0.855 - 0.906)
	Lower (with BB/GV)	18281 (12894 - 25024)	40543 (20114 - 77879)	0.933 (0.910 - 0.957)	54925 (24797 - 115354)	0.909 (0.884 - 0.933)	86958 (34479 - 206313)	0.876 (0.851 - 0.901)
West Westray	Baseline	3445 (2312 - 4974)	8190 (4030 - 16189)	-	11405 (5177 - 23989)	-	18739 (7421 - 44618)	-
	Higher	3450 (2330 - 4984)	5938 (2898 - 11822)	0.727 (0.681 - 0.774)	7350 (3304 - 15467)	0.644 (0.602 - 0.689)	10222 (4035 - 24541)	0.545 (0.506 - 0.586)

Population	Scenario (distributional response mortality rate)	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
	Lower	3448 (2311 - 4996)	6571 (3181 - 13017)	0.804 (0.754 - 0.856)	8457 (3761 - 17808)	0.740 (0.691 - 0.789)	12372 (4808 - 29533)	0.660 (0.614 - 0.707)
Regional	Baseline	130230 (93585 - 175846)	187873 (96617 - 357309)	-	214538 (99864 - 452240)	-	266150 (110262 - 627081)	-
	Higher (no BB/GV)	130217 (93486 - 175861)	166240 (84981 - 316867)	0.885 (0.875 - 0.894)	181083 (84159 - 384422)	0.844 (0.833 - 0.854)	210394 (86850 - 498177)	
	Higher (no BB/GV)	130217 (93486 - 175861)	166240 (84981 - 316867)	0.885 (0.875 - 0.894)	181083 (84159 - 384422)			0.791 (0.780 - 0.802)
	Higher (with BB/GV)	130242 (93494 - 176018)	159294 (81353 - 304387)	0.848 (0.837 - 0.858)	170958 (79305 - 363114)	0.796 (0.785 - 0.806)	194286 (79633 - 460502)	0.730 (0.718 - 0.741)
	Lower (no BB/GV)	130218 (93578 - 175798)	172257 (88124 - 328500)	0.917 (0.907 - 0.927)	190528 (88519 - 402782)	0.887 (0.876 - 0.898)	225392 (93264 - 531534)	0.848 (0.836 - 0.859)
	Lower (with BB/GV)	130206 (93662 - 175764)	166572 (85410 - 318865)	0.886 (0.876 - 0.896)	181912 (84514 - 385105)	0.847 (0.835 - 0.857)	211639 (86797 - 500905)	0.795 (0.783 - 0.806)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.4: Simulated growth rates and counterfactual growth rates for kittiwake. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Buchan Ness to Collieston Coast SPA	Baseline	1.034 (1.010 - 1.058)	-	1.034 (1.013 - 1.054)	-	1.034 (1.017 - 1.050)	-
	Higher (no BB/GV)	1.030 (1.006 - 1.054)	0.996 (0.996 - 0.997)	1.030 (1.009 - 1.050)	0.996 (0.996 - 0.997)	1.030 (1.013 - 1.047)	0.997 (0.996 - 0.997)
	Higher (with BB/GV)	1.030 (1.006 - 1.054)	0.996 (0.995 - 0.997)	1.030 (1.009 - 1.050)	0.996 (0.996 - 0.997)	1.030 (1.013 - 1.047)	0.996 (0.996 - 0.997)
	Lower (no BB/GV)	1.031 (1.007 - 1.055)	0.997 (0.996 - 0.998)	1.031 (1.010 - 1.051)	0.997 (0.997 - 0.998)	1.031 (1.014 - 1.048)	0.997 (0.997 - 0.998)
	Lower (with BB/GV)	1.031 (1.007 - 1.054)	0.997 (0.996 - 0.998)	1.031 (1.010 - 1.051)	0.997 (0.996 - 0.998)	1.031 (1.014 - 1.047)	0.997 (0.997 - 0.998)
Cape Wrath SPA	Baseline	1.034 (1.009 - 1.057)	-	1.034 (1.013 - 1.054)	-	1.034 (1.016 - 1.051)	-
	Higher	1.033 (1.008 - 1.057)	0.999 (0.998 - 1.001)	1.033 (1.012 - 1.053)	0.999 (0.998 - 1.000)	1.033 (1.015 - 1.050)	0.999 (0.998 - 1.000)
	Lower	1.033 (1.008 - 1.057)	0.999 (0.998 - 1.001)	1.033 (1.013 - 1.054)	0.999 (0.998 - 1.001)	1.033 (1.015 - 1.050)	0.999 (0.999 - 1.000)
East Caithness Cliffs	Baseline	1.034 (1.009 - 1.058)	-	1.034 (1.013 - 1.054)	-	1.034 (1.016 - 1.051)	-
	Higher (no BB/GV)	1.027 (1.002 - 1.051)	0.993 (0.993 - 0.994)	1.027 (1.006 - 1.047)	0.993 (0.993 - 0.994)	1.027 (1.009 - 1.044)	0.994 (0.993 - 0.994)
	Higher (with BB/GV)	1.027 (1.002 - 1.051)	0.993 (0.993 - 0.994)	1.027 (1.006 - 1.048)	0.993 (0.993 - 0.994)	1.027 (1.009 - 1.044)	0.994 (0.993 - 0.994)
	Lower (no BB/GV)	1.029 (1.004 - 1.053)	0.996 (0.995 - 0.996)	1.029 (1.008 - 1.050)	0.996 (0.995 - 0.996)	1.029 (1.012 - 1.046)	0.996 (0.995 - 0.996)
	Lower (with BB/GV)	1.029 (1.004 - 1.053)	0.996 (0.995 - 0.996)	1.029 (1.009 - 1.050)	0.996 (0.995 - 0.996)	1.029 (1.012 - 1.046)	0.996 (0.995 - 0.996)
Farne Islands	Baseline	1.034 (1.010 - 1.058)	-	1.034 (1.013 - 1.054)	-	1.034 (1.017 - 1.050)	-
	Higher (no BB/GV)	1.031 (1.007 - 1.055)	0.997 (0.996 - 0.999)	1.031 (1.010 - 1.051)	0.997 (0.996 - 0.999)	1.031 (1.014 - 1.048)	0.997 (0.996 - 0.998)

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
	Higher (with BB/GV)	1.029 (1.005 - 1.052)	0.995 (0.993 - 0.997)	1.029 (1.008 - 1.049)	0.995 (0.994 - 0.996)	1.029 (1.012 - 1.046)	0.995 (0.994 - 0.996)
	Lower (no BB/GV)	1.032 (1.008 - 1.056)	0.998 (0.997 - 1.000)	1.032 (1.011 - 1.052)	0.998 (0.997 - 0.999)	1.032 (1.015 - 1.048)	0.998 (0.997 - 0.999)
	Lower (with BB/GV)	1.030 (1.006 - 1.054)	0.996 (0.995 - 0.998)	1.030 (1.009 - 1.050)	0.996 (0.995 - 0.998)	1.030 (1.013 - 1.047)	0.996 (0.995 - 0.997)
Forth Islands	Baseline	1.034 (1.009 - 1.058)	-	1.034 (1.012 - 1.054)	-	1.034 (1.016 - 1.050)	-
	Higher (no BB/GV)	1.031 (1.006 - 1.055)	0.997 (0.996 - 0.998)	1.031 (1.009 - 1.051)	0.997 (0.996 - 0.998)	1.031 (1.013 - 1.048)	0.997 (0.996 - 0.998)
	Higher (with BB/GV)	1.029 (1.004 - 1.053)	0.995 (0.994 - 0.997)	1.029 (1.007 - 1.050)	0.995 (0.994 - 0.996)	1.029 (1.011 - 1.046)	0.996 (0.995 - 0.996)
	Lower (no BB/GV)	1.032 (1.007 - 1.056)	0.998 (0.997 - 0.999)	1.032 (1.010 - 1.052)	0.998 (0.997 - 0.999)	1.032 (1.014 - 1.049)	0.998 (0.997 - 0.999)
	Lower (with BB/GV)	1.031 (1.005 - 1.054)	0.997 (0.996 - 0.998)	1.031 (1.009 - 1.051)	0.997 (0.996 - 0.998)	1.031 (1.013 - 1.047)	0.997 (0.996 - 0.998)
Fowlsheugh	Baseline	1.034 (1.009 - 1.057)	-	1.034 (1.013 - 1.054)	-	1.034 (1.016 - 1.050)	-
	Higher (no BB/GV)	1.030 (1.005 - 1.053)	0.996 (0.995 - 0.997)	1.030 (1.009 - 1.050)	0.996 (0.995 - 0.997)	1.030 (1.012 - 1.046)	0.996 (0.996 - 0.997)
	Higher (with BB/GV)	1.027 (1.002 - 1.051)	0.994 (0.993 - 0.995)	1.028 (1.007 - 1.048)	0.994 (0.993 - 0.995)	1.028 (1.010 - 1.044)	0.994 (0.994 - 0.995)
	Lower (no BB/GV)	1.031 (1.006 - 1.054)	0.997 (0.996 - 0.998)	1.031 (1.010 - 1.051)	0.997 (0.996 - 0.998)	1.031 (1.013 - 1.047)	0.997 (0.997 - 0.998)
	Lower (with BB/GV)	1.029 (1.004 - 1.053)	0.995 (0.995 - 0.996)	1.029 (1.008 - 1.049)	0.995 (0.995 - 0.996)	1.029 (1.012 - 1.046)	0.996 (0.995 - 0.996)
North Caithness Cliffs	Baseline	1.034 (1.009 - 1.058)	-	1.034 (1.013 - 1.054)	-	1.034 (1.016 - 1.050)	-
	Higher (no BB/GV)	1.028 (1.003 - 1.052)	0.994 (0.993 - 0.996)	1.028 (1.007 - 1.048)	0.994 (0.993 - 0.995)	1.028 (1.011 - 1.045)	0.995 (0.994 - 0.995)
	Higher (with BB/GV)	1.028 (1.003 - 1.052)	0.994 (0.993 - 0.996)	1.028 (1.007 - 1.048)	0.994 (0.993 - 0.995)	1.028 (1.011 - 1.045)	0.995 (0.994 - 0.995)
	Lower (no BB/GV)	1.030 (1.005 - 1.054)	0.996 (0.995 - 0.997)	1.030 (1.009 - 1.049)	0.996 (0.995 - 0.997)	1.030 (1.013 - 1.046)	0.996 (0.995 - 0.997)
	Lower (with BB/GV)	1.029 (1.005 - 1.054)	0.996 (0.995 - 0.997)	1.030 (1.009 - 1.049)	0.996 (0.995 - 0.997)	1.030 (1.013 - 1.046)	0.996 (0.995 - 0.997)
St Abb's Head to Fast Castle	Baseline	1.034 (1.010 - 1.057)	-	1.034 (1.013 - 1.054)	-	1.034 (1.017 - 1.050)	-
	Higher (no BB/GV)	1.030 (1.006 - 1.054)	0.997 (0.995 - 0.998)	1.030 (1.010 - 1.051)	0.997 (0.995 - 0.998)	1.030 (1.013 - 1.047)	0.997 (0.996 - 0.998)
	Higher (with BB/GV)	1.009 (0.984 - 1.033)	0.976 (0.974 - 0.978)	1.009 (0.988 - 1.029)	0.976 (0.974 - 0.977)	1.009 (0.992 - 1.027)	0.977 (0.975 - 0.978)
	Lower (no BB/GV)	1.031 (1.008 - 1.055)	0.998 (0.996 - 0.999)	1.031 (1.011 - 1.052)	0.998 (0.997 - 0.999)	1.031 (1.015 - 1.048)	0.998 (0.997 - 0.999)
	Lower (with BB/GV)	1.014 (0.990 - 1.038)	0.981 (0.979 - 0.983)	1.014 (0.993 - 1.035)	0.981 (0.979 - 0.982)	1.015 (0.998 - 1.032)	0.982 (0.980 - 0.983)
Troup, Pennan and Lion's Heads	Baseline	1.034 (1.009 - 1.058)	-	1.034 (1.012 - 1.054)	-	1.034 (1.016 - 1.050)	-
	Higher (no BB/GV)	1.030 (1.005 - 1.054)	0.996 (0.996 - 0.997)	1.030 (1.008 - 1.050)	0.996 (0.996 - 0.997)	1.030 (1.012 - 1.047)	0.996 (0.996 - 0.997)
	Higher (with BB/GV)	1.030 (1.005 - 1.054)	0.996 (0.995 - 0.997)	1.030 (1.008 - 1.050)	0.996 (0.996 - 0.997)	1.030 (1.012 - 1.047)	0.996 (0.996 - 0.997)
	Lower (no BB/GV)	1.032 (1.006 - 1.055)	0.997 (0.997 - 0.998)	1.031 (1.010 - 1.052)	0.997 (0.997 - 0.998)	1.031 (1.013 - 1.048)	0.997 (0.997 - 0.998)
	Lower (with BB/GV)	1.031 (1.006 - 1.055)	0.997 (0.996 - 0.998)	1.031 (1.010 - 1.051)	0.997 (0.997 - 0.998)	1.031 (1.013 - 1.048)	0.997 (0.997 - 0.998)
West Westray	Baseline	1.034 (1.009 - 1.058)	-	1.034 (1.012 - 1.054)	-	1.034 (1.016 - 1.050)	-
	Higher	1.021 (0.996 - 1.045)	0.988 (0.986 - 0.990)	1.021 (1.000 - 1.041)	0.988 (0.986 - 0.989)	1.022 (1.004 - 1.038)	0.988 (0.987 - 0.989)
	Lower	1.025 (1.000 - 1.049)	0.992 (0.990 - 0.994)	1.025 (1.004 - 1.045)	0.992 (0.990 - 0.993)	1.025 (1.008 - 1.042)	0.992 (0.991 - 0.993)
Regional	Baseline	1.014 (0.991 - 1.038)	-	1.014 (0.994 - 1.034)	-	1.014 (0.998 - 1.031)	-
	Higher (no BB/GV)	1.009 (0.986 - 1.033)	0.995 (0.995 - 0.996)	1.009 (0.989 - 1.029)	0.995 (0.995 - 0.996)	1.009 (0.993 - 1.026)	0.995 (0.995 - 0.996)
	Higher (with BB/GV)	1.008 (0.984 - 1.031)	0.994 (0.993 - 0.994)	1.008 (0.987 - 1.028)	0.994 (0.993 - 0.994)	1.008 (0.991 - 1.024)	0.994 (0.994 - 0.994)
	Lower (no BB/GV)	1.011 (0.987 - 1.034)	0.997 (0.996 - 0.997)	1.011 (0.990 - 1.031)	0.997 (0.996 - 0.997)	1.011 (0.994 - 1.027)	0.997 (0.997 - 0.997)

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
	Lower (with BB/GV)	1.009 (0.986 - 1.033)	0.995 (0.995 - 0.996)	1.009 (0.989 - 1.030)	0.995 (0.995 - 0.996)	1.010 (0.993 - 1.026)	0.996 (0.995 - 0.996)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

3.2. Herring gull

3.2.1. Cumulative impacts

Simulated population sizes and counterfactual population sizes for cumulative herring gull scenarios after 25, 35, and 50 years of operation are presented in Table 3.3. Growth rates and counterfactual growth rates for the same years are presented in Table 3.4. Visual representations of the population projections from the PVA modelling are presented in Annex F. It should be noted that the baseline population trajectory predicted in the herring gull PVA suggests a trend of population increase whilst trends from census data indicate that the Banff and Buchan herring gull population has been declining (a -3.7% decline between the Seabird 2000 census and the latest census - Burnell et al., 2023 – which, based on an average count interval of 18 years, translates to a population growth rate of 0.998). However, these models have been constructed using the demographic parameters agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor at NatureScot, 17th May, 2024) and we also note that the key metrics used to assess the difference among scenarios (the counterfactual growth rate and the counterfactual population size) are relative, and, as noted previously, are therefore relatively insensitive to deviation in population trend (Cook and Robinson, 2016).

Table 3.5: Median simulated population sizes (breeding pairs) and counterfactual population sizes for herring gull. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Buchan Ness to Collieston Coast SPA	Baseline	2370 (1731 - 3243)	2705 (1428 - 5066)	-	2852 (1331 - 5849)	-	3086 (1250 - 6988)	-
	No BB/GV	2372 (1732 - 3256)	2650 (1394 - 4984)	0.981 (0.907 - 1.057)	2770 (1290 - 5655)	0.972 (0.894 - 1.059)	2954 (1209 - 6701)	0.962 (0.871 - 1.063)
	With BB/GV	2368 (1726 - 3246)	2653 (1393 - 4955)	0.980 (0.908 - 1.058)	2768 (1301 - 5682)	0.973 (0.892 - 1.058)	2972 (1222 - 6733)	0.963 (0.873 - 1.062)
Regional	Baseline	2431 (1778 - 3338)	2788 (1452 - 5243)	-	2929 (1383 - 6024)	-	3162 (1284 - 7191)	-
	No BB/GV	2432 (1781 - 3324)	2728 (1429 - 5118)	0.981 (0.908 - 1.055)	2853 (1325 - 5898)	0.972 (0.895 - 1.057)	3042 (1259 - 6906)	0.963 (0.875 - 1.061)
	With BB/GV	2434 (1777 - 3324)	2723 (1438 - 5081)	0.981 (0.909 - 1.055)	2850 (1338 - 5815)	0.973 (0.893 - 1.057)	3046 (1237 - 6928)	0.963 (0.872 - 1.059)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.6: Simulated growth rates and counterfactual growth rates for herring gull. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Buchan Ness to Collieston Coast SPA	Baseline	1.005 (0.981 - 1.029)	-	1.005 (0.985 - 1.024)	-	1.005 (0.988 - 1.021)	-
	No BB/GV	1.005 (0.980 - 1.028)	0.999 (0.997 - 1.002)	1.005 (0.984 - 1.024)	0.999 (0.997 - 1.001)	1.004 (0.987 - 1.020)	0.999 (0.997 - 1.001)
	With BB/GV	1.005 (0.980 - 1.028)	0.999 (0.997 - 1.002)	1.005 (0.984 - 1.024)	0.999 (0.997 - 1.001)	1.004 (0.987 - 1.020)	0.999 (0.997 - 1.001)
Regional	Baseline	1.005 (0.981 - 1.029)	-	1.005 (0.984 - 1.025)	-	1.005 (0.988 - 1.021)	-

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
	No BB/GV	1.005 (0.980 - 1.028)	0.999 (0.997 - 1.002)	1.005 (0.984 - 1.024)	0.999 (0.997 - 1.001)	1.005 (0.987 - 1.020)	0.999 (0.997 - 1.001)
	With BB/GV	1.005 (0.980 - 1.028)	0.999 (0.996 - 1.002)	1.005 (0.984 - 1.024)	0.999 (0.997 - 1.001)	1.005 (0.987 - 1.020)	0.999 (0.997 - 1.001)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

3.3. Guillemot

3.3.1. Project-only

Simulated population sizes and counterfactual population sizes for project-only guillemot scenarios after 25, 35, and 50 years of operation are presented in Table 3.7. Growth rates and counterfactual growth rates for the same years are presented in Table 3.8. Visual representations of the population projections from the PVA modelling are presented in Annex F. It should be noted that population trajectories predicted in the guillemot PVAs suggest a trend of population increase whilst trends from survey data indicate that kittiwake populations have been declining across Scotland (a 31% decline between the Seabird 2000 census and the latest census - Burnell et al., 2023 – which, based on an average count interval of 18 years, translates to a population growth rate of 0.980). However, these models have been constructed using the demographic parameters agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor at NatureScot, 17th May, 2024) and we also note that the key metrics used to assess the difference among scenarios (the counterfactual growth rate and the counterfactual population size) are relative, and, as noted previously, are therefore relatively insensitive to deviation in population trend (Cook and Robinson, 2016).

Table 3.7: Median simulated population sizes (breeding pairs) and counterfactual population sizes for guillemot. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Buchan Ness to Collieston Coast SPA	Baseline	25604 (23000 - 28350)	55362 (44248 - 68135)	-	74681 (57389 - 94842)	-	116018 (85636 - 154890)	-
	Higher	25587 (22990 - 28380)	52933 (42266 - 65223)	0.955 (0.941 - 0.970)	70057 (53791 - 89132)	0.939 (0.924 - 0.954)	106241 (78520 - 141783)	0.916 (0.900 - 0.931)
	Lower	25585 (23001 - 28384)	54606 (43577 - 67299)	0.985 (0.970 - 1.000)	73007 (56153 - 92938)	0.979 (0.964 - 0.995)	112712 (83054 - 150195)	0.971 (0.955 - 0.988)
Troup, Pennan and Lion's Heads SPA	Baseline	29961 (26909 - 33223)	64830 (51764 - 79899)	-	87276 (67069 - 111091)	-	135863 (100212 - 181457)	-
	Higher	29965 (26943 - 33206)	63353 (50676 - 77981)	0.977 (0.963 - 0.990)	84492 (65040 - 107596)	0.968 (0.954 - 0.982)	129750 (95943 - 173325)	0.955 (0.940 - 0.971)
	Lower	29961 (26915 - 33205)	64313 (51323 - 79257)	0.992 (0.979 - 1.010)	86313 (66390 - 110033)	0.989 (0.974 - 1.000)	133689 (98918 - 178352)	0.984 (0.969 - 1.000)
Regional	Baseline	57060 (51286 - 63215)	123518 (98697 - 152210)	-	166285 (127860 - 212009)	-	258807 (191325 - 344695)	-
	Higher	57040 (51267 - 63260)	119212 (95291 - 146950)	0.965 (0.955 - 0.975)	158280 (121527 - 201988)	0.952 (0.942 - 0.963)	241544 (178186 - 322319)	0.934 (0.923 - 0.945)
	Lower	57037 (51269 - 63213)	121960 (97371 - 150323)	0.988 (0.978 - 0.998)	163559 (125843 - 208351)	0.983 (0.972 - 0.994)	252642 (186715 - 337575)	0.976 (0.965 - 0.988)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.8: Simulated growth rates and counterfactual growth rates for guillemot. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Buchan Ness to Collieston Coast SPA	Baseline	1.030 (1.022 - 1.038)	-	1.030 (1.023 - 1.037)	-	1.030 (1.024 - 1.036)	-
	Higher	1.028 (1.020 - 1.036)	0.998 (0.998 - 0.999)	1.028 (1.021 - 1.035)	0.998 (0.998 - 0.999)	1.028 (1.022 - 1.034)	0.998 (0.998 - 0.999)
	Lower	1.030 (1.021 - 1.038)	0.999 (0.999 - 1.000)	1.030 (1.022 - 1.036)	0.999 (0.999 - 1.000)	1.030 (1.024 - 1.035)	0.999 (0.999 - 1.000)
Troup, Pennan and Lion's Heads SPA	Baseline	1.030 (1.022 - 1.038)	-	1.030 (1.023 - 1.037)	-	1.030 (1.024 - 1.036)	-
	Higher	1.029 (1.021 - 1.037)	0.999 (0.999 - 1.000)	1.029 (1.022 - 1.036)	0.999 (0.999 - 0.999)	1.029 (1.023 - 1.035)	0.999 (0.999 - 0.999)
	Lower	1.030 (1.022 - 1.038)	1.000 (0.999 - 1.000)	1.030 (1.023 - 1.037)	1.000 (0.999 - 1.000)	1.030 (1.024 - 1.035)	1.000 (0.999 - 1.000)
Regional	Baseline	1.030 (1.022 - 1.038)	-	1.030 (1.023 - 1.037)	-	1.030 (1.024 - 1.036)	-
	Higher	1.029 (1.020 - 1.037)	0.999 (0.998 - 0.999)	1.029 (1.022 - 1.036)	0.999 (0.998 - 0.999)	1.029 (1.023 - 1.034)	0.999 (0.998 - 0.999)
	Lower	1.030 (1.021 - 1.038)	1.000 (0.999 - 1.000)	1.030 (1.022 - 1.036)	1.000 (0.999 - 1.000)	1.030 (1.024 - 1.035)	1.000 (0.999 - 1.000)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

3.3.2. Cumulative impacts

Simulated population sizes and counterfactual population sizes for cumulative guillemot scenarios after 25, 35, and 50 years of operation are presented in Table 3.3. Growth rates and counterfactual growth rates for the same years are presented in Table 3.4. Visual representations of the population projections from the PVA modelling are presented in Annex F. As noted above, the predicted baseline trajectory of these models differs from that reflected by recent census data, however, the metrics used to assess the difference among scenarios are relatively insensitive to deviations in population trend (Cook and Robinson, 2016).

Table 3.9: Median simulated population sizes (breeding pairs) and counterfactual population sizes for guillemot. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Buchan Ness to Collieston Coast SPA	Baseline	25590 (22985 - 28384)	55402 (44231 - 68212)	-	74584 (57411 - 95035)	-	116053 (85591 - 154734)	-
	Higher (no BB/GV)	25592 (23000 - 28375)	52368 (41848 - 64467)	0.945 (0.931 - 0.959)	68890 (53066 - 87792)	0.924 (0.910 - 0.939)	104023 (76834 - 138661)	0.896 (0.881 - 0.911)
	Higher (with BB/GV)	25592 (22995 - 28382)	48874 (39011 - 60230)	0.882 (0.869 - 0.896)	62674 (48181 - 79668)	0.840 (0.827 - 0.854)	91085 (67188 - 121440)	0.785 (0.771 - 0.799)
	Lower (no BB/GV)	25597 (22992 - 28360)	54245 (43245 - 66777)	0.979 (0.965 - 0.994)	72452 (55670 - 92368)	0.971 (0.956 - 0.987)	111297 (82406 - 148680)	0.960 (0.944 - 0.977)
	Lower (with BB/GV)	25596 (23000 - 28373)	52712 (42094 - 64955)	0.951 (0.937 - 0.966)	69577 (53543 - 88610)	0.933 (0.917 - 0.948)	105359 (77584 - 140599)	0.908 (0.892 - 0.924)
Troup, Pennan and Lion's Heads SPA	Baseline	29957 (26931 - 33213)	64827 (51806 - 80021)	-	87362 (67159 - 111401)	-	135921 (100256 - 181359)	-
	Higher (no BB/GV)	29974 (26950 - 33203)	62238 (49782 - 76713)	0.960 (0.947 - 0.974)	82506 (63420 - 105065)	0.945 (0.931 - 0.959)	125518 (92723 - 167303)	0.924 (0.910 - 0.939)
	Higher (with BB/GV)	29968 (26905 - 33195)	61204 (48871 - 75474)	0.943 (0.931 - 0.957)	80578 (61863 - 102957)	0.923 (0.909 - 0.936)	121541 (89593 - 162302)	0.894 (0.880 - 0.909)

Population	Scenario	2031 (reference year)		2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size	
	Lower (no BB/GV)	29970 (26913 - 33215)	63740 (50931 - 78612)	0.983 (0.970 - 0.997)	85295 (65571 - 108708)	0.977 (0.963 - 0.992)	131404 (97093 - 175313)	0.968 (0.953 - 0.983)	
	Lower (with BB/GV)	29967 (26924 - 33203)	63321 (50633 - 77896)	0.976 (0.963 - 0.990)	84516 (64841 - 107632)	0.967 (0.953 - 0.982)	129671 (95920 - 173245)	0.955 (0.940 - 0.970)	
Regional	Baseline	57067 (51254 - 63271)	123528 (98712 - 151752)	-	166257 (127911 - 211968)	-	258596 (191152 - 344953)	-	
	Higher (no BB/GV)	57032 (51213 - 63224)	117444 (93828 - 144677)	0.951 (0.941 - 0.961)	155025 (119266 - 197298)	0.932 (0.922 - 0.942)	234553 (172929 - 313026)	0.907 (0.896 - 0.918)	
	Higher (with BB/GV)	57037 (51316 - 63219)	112535 (89751 - 138521)	0.911 (0.902 - 0.920)	146231 (112173 - 186106)	0.879 (0.870 - 0.889)	216190 (160135 - 288919)	0.836 (0.827 - 0.846)	
	Lower (no BB/GV)	57063 (51236 - 63265)	121034 (96538 - 149128)	0.980 (0.971 - 0.990)	161773 (124314 - 205960)	0.973 (0.962 - 0.983)	248795 (183758 - 332369)	0.962 (0.952 - 0.973)	
	Lower (with BB/GV)	57059 (51256 - 63259)	118582 (94587 - 146144)	0.960 (0.950 - 0.970)	157178 (120811 - 200261)	0.945 (0.935 - 0.955)	239084 (176813 - 318935)	0.925 (0.914 - 0.935)	

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.10: Simulated growth rates and counterfactual growth rates for guillemot. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Buchan Ness to Collieston Coast SPA	Baseline	1.030 (1.022 - 1.038)	-	1.030 (1.023 - 1.037)	-	1.030 (1.024 - 1.036)	-
	Higher (no BB/GV)	1.028 (1.020 - 1.036)	0.998 (0.997 - 0.998)	1.028 (1.021 - 1.035)	0.998 (0.997 - 0.998)	1.028 (1.022 - 1.033)	0.998 (0.998 - 0.998)
	Higher (with BB/GV)	1.025 (1.017 - 1.033)	0.995 (0.995 - 0.996)	1.025 (1.018 - 1.032)	0.995 (0.995 - 0.996)	1.025 (1.019 - 1.031)	0.995 (0.995 - 0.996)
	Lower (no BB/GV)	1.029 (1.021 - 1.037)	0.999 (0.999 - 1.000)	1.029 (1.022 - 1.036)	0.999 (0.999 - 1.000)	1.029 (1.023 - 1.035)	0.999 (0.999 - 1.000)
	Lower (with BB/GV)	1.028 (1.020 - 1.036)	0.998 (0.998 - 0.999)	1.028 (1.021 - 1.035)	0.998 (0.998 - 0.998)	1.028 (1.022 - 1.034)	0.998 (0.998 - 0.998)
Troup, Pennan and Lion's Heads SPA	Baseline	1.030 (1.022 - 1.038)	-	1.030 (1.023 - 1.037)	-	1.030 (1.024 - 1.036)	-
	Higher (no BB/GV)	1.029 (1.020 - 1.036)	0.998 (0.998 - 0.999)	1.029 (1.021 - 1.035)	0.998 (0.998 - 0.999)	1.029 (1.023 - 1.034)	0.998 (0.998 - 0.999)
	Higher (with BB/GV)	1.028 (1.020 - 1.036)	0.998 (0.997 - 0.998)	1.028 (1.021 - 1.035)	0.998 (0.997 - 0.998)	1.028 (1.022 - 1.033)	0.998 (0.998 - 0.998)
	Lower (no BB/GV)	1.030 (1.021 - 1.037)	0.999 (0.999 - 1.000)	1.030 (1.022 - 1.036)	0.999 (0.999 - 1.000)	1.029 (1.024 - 1.035)	0.999 (0.999 - 1.000)
	Lower (with BB/GV)	1.029 (1.021 - 1.037)	0.999 (0.999 - 1.000)	1.029 (1.022 - 1.036)	0.999 (0.999 - 0.999)	1.029 (1.023 - 1.035)	0.999 (0.999 - 0.999)
Regional	Baseline	1.030 (1.022 - 1.038)	-	1.030 (1.023 - 1.037)	-	1.030 (1.024 - 1.036)	-
	Higher (no BB/GV)	1.028 (1.020 - 1.036)	0.998 (0.998 - 0.998)	1.028 (1.021 - 1.035)	0.998 (0.998 - 0.998)	1.028 (1.022 - 1.034)	0.998 (0.998 - 0.998)
	Higher (with BB/GV)	1.026 (1.018 - 1.034)	0.996 (0.996 - 0.997)	1.026 (1.019 - 1.033)	0.996 (0.996 - 0.997)	1.027 (1.021 - 1.032)	0.996 (0.996 - 0.997)
	Lower (no BB/GV)	1.029 (1.021 - 1.037)	0.999 (0.999 - 1.000)	1.029 (1.022 - 1.036)	0.999 (0.999 - 0.999)	1.029 (1.023 - 1.035)	0.999 (0.999 - 0.999)

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
	Lower (with BB/GV)	1.029 (1.020 - 1.036)	0.998 (0.998 - 0.999)	1.029 (1.021 - 1.035)	0.998 (0.998 - 0.999)	1.029 (1.023 - 1.034)	0.998 (0.998 - 0.999)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

3.4. Razorbill

3.4.1. Project-only

Simulated population sizes and counterfactual population sizes for project-only razorbill scenarios after 25, 35, and 50 years of operation are presented in Table 3.11. Growth rates and counterfactual growth rates for the same years are presented in Table 3.12. Visual representations of the population projections from the PVA modelling are presented in Annex F. Burnell *et al.*, 2023 indicates that Scottish razorbill populations have declined by 2% between the Seabirds 2000 and the Seabirds Count. This trend is well reflected by the baseline PVA run for this species (Table 3.12; Figure F.7).

Table 3.11: Median simulated population sizes (breeding pairs) and counterfactual population sizes for razorbill. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Regional	Baseline	18940 (12429 - 27022)	11142 (4874 - 23545)	-	9100 (3483 - 21321)	-	6635 (2263 - 18153)	-
	Higher	18947 (12422 - 27050)	11038 (4813 - 23430)	0.991 (0.963 - 1.021)	9014 (3437 - 21353)	0.987 (0.953 - 1.024)	6512 (2206 - 17878)	0.982 (0.936 - 1.029)
	Lower	18931 (12484 - 27055)	11054 (4823 - 23482)	0.995 (0.965 - 1.024)	9044 (3463 - 21228)	0.992 (0.956 - 1.029)	6550 (2215 - 17896)	0.989 (0.945 - 1.035)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.12: Simulated growth rates and counterfactual growth rates for razorbill. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Regional	Baseline	0.980 (0.952 - 1.006)	-	0.980 (0.956 - 1.002)	-	0.980 (0.960 - 0.999)	-
	Higher	0.980 (0.951 - 1.006)	1.000 (0.999 - 1.001)	0.980 (0.956 - 1.002)	1.000 (0.999 - 1.001)	0.980 (0.960 - 0.998)	1.000 (0.999 - 1.001)
	Lower	0.980 (0.952 - 1.006)	1.000 (0.999 - 1.001)	0.980 (0.956 - 1.002)	1.000 (0.999 - 1.001)	0.980 (0.960 - 0.998)	1.000 (0.999 - 1.001)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

3.4.2. Cumulative impacts

Simulated population sizes and counterfactual population sizes for cumulative razorbill scenarios after 25, 35, and 50 years of operation are presented in Table 3.3. Growth rates and counterfactual growth rates for the same years are presented in Table 3.4. Visual representations of the population projections from the PVA modelling are presented in Annex F.

Table 3.13: Median simulated population sizes (breeding pairs) and counterfactual population sizes for razorbill . Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Fowlsheugh SPA	Baseline	9041 (5942 - 12920)	5328 (2315 - 11220)	-	4359 (1668 - 10186)	-	3174 (1074 - 8654)	-
	Higher	9050 (5930 - 12935)	4304 (1860 - 9148)	0.808 (0.772 - 0.844)	3236 (1235 - 7694)	0.744 (0.703 - 0.784)	2092 (706 - 5768)	0.662 (0.615 - 0.708)
	Lower	9050 (5936 - 12916)	4766 (2063 - 10072)	0.893 (0.856 - 0.932)	3731 (1436 - 8819)	0.855 (0.810 - 0.902)	2540 (860 - 7026)	0.805 (0.749 - 0.861)
Troup, Pennan and Lion's Heads	Baseline	3817 (2497 - 5443)	2245 (981 - 4764)	-	1836 (703 - 4345)	-	1336 (451 - 3625)	-
	Higher (no BB/GV)	3815 (2507 - 5437)	2060 (891 - 4394)	0.917 (0.858 - 0.977)	1624 (617 - 3844)	0.887 (0.816 - 0.959)	1122 (380 - 3109)	0.847 (0.760 - 0.939)
	Higher (with BB/GV)	3814 (2501 - 5453)	2037 (878 - 4351)	0.908 (0.849 - 0.968)	1608 (611 - 3799)	0.876 (0.805 - 0.949)	1109 (370 - 3032)	0.832 (0.746 - 0.924)
	Lower (no BB/GV)	3815 (2499 - 5440)	2170 (947 - 4566)	0.969 (0.908 - 1.035)	1755 (679 - 4136)	0.956 (0.884 - 1.033)	1256 (420 - 3431)	0.941 (0.848 - 1.042)
	Lower (with BB/GV)	3816 (2496 - 5454)	2161 (939 - 4586)	0.964 (0.904 - 1.029)	1746 (670 - 4112)	0.949 (0.875 - 1.031)	1238 (421 - 3376)	0.931 (0.840 - 1.034)
Regional	Baseline	18952 (12455 - 27005)	11114 (4843 - 23553)	-	9125 (3499 - 21327)	-	6628 (2258 - 18041)	-
	Higher (no BB/GV)	18932 (12449 - 27000)	9516 (4125 - 20211)	0.855 (0.827 - 0.881)	7338 (2788 - 17234)	0.804 (0.773 - 0.834)	4872 (1636 - 13391)	0.738 (0.700 - 0.774)
	Higher (with BB/GV)	18945 (12404 - 26972)	9336 (4047 - 19835)	0.836 (0.811 - 0.861)	7101 (2710 - 16662)	0.780 (0.751 - 0.809)	4664 (1565 - 12870)	0.707 (0.672 - 0.741)
	Lower (no BB/GV)	18936 (12439 - 27041)	10229 (4450 - 21708)	0.918 (0.891 - 0.944)	8075 (3092 - 19042)	0.888 (0.855 - 0.918)	5592 (1888 - 15340)	0.846 (0.807 - 0.886)
	Lower (with BB/GV)	18937 (12471 - 27046)	10087 (4388 - 21474)	0.905 (0.878 - 0.932)	7932 (3046 - 18660)	0.871 (0.839 - 0.902)	5464 (1840 - 14981)	0.825 (0.784 - 0.864)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.14: Simulated growth rates and counterfactual growth rates for razorbill. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Fowlsheugh SPA	Baseline	0.980 (0.952 - 1.006)	-	0.980 (0.956 - 1.002)	-	0.980 (0.960 - 0.999)	-
	Higher	0.972 (0.944 - 0.999)	0.992 (0.990 - 0.993)	0.972 (0.948 - 0.994)	0.992 (0.990 - 0.993)	0.972 (0.952 - 0.990)	0.992 (0.991 - 0.993)
	Lower	0.976 (0.947 - 1.002)	0.996 (0.994 - 0.997)	0.976 (0.952 - 0.998)	0.996 (0.994 - 0.997)	0.976 (0.956 - 0.994)	0.996 (0.994 - 0.997)
	Baseline	0.980 (0.952 - 1.007)	-	0.980 (0.956 - 1.002)	-	0.980 (0.960 - 0.999)	-

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Troup, Pennan and Lion's Heads SPA	Higher (no BB/GV)	0.977 (0.948 - 1.003)	0.997 (0.994 - 0.999)	0.977 (0.953 - 0.999)	0.997 (0.994 - 0.999)	0.977 (0.957 - 0.995)	0.997 (0.995 - 0.999)
	Higher (with BB/GV)	0.976 (0.948 - 1.003)	0.996 (0.994 - 0.999)	0.977 (0.953 - 0.998)	0.996 (0.994 - 0.998)	0.976 (0.956 - 0.995)	0.996 (0.994 - 0.998)
	Lower (no BB/GV)	0.979 (0.950 - 1.005)	0.999 (0.996 - 1.001)	0.979 (0.955 - 1.001)	0.999 (0.997 - 1.001)	0.979 (0.959 - 0.997)	0.999 (0.997 - 1.001)
	Lower (with BB/GV)	0.979 (0.951 - 1.005)	0.999 (0.996 - 1.001)	0.979 (0.954 - 1.001)	0.999 (0.996 - 1.001)	0.978 (0.959 - 0.997)	0.999 (0.997 - 1.001)
Regional	Baseline	0.980 (0.952 - 1.006)	-	0.980 (0.956 - 1.002)	-	0.980 (0.960 - 0.999)	-
	Higher (no BB/GV)	0.974 (0.946 - 1.001)	0.994 (0.993 - 0.995)	0.974 (0.950 - 0.996)	0.994 (0.993 - 0.995)	0.974 (0.954 - 0.993)	0.994 (0.993 - 0.995)
	Higher (with BB/GV)	0.973 (0.945 - 1.000)	0.993 (0.992 - 0.994)	0.974 (0.950 - 0.995)	0.993 (0.992 - 0.994)	0.973 (0.953 - 0.992)	0.993 (0.992 - 0.994)
	Lower (no BB/GV)	0.977 (0.949 - 1.003)	0.997 (0.996 - 0.998)	0.977 (0.953 - 0.999)	0.997 (0.996 - 0.998)	0.977 (0.957 - 0.995)	0.997 (0.996 - 0.998)
	Lower (with BB/GV)	0.976 (0.948 - 1.003)	0.996 (0.995 - 0.997)	0.976 (0.952 - 0.998)	0.996 (0.995 - 0.997)	0.976 (0.956 - 0.995)	0.996 (0.995 - 0.997)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

3.5. Puffin

3.5.1. Cumulative impacts

Simulated population sizes and counterfactual population sizes for cumulative kittiwake scenarios after 25, 35, and 50 years of operation are presented in Table 3.3. Growth rates and counterfactual growth rates for the same years are presented in Table 3.4. Visual representations of the population projections from the PVA modelling are presented in Annex F. It should be noted that baseline population trajectories predicted in the puffin PVAs suggest a trend of population decrease whilst trends from survey data indicate that some puffin populations have been increasing across Scotland (for example, a 2.1% increase in the puffin population at Coquet Island between the Seabird 2000 census and the latest census - Burnell et al., 2023 – which, based on an average count interval of 18 years, translates to a population growth rate of 1.001). However, the baseline population trajectory for puffin at Farne Islands is more reflective with the census data suggesting a decline of 21% between the Seabird 2000 census and the latest census, indicating a population growth rate of 0.987.

Table 3.15: Median simulated population sizes (breeding pairs) and counterfactual population sizes for puffin. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Coquet Island	Baseline	19452 (11048 - 29563)	10596 (4399 - 23542)	-	8359 (3132 - 21049)	-	5941 (1891 - 16604)	-
	Higher (no BB/GV)	19459 (11037 - 29625)	10481 (4360 - 23376)	0.990 (0.960 - 1.022)	8251 (3057 - 20862)	0.987 (0.950 - 1.025)	5807 (1857 - 16368)	0.982 (0.936 - 1.031)
	Higher (with BB/GV)	19461 (11025 - 29638)	10438 (4365 - 23142)	0.986 (0.957 - 1.018)	8195 (3057 - 20758)	0.981 (0.944 - 1.019)	5787 (1844 - 16235)	0.974 (0.927 - 1.022)
	Lower (no BB/GV)	19440 (11054 - 29611)	10510 (4369 - 23410)	0.994 (0.964 - 1.024)	8281 (3076 - 20959)	0.992 (0.954 - 1.029)	5848 (1870 - 16379)	0.988 (0.941 - 1.037)
	Lower (with BB/GV)	19448 (11000 - 29605)	10492 (4347 - 23533)	0.991 (0.961 - 1.022)	8236 (3076 - 20798)	0.988 (0.951 - 1.026)	5833 (1864 - 16282)	0.983 (0.939 - 1.034)
Farne Islands	Baseline	26770 (14150 - 42369)	8427 (3146 - 20502)	-	5392 (1794 - 15037)	-	2803 (760 - 8782)	-

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
	Higher (no BB/GV)	26774 (14143 - 42346)	8277 (3058 - 20184)	0.985 (0.954 - 1.017)	5295 (1743 - 14750)	0.979 (0.940 - 1.021)	2712 (749 - 8597)	0.971 (0.914 - 1.033)
	Higher (with BB/GV)	26749 (14098 - 42371)	8207 (3061 - 19956)	0.976 (0.945 - 1.006)	5222 (1733 - 14537)	0.967 (0.927 - 1.007)	2662 (728 - 8399)	0.954 (0.894 - 1.012)
	Lower (no BB/GV)	26799 (14138 - 42327)	8343 (3091 - 20327)	0.990 (0.960 - 1.021)	5322 (1752 - 14875)	0.987 (0.947 - 1.027)	2743 (742 - 8610)	0.982 (0.924 - 1.042)
	Lower (with BB/GV)	26767 (14115 - 42422)	8278 (3081 - 20224)	0.985 (0.954 - 1.016)	5278 (1749 - 14733)	0.979 (0.939 - 1.020)	2717 (747 - 8521)	0.970 (0.913 - 1.031)
Forth Islands	Baseline	35905 (20476 - 54081)	19779 (7944 - 44366)	-	15632 (5672 - 38361)	-	10938 (3369 - 31667)	-
	Higher (no BB/GV)	35918 (20462 - 54006)	18022 (7221 - 40459)	0.911 (0.890 - 0.931)	13767 (4971 - 33772)	0.879 (0.853 - 0.904)	9136 (2797 - 26578)	0.835 (0.804 - 0.865)
	Higher (with BB/GV)	35913 (20412 - 54064)	17804 (7105 - 39822)	0.900 (0.879 - 0.920)	13533 (4865 - 33121)	0.864 (0.839 - 0.887)	8942 (2715 - 25776)	0.815 (0.785 - 0.845)
	Lower (no BB/GV)	35895 (20539 - 54102)	18662 (7542 - 41986)	0.945 (0.923 - 0.966)	14477 (5199 - 35653)	0.924 (0.898 - 0.949)	9809 (2992 - 28492)	0.895 (0.863 - 0.929)
	Lower (with BB/GV)	35920 (20441 - 54066)	18549 (7435 - 41526)	0.938 (0.916 - 0.959)	14338 (5158 - 35103)	0.914 (0.889 - 0.940)	9682 (2957 - 27977)	0.883 (0.850 - 0.915)
North Caithness Cliffs	Baseline	2114 (1196 - 3220)	1156 (475 - 2575)	-	907 (340 - 2284)	-	646 (199 - 1795)	-
	Higher (no BB/GV)	2110 (1196 - 3218)	851 (348 - 1928)	0.742 (0.673 - 0.818)	600 (221 - 1517)	0.661 (0.583 - 0.745)	361 (110 - 1041)	0.563 (0.471 - 0.659)
	Higher (with BB/GV)	2117 (1188 - 3202)	850 (346 - 1912)	0.741 (0.668 - 0.817)	598 (222 - 1526)	0.660 (0.581 - 0.742)	360 (110 - 1023)	0.561 (0.468 - 0.661)
	Lower (no BB/GV)	2111 (1198 - 3215)	962 (394 - 2150)	0.834 (0.757 - 0.919)	706 (256 - 1791)	0.778 (0.690 - 0.877)	452 (138 - 1285)	0.704 (0.600 - 0.818)
	Lower (with BB/GV)	2111 (1191 - 3222)	957 (395 - 2135)	0.834 (0.756 - 0.916)	703 (258 - 1779)	0.778 (0.688 - 0.871)	454 (142 - 1288)	0.705 (0.596 - 0.818)
Regional	Baseline	102043 (58032 - 155289)	55555 (23027 - 123575)	-	43876 (16450 - 111002)	-	31122 (9954 - 87632)	-
	Higher (no BB/GV)	102015 (57991 - 155179)	52857 (21809 - 117931)	0.952 (0.939 - 0.964)	40942 (15326 - 103418)	0.933 (0.918 - 0.949)	28277 (8996 - 79176)	0.909 (0.889 - 0.929)
	Higher (with BB/GV)	102092 (57893 - 155093)	52350 (21653 - 116636)	0.943 (0.930 - 0.956)	40408 (14982 - 102431)	0.922 (0.906 - 0.938)	27746 (8745 - 77924)	0.893 (0.873 - 0.912)
	Lower (no BB/GV)	102004 (58050 - 155094)	53768 (22290 - 120087)	0.970 (0.957 - 0.983)	42015 (15577 - 106411)	0.959 (0.943 - 0.974)	29286 (9330 - 82466)	0.943 (0.922 - 0.963)
	Lower (with BB/GV)	102021 (57986 - 154939)	53555 (22163 - 119299)	0.965 (0.952 - 0.978)	41694 (15610 - 105722)	0.952 (0.936 - 0.968)	29003 (9224 - 81616)	0.934 (0.913 - 0.954)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.16: Simulated growth rates and counterfactual growth rates for puffin. Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Coquet Island	Baseline	0.978 (0.949 - 1.003)	-	0.977 (0.953 - 0.999)	-	0.977 (0.957 - 0.996)	-
	Higher (no BB/GV)	0.978 (0.949 - 1.002)	1.000 (0.999 - 1.001)	0.977 (0.953 - 0.999)	1.000 (0.999 - 1.001)	0.977 (0.957 - 0.995)	1.000 (0.999 - 1.001)
	Higher (with BB/GV)	0.977 (0.948 - 1.002)	0.999 (0.998 - 1.001)	0.977 (0.953 - 0.998)	0.999 (0.998 - 1.000)	0.977 (0.956 - 0.995)	0.999 (0.999 - 1.000)
	Lower (no BB/GV)	0.978 (0.949 - 1.003)	1.000 (0.999 - 1.001)	0.977 (0.953 - 0.999)	1.000 (0.999 - 1.001)	0.977 (0.957 - 0.995)	1.000 (0.999 - 1.001)
	Lower (with BB/GV)	0.978 (0.949 - 1.002)	1.000 (0.999 - 1.001)	0.977 (0.953 - 0.999)	1.000 (0.999 - 1.001)	0.977 (0.957 - 0.995)	1.000 (0.999 - 1.001)
Farne Islands	Baseline	0.958 (0.926 - 0.985)	-	0.957 (0.931 - 0.981)	-	0.957 (0.935 - 0.976)	-
	Higher (no BB/GV)	0.957 (0.926 - 0.984)	0.999 (0.998 - 1.001)	0.957 (0.930 - 0.980)	0.999 (0.998 - 1.001)	0.956 (0.934 - 0.976)	0.999 (0.998 - 1.001)
	Higher (with BB/GV)	0.957 (0.925 - 0.984)	0.999 (0.998 - 1.000)	0.956 (0.930 - 0.980)	0.999 (0.998 - 1.000)	0.956 (0.934 - 0.976)	0.999 (0.998 - 1.000)
	Lower (no BB/GV)	0.957 (0.926 - 0.985)	1.000 (0.999 - 1.001)	0.957 (0.930 - 0.980)	1.000 (0.998 - 1.001)	0.957 (0.934 - 0.976)	1.000 (0.998 - 1.001)
	Lower (with BB/GV)	0.957 (0.926 - 0.985)	0.999 (0.998 - 1.001)	0.957 (0.930 - 0.980)	0.999 (0.998 - 1.001)	0.956 (0.934 - 0.976)	0.999 (0.998 - 1.001)
Forth Islands	Baseline	0.978 (0.948 - 1.003)	-	0.978 (0.953 - 0.999)	-	0.978 (0.957 - 0.996)	-
	Higher (no BB/GV)	0.975 (0.944 - 0.999)	0.996 (0.996 - 0.997)	0.974 (0.949 - 0.995)	0.996 (0.996 - 0.997)	0.974 (0.953 - 0.992)	0.996 (0.996 - 0.997)
	Higher (with BB/GV)	0.974 (0.944 - 0.999)	0.996 (0.995 - 0.997)	0.974 (0.949 - 0.995)	0.996 (0.995 - 0.997)	0.974 (0.953 - 0.992)	0.996 (0.995 - 0.997)
	Lower (no BB/GV)	0.976 (0.945 - 1.001)	0.998 (0.997 - 0.999)	0.976 (0.951 - 0.996)	0.998 (0.997 - 0.999)	0.975 (0.955 - 0.993)	0.998 (0.997 - 0.999)
	Lower (with BB/GV)	0.976 (0.945 - 1.000)	0.998 (0.997 - 0.998)	0.975 (0.950 - 0.996)	0.998 (0.997 - 0.998)	0.975 (0.954 - 0.993)	0.998 (0.997 - 0.998)
North Caithness Cliffs	Baseline	0.978 (0.949 - 1.003)	-	0.977 (0.953 - 0.999)	-	0.977 (0.957 - 0.995)	-
	Higher (no BB/GV)	0.967 (0.938 - 0.991)	0.989 (0.985 - 0.992)	0.966 (0.941 - 0.988)	0.989 (0.985 - 0.992)	0.966 (0.946 - 0.985)	0.989 (0.985 - 0.992)
	Higher (with BB/GV)	0.967 (0.937 - 0.992)	0.989 (0.985 - 0.992)	0.966 (0.942 - 0.988)	0.989 (0.985 - 0.992)	0.966 (0.946 - 0.984)	0.989 (0.985 - 0.992)
	Lower (no BB/GV)	0.971 (0.942 - 0.996)	0.993 (0.990 - 0.996)	0.970 (0.946 - 0.992)	0.993 (0.990 - 0.996)	0.971 (0.950 - 0.989)	0.993 (0.990 - 0.996)
	Lower (with BB/GV)	0.971 (0.942 - 0.996)	0.993 (0.990 - 0.996)	0.971 (0.946 - 0.992)	0.993 (0.990 - 0.996)	0.970 (0.950 - 0.989)	0.993 (0.990 - 0.996)
Regional	Baseline	0.978 (0.949 - 1.003)	-	0.977 (0.953 - 0.999)	-	0.977 (0.957 - 0.995)	-
	Higher (no BB/GV)	0.976 (0.947 - 1.001)	0.998 (0.998 - 0.999)	0.976 (0.951 - 0.997)	0.998 (0.998 - 0.999)	0.975 (0.955 - 0.994)	0.998 (0.998 - 0.999)
	Higher (with BB/GV)	0.976 (0.947 - 1.000)	0.998 (0.997 - 0.998)	0.975 (0.951 - 0.997)	0.998 (0.997 - 0.998)	0.975 (0.955 - 0.993)	0.998 (0.997 - 0.998)
	Lower (no BB/GV)	0.977 (0.948 - 1.001)	0.999 (0.998 - 0.999)	0.976 (0.952 - 0.998)	0.999 (0.998 - 0.999)	0.976 (0.956 - 0.994)	0.999 (0.998 - 0.999)
	Lower (with BB/GV)	0.977 (0.948 - 1.001)	0.999 (0.998 - 0.999)	0.976 (0.952 - 0.998)	0.999 (0.998 - 0.999)	0.976 (0.956 - 0.994)	0.999 (0.998 - 0.999)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

3.6. Gannet

3.6.1. Cumulative impacts

Simulated population sizes and counterfactual population sizes for cumulative gannet scenarios after 25, 35, and 50 years of operation are presented in Table 3.3. Growth rates and counterfactual growth rates for the same years are presented in Table 3.4. Visual representations of the population projections from the PVA modelling are presented in Annex F.

Table 3.17: Median simulated population sizes (breeding pairs) and counterfactual population sizes for gannet . Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Fair Isle	Baseline	5079 (4142 - 6064)	5943 (4033 - 8438)	-	6318 (4051 - 9561)	-	6869 (4117 - 11232)	-
	Higher (no BB/GV)	5082 (4154 - 6053)	5688 (3846 - 8116)	0.957 (0.917 - 1.001)	5946 (3814 - 8971)	0.941 (0.894 - 0.989)	6330 (3790 - 10299)	0.919 (0.867 - 0.974)
	Higher (with BB/GV)	5082 (4138 - 6048)	5664 (3845 - 8085)	0.954 (0.913 - 0.997)	5918 (3796 - 8927)	0.936 (0.892 - 0.985)	6276 (3769 - 10237)	0.913 (0.863 - 0.965)
	Lower (no BB/GV)	5079 (4136 - 6051)	5792 (3932 - 8264)	0.974 (0.930 - 1.018)	6100 (3912 - 9201)	0.964 (0.915 - 1.013)	6523 (3905 - 10626)	0.950 (0.897 - 1.005)
	Lower (with BB/GV)	5078 (4144 - 6056)	5778 (3909 - 8260)	0.972 (0.928 - 1.015)	6074 (3896 - 9182)	0.961 (0.914 - 1.010)	6498 (3895 - 10639)	0.946 (0.894 - 1.000)
Flamborough Head and Filey Coast	Baseline	16036 (13067 - 19103)	18787 (12766 - 26781)	-	19952 (12824 - 30144)	-	21708 (13046 - 35272)	-
	Higher (no BB/GV)	16028 (13081 - 19099)	14132 (9584 - 20128)	0.753 (0.733 - 0.773)	13501 (8665 - 20434)	0.676 (0.657 - 0.697)	12681 (7650 - 20666)	0.584 (0.564 - 0.605)
	Higher (with BB/GV)	16038 (13033 - 19085)	14084 (9563 - 20054)	0.751 (0.731 - 0.771)	13418 (8619 - 20269)	0.673 (0.654 - 0.694)	12612 (7569 - 20613)	0.581 (0.561 - 0.601)
	Lower (no BB/GV)	16044 (13074 - 19091)	15662 (10667 - 22295)	0.835 (0.814 - 0.857)	15543 (10008 - 23432)	0.780 (0.758 - 0.803)	15436 (9273 - 25167)	0.711 (0.687 - 0.734)
	Lower (with BB/GV)	16037 (13076 - 19061)	15603 (10670 - 22320)	0.833 (0.812 - 0.856)	15512 (10028 - 23364)	0.778 (0.756 - 0.801)	15380 (9207 - 25062)	0.708 (0.684 - 0.732)
Forth Islands	Baseline	84194 (63151 - 106721)	98702 (63945 - 146246)	-	104850 (65624 - 161342)	-	114727 (67197 - 189866)	-
	Higher (no BB/GV)	84172 (63120 - 106830)	87042 (56430 - 129158)	0.882 (0.871 - 0.893)	88138 (54970 - 135958)	0.841 (0.829 - 0.853)	90304 (52879 - 149817)	0.787 (0.775 - 0.800)
	Higher (with BB/GV)	84150 (63186 - 106911)	84464 (54707 - 125078)	0.856 (0.845 - 0.867)	84561 (52891 - 130935)	0.807 (0.796 - 0.818)	85450 (50079 - 140943)	0.744 (0.732 - 0.756)
	Lower (no BB/GV)	84175 (63220 - 106857)	90327 (58490 - 133684)	0.916 (0.904 - 0.927)	92775 (57972 - 143467)	0.886 (0.873 - 0.898)	96996 (56680 - 160673)	0.846 (0.832 - 0.858)
	Lower (with BB/GV)	84116 (63262 - 106789)	88489 (57259 - 131459)	0.897 (0.886 - 0.908)	90160 (56592 - 139594)	0.861 (0.849 - 0.873)	93190 (54683 - 155450)	0.813 (0.801 - 0.826)
Hermaness Saxa Vord and Valla Field	Baseline	31533 (25114 - 38297)	36864 (24608 - 53197)	-	39067 (25094 - 59313)	-	43228 (25527 - 69786)	-

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
	Higher (no BB/GV)	31546 (25134 - 38291)	35135 (23478 - 50852)	0.953 (0.936 - 0.971)	36640 (23445 - 55554)	0.936 (0.916 - 0.955)	39414 (23357 - 63492)	0.912 (0.891 - 0.933)
	Higher (with BB/GV)	31560 (25117 - 38301)	35066 (23358 - 50637)	0.951 (0.934 - 0.968)	36466 (23279 - 55247)	0.932 (0.914 - 0.952)	39175 (23172 - 63047)	0.907 (0.886 - 0.928)
	Lower (no BB/GV)	31535 (25114 - 38293)	35824 (23936 - 51725)	0.971 (0.954 - 0.989)	37542 (24030 - 57001)	0.961 (0.942 - 0.980)	40874 (24147 - 65736)	0.945 (0.924 - 0.967)
	Lower (with BB/GV)	31539 (25085 - 38314)	35718 (23846 - 51706)	0.970 (0.953 - 0.988)	37491 (23989 - 56712)	0.958 (0.939 - 0.978)	40798 (23977 - 65689)	0.942 (0.921 - 0.964)
North Rona and Sula Sgeir	Baseline	10084 (8196 - 12076)	12142 (8164 - 17346)	-	13037 (8335 - 19818)	-	14428 (8694 - 23774)	-
	Higher (no BB/GV)	10087 (8207 - 12058)	11996 (8105 - 17210)	0.989 (0.959 - 1.022)	12848 (8218 - 19392)	0.985 (0.952 - 1.021)	14128 (8417 - 23255)	0.980 (0.942 - 1.021)
	Higher (with BB/GV)	10084 (8195 - 12080)	11992 (8127 - 17172)	0.989 (0.957 - 1.020)	12827 (8205 - 19486)	0.984 (0.949 - 1.020)	14110 (8438 - 23308)	0.978 (0.939 - 1.019)
	Lower (no BB/GV)	10080 (8174 - 12048)	12068 (8151 - 17235)	0.994 (0.963 - 1.025)	12922 (8270 - 19624)	0.991 (0.959 - 1.027)	14251 (8507 - 23421)	0.988 (0.951 - 1.027)
	Lower (with BB/GV)	10082 (8195 - 12061)	12042 (8132 - 17277)	0.993 (0.962 - 1.023)	12918 (8295 - 19566)	0.991 (0.957 - 1.025)	14224 (8519 - 23445)	0.987 (0.948 - 1.026)
Noss	Baseline	12985 (10580 - 15459)	15170 (10325 - 21667)	-	16125 (10370 - 24471)	-	17552 (10552 - 28662)	-
	Higher (no BB/GV)	12986 (10580 - 15469)	14377 (9799 - 20520)	0.947 (0.921 - 0.973)	14971 (9675 - 22606)	0.927 (0.898 - 0.957)	15835 (9480 - 25888)	0.900 (0.868 - 0.933)
	Higher (with BB/GV)	12982 (10588 - 15436)	14328 (9728 - 20387)	0.943 (0.918 - 0.970)	14882 (9573 - 22488)	0.922 (0.893 - 0.950)	15710 (9383 - 25556)	0.894 (0.862 - 0.926)
	Lower (no BB/GV)	12992 (10577 - 15475)	14695 (10004 - 20973)	0.968 (0.941 - 0.994)	15425 (9904 - 23271)	0.956 (0.926 - 0.985)	16460 (9910 - 26994)	0.938 (0.906 - 0.971)
	Lower (with BB/GV)	12991 (10615 - 15465)	14661 (9951 - 20881)	0.966 (0.939 - 0.993)	15368 (9870 - 23295)	0.953 (0.924 - 0.982)	16425 (9882 - 26784)	0.935 (0.903 - 0.967)
Sule Skerry and Sule Stack	Baseline	9826 (7622 - 12226)	11504 (7697 - 16803)	-	12261 (7800 - 19044)	-	13400 (7924 - 22167)	-
	Higher (no BB/GV)	9822 (7580 - 12205)	10752 (7140 - 15754)	0.934 (0.902 - 0.967)	11162 (7068 - 17265)	0.910 (0.875 - 0.945)	11777 (6907 - 19480)	0.877 (0.840 - 0.917)
	Higher (with BB/GV)	9826 (7605 - 12211)	10746 (7178 - 15746)	0.933 (0.901 - 0.967)	11120 (7057 - 17242)	0.909 (0.875 - 0.945)	11768 (6932 - 19418)	0.876 (0.838 - 0.913)
	Lower (no BB/GV)	9824 (7591 - 12214)	10993 (7322 - 16076)	0.954 (0.920 - 0.988)	11506 (7274 - 17834)	0.936 (0.900 - 0.974)	12280 (7178 - 20277)	0.912 (0.874 - 0.953)
	Lower (with BB/GV)	9830 (7611 - 12214)	10965 (7319 - 16000)	0.953 (0.921 - 0.985)	11453 (7276 - 17789)	0.935 (0.900 - 0.971)	12253 (7236 - 20217)	0.911 (0.873 - 0.950)

Population	Scenario	2031 (reference year)	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population size	Population size	Counterfactual population size	Population size	Counterfactual population size	Population size	Counterfactual population size
Regional	Baseline	241828 (196861 - 288039)	284131 (192938 - 405258)	-	302197 (194269 - 458298)	-	330161 (198045 - 540613)	-
	Higher (no BB/GV)	241777 (196878 - 287951)	262692 (178668 - 376210)	0.925 (0.919 - 0.931)	271648 (174316 - 411869)	0.898 (0.892 - 0.905)	284812 (170858 - 464829)	0.862 (0.855 - 0.869)
	Higher (with BB/GV)	241726 (197052 - 288078)	259982 (176264 - 371277)	0.915 (0.909 - 0.921)	267555 (171684 - 404854)	0.884 (0.878 - 0.891)	278696 (167100 - 456485)	0.844 (0.837 - 0.851)
	Lower (no BB/GV)	241731 (196844 - 288032)	269650 (183232 - 385678)	0.949 (0.943 - 0.955)	281472 (180819 - 425487)	0.930 (0.924 - 0.937)	298839 (179596 - 489088)	0.905 (0.898 - 0.913)
	Lower (with BB/GV)	241748 (196741 - 288014)	267623 (181488 - 382347)	0.942 (0.936 - 0.948)	278519 (178836 - 422170)	0.921 (0.914 - 0.928)	294617 (176495 - 481648)	0.892 (0.885 - 0.899)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

Table 3.18: Simulated growth rates and counterfactual growth rates for gannet . Values are median values with 95% confidence intervals in brackets.

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
Fair Isle	Baseline	1.006 (0.992 - 1.018)	-	1.006 (0.995 - 1.017)	-	1.006 (0.997 - 1.015)	-
	Higher (no BB/GV)	1.005 (0.991 - 1.017)	0.998 (0.997 - 1.000)	1.005 (0.993 - 1.015)	0.998 (0.997 - 1.000)	1.004 (0.995 - 1.013)	0.998 (0.997 - 0.999)
	Higher (with BB/GV)	1.004 (0.991 - 1.017)	0.998 (0.997 - 1.000)	1.004 (0.993 - 1.015)	0.998 (0.997 - 0.999)	1.004 (0.995 - 1.013)	0.998 (0.997 - 0.999)
	Lower (no BB/GV)	1.005 (0.992 - 1.018)	0.999 (0.997 - 1.001)	1.005 (0.994 - 1.016)	0.999 (0.998 - 1.000)	1.005 (0.996 - 1.014)	0.999 (0.998 - 1.000)
	Lower (with BB/GV)	1.005 (0.991 - 1.017)	0.999 (0.997 - 1.000)	1.005 (0.993 - 1.015)	0.999 (0.998 - 1.000)	1.005 (0.995 - 1.014)	0.999 (0.998 - 1.000)
Flamborough Head and Filey Coast	Baseline	1.006 (0.993 - 1.018)	-	1.006 (0.995 - 1.017)	-	1.006 (0.997 - 1.015)	-
	Higher (no BB/GV)	0.995 (0.982 - 1.007)	0.989 (0.988 - 0.990)	0.995 (0.984 - 1.006)	0.989 (0.988 - 0.990)	0.996 (0.986 - 1.005)	0.990 (0.989 - 0.990)
	Higher (with BB/GV)	0.995 (0.982 - 1.007)	0.989 (0.988 - 0.990)	0.995 (0.984 - 1.006)	0.989 (0.988 - 0.990)	0.995 (0.986 - 1.005)	0.989 (0.989 - 0.990)
	Lower (no BB/GV)	0.999 (0.986 - 1.012)	0.993 (0.992 - 0.994)	0.999 (0.988 - 1.010)	0.993 (0.992 - 0.994)	0.999 (0.990 - 1.008)	0.993 (0.993 - 0.994)
	Lower (with BB/GV)	0.999 (0.986 - 1.011)	0.993 (0.992 - 0.994)	0.999 (0.988 - 1.009)	0.993 (0.992 - 0.994)	0.999 (0.990 - 1.008)	0.993 (0.993 - 0.994)
Forth Islands	Baseline	1.006 (0.993 - 1.018)	-	1.006 (0.995 - 1.017)	-	1.006 (0.997 - 1.015)	-
	Higher (no BB/GV)	1.001 (0.988 - 1.014)	0.995 (0.995 - 0.996)	1.001 (0.990 - 1.012)	0.995 (0.995 - 0.996)	1.001 (0.992 - 1.010)	0.995 (0.995 - 0.996)
	Higher (with BB/GV)	1.000 (0.987 - 1.012)	0.994 (0.994 - 0.994)	1.000 (0.989 - 1.010)	0.994 (0.994 - 0.994)	1.000 (0.991 - 1.009)	0.994 (0.994 - 0.994)
	Lower (no BB/GV)	1.003 (0.990 - 1.015)	0.997 (0.996 - 0.997)	1.003 (0.992 - 1.013)	0.997 (0.996 - 0.997)	1.003 (0.994 - 1.012)	0.997 (0.996 - 0.997)
	Lower (with BB/GV)	1.002 (0.989 - 1.014)	0.996 (0.995 - 0.996)	1.002 (0.991 - 1.012)	0.996 (0.996 - 0.996)	1.002 (0.993 - 1.011)	0.996 (0.996 - 0.996)
Hermaness Saxa Vord and Valla Field	Baseline	1.006 (0.993 - 1.018)	-	1.006 (0.995 - 1.016)	-	1.006 (0.997 - 1.015)	-
	Higher (no BB/GV)	1.004 (0.991 - 1.016)	0.998 (0.998 - 0.999)	1.004 (0.993 - 1.014)	0.998 (0.998 - 0.999)	1.004 (0.995 - 1.013)	0.998 (0.998 - 0.999)
	Higher (with BB/GV)	1.004 (0.991 - 1.016)	0.998 (0.997 - 0.999)	1.004 (0.993 - 1.014)	0.998 (0.998 - 0.999)	1.004 (0.995 - 1.013)	0.998 (0.998 - 0.998)

Population	Scenario	2057 (25 years operation)		2067 (35 years - intended lease period)		2082 (50 years of operation)	
		Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate	Population growth rate	Counterfactual population growth rate
	Lower (no BB/GV)	1.005 (0.992 - 1.017)	0.999 (0.998 - 0.999)	1.005 (0.994 - 1.015)	0.999 (0.998 - 0.999)	1.005 (0.996 - 1.014)	0.999 (0.998 - 0.999)
	Lower (with BB/GV)	1.005 (0.992 - 1.017)	0.999 (0.998 - 0.999)	1.005 (0.994 - 1.015)	0.999 (0.998 - 0.999)	1.005 (0.996 - 1.014)	0.999 (0.998 - 0.999)
North Rona and Sula Sgeir	Baseline	1.007 (0.993 - 1.020)	-	1.007 (0.996 - 1.018)	-	1.007 (0.998 - 1.016)	-
	Higher (no BB/GV)	1.007 (0.993 - 1.019)	1.000 (0.999 - 1.001)	1.007 (0.995 - 1.017)	1.000 (0.999 - 1.000)	1.007 (0.997 - 1.016)	1.000 (0.999 - 1.000)
	Higher (with BB/GV)	1.007 (0.993 - 1.019)	1.000 (0.998 - 1.001)	1.007 (0.995 - 1.017)	1.000 (0.999 - 1.000)	1.007 (0.997 - 1.016)	1.000 (0.999 - 1.000)
	Lower (no BB/GV)	1.007 (0.993 - 1.019)	1.000 (0.999 - 1.001)	1.007 (0.995 - 1.018)	1.000 (0.999 - 1.001)	1.007 (0.997 - 1.016)	1.000 (0.999 - 1.000)
	Lower (with BB/GV)	1.007 (0.993 - 1.019)	1.000 (0.999 - 1.001)	1.007 (0.995 - 1.018)	1.000 (0.999 - 1.001)	1.007 (0.997 - 1.016)	1.000 (0.999 - 1.000)
Noss	Baseline	1.006 (0.993 - 1.019)	-	1.006 (0.995 - 1.017)	-	1.006 (0.997 - 1.015)	-
	Higher (no BB/GV)	1.004 (0.991 - 1.016)	0.998 (0.997 - 0.999)	1.004 (0.993 - 1.014)	0.998 (0.997 - 0.999)	1.004 (0.995 - 1.013)	0.998 (0.997 - 0.999)
	Higher (with BB/GV)	1.004 (0.991 - 1.016)	0.998 (0.997 - 0.999)	1.004 (0.992 - 1.014)	0.998 (0.997 - 0.999)	1.004 (0.994 - 1.013)	0.998 (0.997 - 0.998)
	Lower (no BB/GV)	1.005 (0.991 - 1.017)	0.999 (0.998 - 1.000)	1.005 (0.993 - 1.015)	0.999 (0.998 - 1.000)	1.005 (0.995 - 1.014)	0.999 (0.998 - 0.999)
	Lower (with BB/GV)	1.005 (0.991 - 1.017)	0.999 (0.998 - 1.000)	1.005 (0.993 - 1.015)	0.999 (0.998 - 0.999)	1.005 (0.995 - 1.014)	0.999 (0.998 - 0.999)
Sule Skerry and Sule Stack	Baseline	1.006 (0.993 - 1.019)	-	1.006 (0.995 - 1.017)	-	1.006 (0.997 - 1.015)	-
	Higher (no BB/GV)	1.004 (0.991 - 1.016)	0.997 (0.996 - 0.999)	1.004 (0.992 - 1.014)	0.997 (0.996 - 0.998)	1.004 (0.994 - 1.012)	0.997 (0.997 - 0.998)
	Higher (with BB/GV)	1.004 (0.990 - 1.016)	0.997 (0.996 - 0.998)	1.004 (0.992 - 1.014)	0.997 (0.996 - 0.998)	1.004 (0.994 - 1.012)	0.997 (0.997 - 0.998)
	Lower (no BB/GV)	1.005 (0.991 - 1.017)	0.998 (0.997 - 0.999)	1.004 (0.993 - 1.015)	0.998 (0.997 - 0.999)	1.004 (0.995 - 1.013)	0.998 (0.997 - 0.999)
	Lower (with BB/GV)	1.005 (0.991 - 1.017)	0.998 (0.997 - 0.999)	1.004 (0.993 - 1.015)	0.998 (0.997 - 0.999)	1.004 (0.995 - 1.013)	0.998 (0.997 - 0.999)
Regional	Baseline	1.007 (0.993 - 1.019)	-	1.006 (0.995 - 1.017)	-	1.006 (0.997 - 1.015)	-
	Higher (no BB/GV)	1.004 (0.990 - 1.016)	0.997 (0.997 - 0.997)	1.003 (0.992 - 1.014)	0.997 (0.997 - 0.997)	1.003 (0.994 - 1.012)	0.997 (0.997 - 0.997)
	Higher (with BB/GV)	1.003 (0.989 - 1.015)	0.997 (0.996 - 0.997)	1.003 (0.991 - 1.013)	0.997 (0.996 - 0.997)	1.003 (0.993 - 1.012)	0.997 (0.997 - 0.997)
	Lower (no BB/GV)	1.004 (0.991 - 1.017)	0.998 (0.998 - 0.998)	1.004 (0.993 - 1.015)	0.998 (0.998 - 0.998)	1.004 (0.995 - 1.013)	0.998 (0.998 - 0.998)
	Lower (with BB/GV)	1.004 (0.991 - 1.016)	0.998 (0.997 - 0.998)	1.004 (0.993 - 1.014)	0.998 (0.998 - 0.998)	1.004 (0.995 - 1.013)	0.998 (0.998 - 0.998)

Source: NEPVA outputs – the NEPVA tool generates each iteration for each scenario run independently so that there are small differences in the reference year population sizes due to the stochasticity inherent within the model.

4. Summary

Population viability analysis is a tool which can be used to simulate the likely trajectory of a biological population both under current conditions, and with additional mortality arising from anthropogenic perturbations, thereby allowing assessment of the likely population level impacts of these effects. Population viability analysis was carried out for the Proposed Development according to methodology laid out in NatureScot guidance (NatureScot, 2023a) for all species-population combinations for which additional mortality attributable to the Proposed Development was predicted to exceed a change to the adult annual survival rate of 0.02 percentage points. In addition, further analysis was carried out for cumulative impacts to species-SPA combinations for which the predicted project-only mortality was equal to or greater than 0.2 birds per year and where the cumulative predicted mortality would result in a change in adult annual survival rate of 0.02 percentage points more. Counterfactual population sizes and counterfactual growth rates were calculated by comparing PVA baseline runs with PVA runs incorporating two impact scenarios based on a higher distributional response mortality rate scenario and a lower distributional response mortality rate scenario. These metrics were derived for three time points: 25 years of simulated impact, 35 years of simulated impact (based on the intended lease period), and 50 years of simulated impact. Species and populations analysed on this basis, and the counterfactual population sizes and counterfactual population growth rates derived from the PVA models for project-only and cumulative impacts, are presented in Table 4.1 and Table 4.2 respectively.

Table 4.1: Summary of population viability analysis and the key output metrics, counterfactual population size (CPS) and counterfactial growth rate (CGR), for the Proposed Development. Values are median values with 95% confidence intervals in brackets.

Species	Population	Scenario (distributional response mortality rate)	2057 (25 years operation)		2067 (35 years operation – intended lease period)		2082 (50 years operation)	
			CPS	CGR	CPS	CGR	CPS	CGR
Kittiwake	Buchan Ness to Collieston Coast SPA	Higher	0.981 (0.957 - 1.010)	0.999 (0.998 - 1.000)	0.973 (0.948 - 1.000)	0.999 (0.999 - 1.000)	0.962 (0.935 - 0.990)	0.999 (0.999 - 1.000)
		Lower	0.981 (0.957 - 1.010)	0.999 (0.998 - 1.000)	0.973 (0.948 - 1.000)	0.999 (0.999 - 1.000)	0.962 (0.936 - 0.990)	0.999 (0.999 - 1.000)
	Troup, Pennan and Lion's Heads SPA	Higher	0.988 (0.963 - 1.010)	1.000 (0.999 - 1.000)	0.983 (0.957 - 1.010)	1.000 (0.999 - 1.000)	0.977 (0.949 - 1.000)	1.000 (0.999 - 1.000)
		Lower	0.988 (0.963 - 1.010)	1.000 (0.999 - 1.000)	0.983 (0.957 - 1.010)	1.000 (0.999 - 1.000)	0.977 (0.949 - 1.000)	1.000 (0.999 - 1.000)
	Regional	Higher	0.991 (0.981 - 1.001)	1.000 (0.999 - 1.000)	0.987 (0.976 - 0.998)	1.000 (0.999 - 1.000)	0.981 (0.969 - 0.993)	1.000 (0.999 - 1.000)
		Lower	0.991 (0.981 - 1.001)	1.000 (0.999 - 1.000)	0.987 (0.976 - 0.998)	1.000 (0.999 - 1.000)	0.982 (0.969 - 0.994)	1.000 (0.999 - 1.000)
Guillemot	Buchan Ness to Collieston Coast SPA	Higher	0.955 (0.941 - 0.970)	0.998 (0.998 - 0.999)	0.939 (0.924 - 0.954)	0.998 (0.998 - 0.999)	0.916 (0.900 - 0.931)	0.998 (0.998 - 0.999)
		Lower	0.985 (0.970 - 1.000)	0.999 (0.999 - 1.000)	0.979 (0.964 - 0.995)	0.999 (0.999 - 1.000)	0.971 (0.955 - 0.988)	0.999 (0.999 - 1.000)
	Troup, Pennan and Lion's Heads SPA	Higher	0.977 (0.963 - 0.990)	0.999 (0.999 - 1.000)	0.968 (0.954 - 0.982)	0.999 (0.999 - 0.999)	0.955 (0.940 - 0.971)	0.999 (0.999 - 0.999)
		Lower	0.992 (0.979 - 1.010)	1.000 (0.999 - 1.000)	0.989 (0.974 - 1.000)	1.000 (0.999 - 1.000)	0.984 (0.969 - 1.000)	1.000 (0.999 - 1.000)
	Regional	Higher	0.965 (0.955 - 0.975)	0.999 (0.998 - 0.999)	0.952 (0.942 - 0.963)	0.999 (0.998 - 0.999)	0.934 (0.923 - 0.945)	0.999 (0.998 - 0.999)
		Lower	0.988 (0.978 - 0.998)	1.000 (0.999 - 1.000)	0.983 (0.972 - 0.994)	1.000 (0.999 - 1.000)	0.976 (0.965 - 0.988)	1.000 (0.999 - 1.000)
Razorbill	Regional	Higher	0.991 (0.963 - 1.021)	1.000 (0.999 - 1.001)	0.987 (0.953 - 1.024)	1.000 (0.999 - 1.001)	0.982 (0.936 - 1.029)	1.000 (0.999 - 1.001)
		Lower	0.995 (0.965 - 1.024)	1.000 (0.999 - 1.001)	0.992 (0.956 - 1.029)	1.000 (0.999 - 1.001)	0.989 (0.945 - 1.035)	1.000 (0.999 - 1.001)

Source: NEPVA outputs

Table 4.2: Summary of population viability analysis and the key output metrics, counterfactual population size (CPS) and counterfactial growth rate (CGR), for cumulative effects. Values are median values with 95% confidence intervals in brackets.

Species	Population	Scenario (distributional response mortality rate)	2057 (25 years operation)		2067 (35 years operation – intended lease period)		2082 (50 years operation)	
			CPS	CGR	CPS	CGR	CPS	CGR
Kittiwake	Buchan Ness to Collieston Coast	Higher no BB/GV	0.912 (0.888 - 0.936)	0.996 (0.996 - 0.997)	0.880 (0.857 - 0.905)	0.996 (0.996 - 0.997)	0.838 (0.815 - 0.864)	0.997 (0.996 - 0.997)
		Higher with BB/GV	0.908 (0.884 - 0.930)	0.996 (0.995 - 0.997)	0.875 (0.850 - 0.898)	0.996 (0.996 - 0.997)	0.831 (0.806 - 0.854)	0.996 (0.996 - 0.997)
		Lower no BB/GV	0.930 (0.907 - 0.954)	0.997 (0.996 - 0.998)	0.905 (0.881 - 0.930)	0.997 (0.997 - 0.998)	0.870 (0.845 - 0.896)	0.997 (0.997 - 0.998)
		Lower with BB/GV	0.927 (0.904 - 0.950)	0.997 (0.996 - 0.998)	0.900 (0.875 - 0.924)	0.997 (0.996 - 0.998)	0.864 (0.839 - 0.889)	0.997 (0.997 - 0.998)
	Cape Wrath	Higher	0.978 (0.929 - 1.030)	0.999 (0.998 - 1.001)	0.971 (0.918 - 1.024)	0.999 (0.998 - 1.000)	0.960 (0.906 - 1.015)	0.999 (0.998 - 1.000)
		Lower	0.984 (0.936 - 1.037)	0.999 (0.998 - 1.001)	0.978 (0.928 - 1.033)	0.999 (0.998 - 1.001)	0.969 (0.917 - 1.026)	0.999 (0.999 - 1.000)
	East Caithness Cliffs	Higher no BB/GV	0.842 (0.824 - 0.859)	0.993 (0.993 - 0.994)	0.789 (0.771 - 0.806)	0.993 (0.993 - 0.994)	0.721 (0.703 - 0.738)	0.994 (0.993 - 0.994)
		Higher with BB/GV	0.841 (0.823 - 0.859)	0.993 (0.993 - 0.994)	0.788 (0.771 - 0.806)	0.993 (0.993 - 0.994)	0.721 (0.703 - 0.737)	0.994 (0.993 - 0.994)
		Lower no BB/GV	0.892 (0.873 - 0.909)	0.996 (0.995 - 0.996)	0.854 (0.835 - 0.872)	0.996 (0.995 - 0.996)	0.804 (0.785 - 0.822)	0.996 (0.995 - 0.996)
		Lower with BB/GV	0.891 (0.873 - 0.909)	0.996 (0.995 - 0.996)	0.853 (0.835 - 0.871)	0.996 (0.995 - 0.996)	0.804 (0.785 - 0.822)	0.996 (0.995 - 0.996)
	Farne Islands	Higher no BB/GV	0.933 (0.889 - 0.981)	0.997 (0.996 - 0.999)	0.908 (0.862 - 0.960)	0.997 (0.996 - 0.999)	0.876 (0.828 - 0.928)	0.997 (0.996 - 0.998)
		Higher with BB/GV	0.877 (0.834 - 0.923)	0.995 (0.993 - 0.997)	0.835 (0.792 - 0.881)	0.995 (0.994 - 0.996)	0.781 (0.737 - 0.826)	0.995 (0.994 - 0.996)
		Lower no BB/GV	0.953 (0.908 - 1.002)	0.998 (0.997 - 1.000)	0.936 (0.888 - 0.988)	0.998 (0.997 - 0.999)	0.913 (0.862 - 0.965)	0.998 (0.997 - 0.999)
		Lower with BB/GV	0.907 (0.864 - 0.953)	0.996 (0.995 - 0.998)	0.874 (0.829 - 0.922)	0.996 (0.995 - 0.998)	0.831 (0.786 - 0.880)	0.996 (0.995 - 0.997)

Species	Population	Scenario (distributional response mortality rate)	2057 (25 years operation)		2067 (35 years operation – intended lease period)		2082 (50 years operation)	
			CPS	CGR	CPS	CGR	CPS	CGR
	Forth Islands	Higher no BB/GV	0.926 (0.891 - 0.959)	0.997 (0.996 - 0.998)	0.898 (0.863 - 0.934)	0.997 (0.996 - 0.998)	0.863 (0.826 - 0.899)	0.997 (0.996 - 0.998)
		Higher with BB/GV	0.887 (0.854 - 0.921)	0.995 (0.994 - 0.997)	0.848 (0.814 - 0.882)	0.995 (0.994 - 0.996)	0.797 (0.764 - 0.832)	0.996 (0.995 - 0.996)
		Lower no BB/GV	0.949 (0.914 - 0.985)	0.998 (0.997 - 0.999)	0.931 (0.894 - 0.968)	0.998 (0.997 - 0.999)	0.906 (0.867 - 0.943)	0.998 (0.997 - 0.999)
		Lower with BB/GV	0.918 (0.884 - 0.952)	0.997 (0.996 - 0.998)	0.888 (0.853 - 0.924)	0.997 (0.996 - 0.998)	0.850 (0.815 - 0.887)	0.997 (0.996 - 0.998)
	Fowlsheugh	Higher no BB/GV	0.902 (0.880 - 0.924)	0.996 (0.995 - 0.997)	0.868 (0.845 - 0.890)	0.996 (0.995 - 0.997)	0.822 (0.799 - 0.845)	0.996 (0.996 - 0.997)
		Higher with BB/GV	0.854 (0.834 - 0.876)	0.994 (0.993 - 0.995)	0.805 (0.783 - 0.827)	0.994 (0.993 - 0.995)	0.742 (0.720 - 0.764)	0.994 (0.994 - 0.995)
		Lower no BB/GV	0.926 (0.903 - 0.949)	0.997 (0.996 - 0.998)	0.899 (0.876 - 0.923)	0.997 (0.996 - 0.998)	0.864 (0.839 - 0.888)	0.997 (0.997 - 0.998)
		Lower with BB/GV	0.887 (0.865 - 0.908)	0.995 (0.995 - 0.996)	0.847 (0.825 - 0.869)	0.995 (0.995 - 0.996)	0.796 (0.774 - 0.818)	0.996 (0.995 - 0.996)
	North Caithness Cliffs	Higher no BB/GV	0.865 (0.829 - 0.901)	0.994 (0.993 - 0.996)	0.818 (0.784 - 0.855)	0.994 (0.993 - 0.995)	0.759 (0.724 - 0.793)	0.995 (0.994 - 0.995)
		Higher with BB/GV	0.864 (0.830 - 0.900)	0.994 (0.993 - 0.996)	0.817 (0.782 - 0.855)	0.994 (0.993 - 0.995)	0.758 (0.724 - 0.794)	0.995 (0.994 - 0.995)
		Lower no BB/GV	0.902 (0.864 - 0.940)	0.996 (0.995 - 0.997)	0.867 (0.830 - 0.906)	0.996 (0.995 - 0.997)	0.821 (0.784 - 0.860)	0.996 (0.995 - 0.997)
		Lower with BB/GV	0.902 (0.863 - 0.940)	0.996 (0.995 - 0.997)	0.867 (0.828 - 0.906)	0.996 (0.995 - 0.997)	0.821 (0.783 - 0.859)	0.996 (0.995 - 0.997)
	St Abbs Head to Fast Castle	Higher no BB/GV	0.916 (0.876 - 0.957)	0.997 (0.995 - 0.998)	0.885 (0.845 - 0.926)	0.997 (0.995 - 0.998)	0.845 (0.804 - 0.887)	0.997 (0.996 - 0.998)
		Higher with BB/GV	0.527 (0.498 - 0.557)	0.976 (0.974 - 0.978)	0.414 (0.388 - 0.439)	0.976 (0.974 - 0.977)	0.299 (0.278 - 0.319)	0.977 (0.975 - 0.978)
		Lower no BB/GV	0.942 (0.903 - 0.985)	0.998 (0.996 - 0.999)	0.920 (0.881 - 0.965)	0.998 (0.997 - 0.999)	0.893 (0.849 - 0.936)	0.998 (0.997 - 0.999)
		Lower with BB/GV	0.605 (0.573 - 0.636)	0.981 (0.979 - 0.983)	0.501 (0.471 - 0.529)	0.981 (0.979 - 0.982)	0.388 (0.362 - 0.412)	0.982 (0.980 - 0.983)
	Troup Pennan and Lions Heads	Higher no BB/GV	0.910 (0.887 - 0.933)	0.996 (0.996 - 0.997)	0.878 (0.854 - 0.902)	0.996 (0.996 - 0.997)	0.835 (0.811 - 0.860)	0.996 (0.996 - 0.997)
		Higher with BB/GV	0.908 (0.885 - 0.931)	0.996 (0.995 - 0.997)	0.875 (0.851 - 0.899)	0.996 (0.996 - 0.997)	0.832 (0.807 - 0.856)	0.996 (0.996 - 0.997)
		Lower no BB/GV	0.935 (0.911 - 0.959)	0.997 (0.997 - 0.998)	0.911 (0.887 - 0.936)	0.997 (0.997 - 0.998)	0.879 (0.855 - 0.906)	0.997 (0.997 - 0.998)
		Lower with BB/GV	0.933 (0.910 - 0.957)	0.997 (0.996 - 0.998)	0.909 (0.884 - 0.933)	0.997 (0.997 - 0.998)	0.876 (0.851 - 0.901)	0.997 (0.997 - 0.998)
	West Westray	Higher	0.727 (0.681 - 0.774)	0.988 (0.986 - 0.990)	0.644 (0.602 - 0.689)	0.988 (0.986 - 0.989)	0.545 (0.506 - 0.586)	0.988 (0.987 - 0.989)
		Lower	0.804 (0.754 - 0.856)	0.992 (0.990 - 0.994)	0.740 (0.691 - 0.789)	0.992 (0.990 - 0.993)	0.660 (0.614 - 0.707)	0.992 (0.991 - 0.993)
	Regional	Higher no BB/GV	0.885 (0.875 - 0.894)	0.995 (0.995 - 0.996)	0.844 (0.833 - 0.854)	0.995 (0.995 - 0.996)	0.791 (0.780 - 0.802)	0.995 (0.995 - 0.996)
		Higher with BB/GV	0.848 (0.837 - 0.858)	0.994 (0.993 - 0.994)	0.796 (0.785 - 0.806)	0.994 (0.993 - 0.994)	0.730 (0.718 - 0.741)	0.994 (0.994 - 0.994)
		Lower no BB/GV	0.917 (0.907 - 0.927)	0.997 (0.996 - 0.997)	0.887 (0.876 - 0.898)	0.997 (0.996 - 0.997)	0.848 (0.836 - 0.859)	0.997 (0.997 - 0.997)
		Lower with BB/GV	0.886 (0.876 - 0.896)	0.995 (0.995 - 0.996)	0.847 (0.835 - 0.857)	0.995 (0.995 - 0.996)	0.795 (0.783 - 0.806)	0.996 (0.995 - 0.996)
Herring gull	Buchan Ness to Collieston Coast	No BB/GV	0.981 (0.907 - 1.057)	0.999 (0.997 - 1.002)	0.972 (0.894 - 1.059)	0.999 (0.997 - 1.001)	0.962 (0.871 - 1.063)	0.999 (0.997 - 1.001)
		With BB/GV	0.980 (0.908 - 1.058)	0.999 (0.997 - 1.002)	0.973 (0.892 - 1.058)	0.999 (0.997 - 1.001)	0.963 (0.873 - 1.062)	0.999 (0.997 - 1.001)
Guillemot	Buchan Ness to Collieston Coast	Higher no BB/GV	0.945 (0.931 - 0.959)	0.998 (0.997 - 0.998)	0.924 (0.910 - 0.939)	0.998 (0.997 - 0.998)	0.896 (0.881 - 0.911)	0.998 (0.998 - 0.998)
		Higher with BB/GV	0.882 (0.869 - 0.896)	0.995 (0.995 - 0.996)	0.840 (0.827 - 0.854)	0.995 (0.995 - 0.996)	0.785 (0.771 - 0.799)	0.995 (0.995 - 0.996)
		Lower no BB/GV	0.979 (0.965 - 0.994)	0.999 (0.999 - 1.000)	0.971 (0.956 - 0.987)	0.999 (0.999 - 1.000)	0.960 (0.944 - 0.977)	0.999 (0.999 - 1.000)
		Lower with BB/GV	0.951 (0.937 - 0.966)	0.998 (0.998 - 0.999)	0.933 (0.917 - 0.948)	0.998 (0.998 - 0.998)	0.908 (0.892 - 0.924)	0.998 (0.998 - 0.998)

Species	Population	Scenario (distributional response mortality rate)	2057 (25 years operation)		2067 (35 years operation – intended lease period)		2082 (50 years operation)	
			CPS	CGR	CPS	CGR	CPS	CGR
	Troup Pennans and Lion Heads	Higher no BB/GV	0.960 (0.947 - 0.974)	0.998 (0.998 - 0.999)	0.945 (0.931 - 0.959)	0.998 (0.998 - 0.999)	0.924 (0.910 - 0.939)	0.998 (0.998 - 0.999)
		Higher with BB/GV	0.943 (0.931 - 0.957)	0.998 (0.997 - 0.998)	0.923 (0.909 - 0.936)	0.998 (0.997 - 0.998)	0.894 (0.880 - 0.909)	0.998 (0.998 - 0.998)
		Lower no BB/GV	0.983 (0.970 - 0.997)	0.999 (0.999 - 1.000)	0.977 (0.963 - 0.992)	0.999 (0.999 - 1.000)	0.968 (0.953 - 0.983)	0.999 (0.999 - 1.000)
		Lower with BB/GV	0.976 (0.963 - 0.990)	0.999 (0.999 - 1.000)	0.967 (0.953 - 0.982)	0.999 (0.999 - 0.999)	0.955 (0.940 - 0.970)	0.999 (0.999 - 0.999)
	Regional	Higher no BB/GV	0.951 (0.941 - 0.961)	0.998 (0.998 - 0.998)	0.932 (0.922 - 0.942)	0.998 (0.998 - 0.998)	0.907 (0.896 - 0.918)	0.998 (0.998 - 0.998)
		Higher with BB/GV	0.911 (0.902 - 0.920)	0.996 (0.996 - 0.997)	0.879 (0.870 - 0.889)	0.996 (0.996 - 0.997)	0.836 (0.827 - 0.846)	0.996 (0.996 - 0.997)
		Lower no BB/GV	0.980 (0.971 - 0.990)	0.999 (0.999 - 1.000)	0.973 (0.962 - 0.983)	0.999 (0.999 - 0.999)	0.962 (0.952 - 0.973)	0.999 (0.999 - 0.999)
		Lower with BB/GV	0.960 (0.950 - 0.970)	0.998 (0.998 - 0.999)	0.945 (0.935 - 0.955)	0.998 (0.998 - 0.999)	0.925 (0.914 - 0.935)	0.998 (0.998 - 0.999)
Razorbill	Troup Pennan and Lions Heads	Higher no BB/GV	0.917 (0.858 - 0.977)	0.997 (0.994 - 0.999)	0.887 (0.816 - 0.959)	0.997 (0.994 - 0.999)	0.847 (0.760 - 0.939)	0.997 (0.995 - 0.999)
		Higher with BB/GV	0.908 (0.849 - 0.968)	0.996 (0.994 - 0.999)	0.876 (0.805 - 0.949)	0.996 (0.994 - 0.998)	0.832 (0.746 - 0.924)	0.996 (0.994 - 0.998)
		Lower no BB/GV	0.969 (0.908 - 1.035)	0.999 (0.996 - 1.001)	0.956 (0.884 - 1.033)	0.999 (0.997 - 1.001)	0.941 (0.848 - 1.042)	0.999 (0.997 - 1.001)
		Lower with BB/GV	0.964 (0.904 - 1.029)	0.999 (0.996 - 1.001)	0.949 (0.875 - 1.031)	0.999 (0.996 - 1.001)	0.931 (0.840 - 1.034)	0.999 (0.997 - 1.001)
	Fowlsheugh	Higher	0.808 (0.772 - 0.844)	0.992 (0.990 - 0.993)	0.744 (0.703 - 0.784)	0.992 (0.990 - 0.993)	0.662 (0.615 - 0.708)	0.992 (0.991 - 0.993)
		Lower	0.893 (0.856 - 0.932)	0.996 (0.994 - 0.997)	0.855 (0.810 - 0.902)	0.996 (0.994 - 0.997)	0.805 (0.749 - 0.861)	0.996 (0.994 - 0.997)
	Regional	Higher no BB/GV	0.855 (0.827 - 0.881)	0.994 (0.993 - 0.995)	0.804 (0.773 - 0.834)	0.994 (0.993 - 0.995)	0.738 (0.700 - 0.774)	0.994 (0.993 - 0.995)
		Higher with BB/GV	0.836 (0.811 - 0.861)	0.993 (0.992 - 0.994)	0.780 (0.751 - 0.809)	0.993 (0.992 - 0.994)	0.707 (0.672 - 0.741)	0.993 (0.992 - 0.994)
		Lower no BB/GV	0.918 (0.891 - 0.944)	0.997 (0.996 - 0.998)	0.888 (0.855 - 0.918)	0.997 (0.996 - 0.998)	0.846 (0.807 - 0.886)	0.997 (0.996 - 0.998)
		Lower with BB/GV	0.905 (0.878 - 0.932)	0.996 (0.995 - 0.997)	0.871 (0.839 - 0.902)	0.996 (0.995 - 0.997)	0.825 (0.784 - 0.864)	0.996 (0.995 - 0.997)
Puffin	Coquet Island	Higher no BB/GV	0.990 (0.960 - 1.022)	1.000 (0.999 - 1.001)	0.987 (0.950 - 1.025)	1.000 (0.999 - 1.001)	0.982 (0.936 - 1.031)	1.000 (0.999 - 1.001)
		Higher with BB/GV	0.986 (0.957 - 1.018)	0.999 (0.998 - 1.001)	0.981 (0.944 - 1.019)	0.999 (0.998 - 1.000)	0.974 (0.927 - 1.022)	0.999 (0.999 - 1.000)
		Lower no BB/GV	0.994 (0.964 - 1.024)	1.000 (0.999 - 1.001)	0.992 (0.954 - 1.029)	1.000 (0.999 - 1.001)	0.988 (0.941 - 1.037)	1.000 (0.999 - 1.001)
		Lower with BB/GV	0.991 (0.961 - 1.022)	1.000 (0.999 - 1.001)	0.988 (0.951 - 1.026)	1.000 (0.999 - 1.001)	0.983 (0.939 - 1.034)	1.000 (0.999 - 1.001)
	Farne Islands	Higher no BB/GV	0.985 (0.954 - 1.017)	0.999 (0.998 - 1.001)	0.979 (0.940 - 1.021)	0.999 (0.998 - 1.001)	0.971 (0.914 - 1.033)	0.999 (0.998 - 1.001)
		Higher with BB/GV	0.976 (0.945 - 1.006)	0.999 (0.998 - 1.000)	0.967 (0.927 - 1.007)	0.999 (0.998 - 1.000)	0.954 (0.894 - 1.012)	0.999 (0.998 - 1.000)
		Lower no BB/GV	0.990 (0.960 - 1.021)	1.000 (0.999 - 1.001)	0.987 (0.947 - 1.027)	1.000 (0.998 - 1.001)	0.982 (0.924 - 1.042)	1.000 (0.998 - 1.001)
		Lower with BB/GV	0.985 (0.954 - 1.016)	0.999 (0.998 - 1.001)	0.979 (0.939 - 1.020)	0.999 (0.998 - 1.001)	0.970 (0.913 - 1.031)	0.999 (0.998 - 1.001)
	Forth Islands	Higher no BB/GV	0.911 (0.890 - 0.931)	0.996 (0.996 - 0.997)	0.879 (0.853 - 0.904)	0.996 (0.996 - 0.997)	0.835 (0.804 - 0.865)	0.996 (0.996 - 0.997)
		Higher with BB/GV	0.900 (0.879 - 0.920)	0.996 (0.995 - 0.997)	0.864 (0.839 - 0.887)	0.996 (0.995 - 0.997)	0.815 (0.785 - 0.845)	0.996 (0.995 - 0.997)
		Lower no BB/GV	0.945 (0.923 - 0.966)	0.998 (0.997 - 0.999)	0.924 (0.898 - 0.949)	0.998 (0.997 - 0.999)	0.895 (0.863 - 0.929)	0.998 (0.997 - 0.999)
		Lower with BB/GV	0.938 (0.916 - 0.959)	0.998 (0.997 - 0.998)	0.914 (0.889 - 0.940)	0.998 (0.997 - 0.998)	0.883 (0.850 - 0.915)	0.998 (0.997 - 0.998)
	North Caithness Cliffs	Higher no BB/GV	0.742 (0.673 - 0.818)	0.989 (0.985 - 0.992)	0.661 (0.583 - 0.745)	0.989 (0.985 - 0.992)	0.563 (0.471 - 0.659)	0.989 (0.985 - 0.992)
		Higher with BB/GV	0.741 (0.668 - 0.817)	0.989 (0.985 - 0.992)	0.660 (0.581 - 0.742)	0.989 (0.985 - 0.992)	0.561 (0.468 - 0.661)	0.989 (0.985 - 0.992)
		Lower no BB/GV	0.834 (0.757 - 0.919)	0.993 (0.990 - 0.996)	0.778 (0.690 - 0.877)	0.993 (0.990 - 0.996)	0.704 (0.600 - 0.818)	0.993 (0.990 - 0.996)
		Lower with BB/GV	0.834 (0.756 - 0.916)	0.993 (0.990 - 0.996)	0.778 (0.688 - 0.871)	0.993 (0.990 - 0.996)	0.705 (0.596 - 0.818)	0.993 (0.990 - 0.996)

Species	Population	Scenario (distributional response mortality rate)	2057 (25 years operation)		2067 (35 years operation – intended lease period)		2082 (50 years operation)	
			CPS	CGR	CPS	CGR	CPS	CGR
	Regional	Higher no BB/GV	0.952 (0.939 - 0.964)	0.998 (0.998 - 0.999)	0.933 (0.918 - 0.949)	0.998 (0.998 - 0.999)	0.909 (0.889 - 0.929)	0.998 (0.998 - 0.999)
		Higher with BB/GV	0.943 (0.930 - 0.956)	0.998 (0.997 - 0.998)	0.922 (0.906 - 0.938)	0.998 (0.997 - 0.998)	0.893 (0.873 - 0.912)	0.998 (0.997 - 0.998)
		Lower no BB/GV	0.970 (0.957 - 0.983)	0.999 (0.998 - 0.999)	0.959 (0.943 - 0.974)	0.999 (0.998 - 0.999)	0.943 (0.922 - 0.963)	0.999 (0.998 - 0.999)
		Lower with BB/GV	0.965 (0.952 - 0.978)	0.999 (0.998 - 0.999)	0.952 (0.936 - 0.968)	0.999 (0.998 - 0.999)	0.934 (0.913 - 0.954)	0.999 (0.998 - 0.999)
Gannet	Fair Isle	Higher no BB/GV	0.957 (0.917 - 1.001)	0.998 (0.997 - 1.000)	0.941 (0.894 - 0.989)	0.998 (0.997 - 1.000)	0.919 (0.867 - 0.974)	0.998 (0.997 - 0.999)
		Higher with BB/GV	0.954 (0.913 - 0.997)	0.998 (0.997 - 1.000)	0.936 (0.892 - 0.985)	0.998 (0.997 - 0.999)	0.913 (0.863 - 0.965)	0.998 (0.997 - 0.999)
		Lower no BB/GV	0.974 (0.930 - 1.018)	0.999 (0.997 - 1.001)	0.964 (0.915 - 1.013)	0.999 (0.998 - 1.000)	0.950 (0.897 - 1.005)	0.999 (0.998 - 1.000)
		Lower with BB/GV	0.972 (0.928 - 1.015)	0.999 (0.997 - 1.000)	0.961 (0.914 - 1.010)	0.999 (0.998 - 1.000)	0.946 (0.894 - 1.000)	0.999 (0.998 - 1.000)
	Flamborough Head and Filey Coast	Higher no BB/GV	0.753 (0.733 - 0.773)	0.989 (0.988 - 0.990)	0.676 (0.657 - 0.697)	0.989 (0.988 - 0.990)	0.584 (0.564 - 0.605)	0.990 (0.989 - 0.990)
		Higher with BB/GV	0.751 (0.731 - 0.771)	0.989 (0.988 - 0.990)	0.673 (0.654 - 0.694)	0.989 (0.988 - 0.990)	0.581 (0.561 - 0.601)	0.989 (0.989 - 0.990)
		Lower no BB/GV	0.835 (0.814 - 0.857)	0.993 (0.992 - 0.994)	0.780 (0.758 - 0.803)	0.993 (0.992 - 0.994)	0.711 (0.687 - 0.734)	0.993 (0.993 - 0.994)
		Lower with BB/GV	0.833 (0.812 - 0.856)	0.993 (0.992 - 0.994)	0.778 (0.756 - 0.801)	0.993 (0.992 - 0.994)	0.708 (0.684 - 0.732)	0.993 (0.993 - 0.994)
	Forth Islands	Higher no BB/GV	0.882 (0.871 - 0.893)	0.995 (0.995 - 0.996)	0.841 (0.829 - 0.853)	0.995 (0.995 - 0.996)	0.787 (0.775 - 0.800)	0.995 (0.995 - 0.996)
		Higher with BB/GV	0.856 (0.845 - 0.867)	0.994 (0.994 - 0.994)	0.807 (0.796 - 0.818)	0.994 (0.994 - 0.994)	0.744 (0.732 - 0.756)	0.994 (0.994 - 0.994)
		Lower no BB/GV	0.916 (0.904 - 0.927)	0.997 (0.996 - 0.997)	0.886 (0.873 - 0.898)	0.997 (0.996 - 0.997)	0.846 (0.832 - 0.858)	0.997 (0.996 - 0.997)
		Lower with BB/GV	0.897 (0.886 - 0.908)	0.996 (0.995 - 0.996)	0.861 (0.849 - 0.873)	0.996 (0.996 - 0.996)	0.813 (0.801 - 0.826)	0.996 (0.996 - 0.996)
	Hermaness Saxa Vord and Valla Field	Higher no BB/GV	0.953 (0.936 - 0.971)	0.998 (0.998 - 0.999)	0.936 (0.916 - 0.955)	0.998 (0.998 - 0.999)	0.912 (0.891 - 0.933)	0.998 (0.998 - 0.999)
		Higher with BB/GV	0.951 (0.934 - 0.968)	0.998 (0.997 - 0.999)	0.932 (0.914 - 0.952)	0.998 (0.998 - 0.999)	0.907 (0.886 - 0.928)	0.998 (0.998 - 0.998)
		Lower no BB/GV	0.971 (0.954 - 0.989)	0.999 (0.998 - 0.999)	0.961 (0.942 - 0.980)	0.999 (0.998 - 0.999)	0.945 (0.924 - 0.967)	0.999 (0.998 - 0.999)
		Lower with BB/GV	0.970 (0.953 - 0.988)	0.999 (0.998 - 0.999)	0.958 (0.939 - 0.978)	0.999 (0.998 - 0.999)	0.942 (0.921 - 0.964)	0.999 (0.998 - 0.999)
	North Rona and Sula Sgeir	Higher no BB/GV	0.989 (0.959 - 1.022)	1.000 (0.999 - 1.001)	0.985 (0.952 - 1.021)	1.000 (0.999 - 1.000)	0.980 (0.942 - 1.021)	1.000 (0.999 - 1.000)
		Higher with BB/GV	0.989 (0.957 - 1.020)	1.000 (0.998 - 1.001)	0.984 (0.949 - 1.020)	1.000 (0.999 - 1.000)	0.978 (0.939 - 1.019)	1.000 (0.999 - 1.000)
		Lower no BB/GV	0.994 (0.963 - 1.025)	1.000 (0.999 - 1.001)	0.991 (0.959 - 1.027)	1.000 (0.999 - 1.001)	0.988 (0.951 - 1.027)	1.000 (0.999 - 1.000)
		Lower with BB/GV	0.993 (0.962 - 1.023)	1.000 (0.999 - 1.001)	0.991 (0.957 - 1.025)	1.000 (0.999 - 1.001)	0.987 (0.948 - 1.026)	1.000 (0.999 - 1.000)
	Noss	Higher no BB/GV	0.947 (0.921 - 0.973)	0.998 (0.997 - 0.999)	0.927 (0.898 - 0.957)	0.998 (0.997 - 0.999)	0.900 (0.868 - 0.933)	0.998 (0.997 - 0.999)
		Higher with BB/GV	0.943 (0.918 - 0.970)	0.998 (0.997 - 0.999)	0.922 (0.893 - 0.950)	0.998 (0.997 - 0.999)	0.894 (0.862 - 0.926)	0.998 (0.997 - 0.998)
		Lower no BB/GV	0.968 (0.941 - 0.994)	0.999 (0.998 - 1.000)	0.956 (0.926 - 0.985)	0.999 (0.998 - 1.000)	0.938 (0.906 - 0.971)	0.999 (0.998 - 0.999)
		Lower with BB/GV	0.966 (0.939 - 0.993)	0.999 (0.998 - 1.000)	0.953 (0.924 - 0.982)	0.999 (0.998 - 0.999)	0.935 (0.903 - 0.967)	0.999 (0.998 - 0.999)
	Sule Skerry and Sule Stack	Higher no BB/GV	0.934 (0.902 - 0.967)	0.997 (0.996 - 0.999)	0.910 (0.875 - 0.945)	0.997 (0.996 - 0.998)	0.877 (0.840 - 0.917)	0.997 (0.997 - 0.998)

Species	Population	Scenario (distributional response mortality rate)	2057 (25 years operation)		2067 (35 years operation – intended lease period)		2082 (50 years operation)	
			CPS	CGR	CPS	CGR	CPS	CGR
		Higher with BB/GV	0.933 (0.901 - 0.967)	0.997 (0.996 - 0.998)	0.909 (0.875 - 0.945)	0.997 (0.996 - 0.998)	0.876 (0.838 - 0.913)	0.997 (0.997 - 0.998)
		Lower no BB/GV	0.954 (0.920 - 0.988)	0.998 (0.997 - 0.999)	0.936 (0.900 - 0.974)	0.998 (0.997 - 0.999)	0.912 (0.874 - 0.953)	0.998 (0.997 - 0.999)
		Lower with BB/GV	0.953 (0.921 - 0.985)	0.998 (0.997 - 0.999)	0.935 (0.900 - 0.971)	0.998 (0.997 - 0.999)	0.911 (0.873 - 0.950)	0.998 (0.997 - 0.999)
	Regional	Higher no BB/GV	0.925 (0.919 - 0.931)	0.997 (0.997 - 0.997)	0.898 (0.892 - 0.905)	0.997 (0.997 - 0.997)	0.862 (0.855 - 0.869)	0.997 (0.997 - 0.997)
		Higher with BB/GV	0.915 (0.909 - 0.921)	0.997 (0.996 - 0.997)	0.884 (0.878 - 0.891)	0.997 (0.996 - 0.997)	0.844 (0.837 - 0.851)	0.997 (0.997 - 0.997)
		Lower no BB/GV	0.949 (0.943 - 0.955)	0.998 (0.998 - 0.998)	0.930 (0.924 - 0.937)	0.998 (0.998 - 0.998)	0.905 (0.898 - 0.913)	0.998 (0.998 - 0.998)
		Lower with BB/GV	0.942 (0.936 - 0.948)	0.998 (0.997 - 0.998)	0.921 (0.914 - 0.928)	0.998 (0.998 - 0.998)	0.892 (0.885 - 0.899)	0.998 (0.998 - 0.998)

Source: NEPVA outputs

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A. Calculation of overall project-only mortality rates

A.1. Kittiwake

Kittiwake has been assessed for both collision and distributional response impacts. Breeding season distributional response impacts were derived using SeabORD for six of the 19 SPA colonies assessed. These colonies are marked with an asterisk in Table 5.1 below. All other kittiwake distributional response impacts were calculated using the distributional response matrix approach. Non-breeding season apportioning was done using Furness, 2015 (see Volume 3, Appendix 11.4, Ornithology Apportionment Technical Report for details).

Table 5.1: Partitioning of predicted breeding season impacts among adults and immatures for kittiwake – higher distributional response mortality rate scenario (collision plus distributional response assuming 3% mortality rate of displaced birds).

Population	Proportion of population adult (a)	Sabbatical rate (b)	Breeding season collision mortality (c)	Breeding season distributional response mortality (d)	Adult collision mortality excluding sabbatical birds (e) = a * (1-b) * c	Immature collision mortality (f) = (1-a) * c	Adult distributional response mortality excluding sabbatical birds (g) = a * (1-b) * d	Immature distributional response mortality (h) = (1-a) * d	Total adult mortality excluding sabbatical birds (i) = e + g	Total immature mortality (j) = f + h	Adult breeding population size (k)	Immature population size (l) = (k/a) * (1-a)	Adult breeding season mortality rate (m) = i/k	Immature breeding season mortality rate (n) = j/l
Buchan Ness to Collieston Coast SPA*	0.46	0.1	20.357	-	8.358	11.071	5.200	-	13.558	11.071	27094	32299	0.00050	0.00034
Calf of Eday SPA	0.46	0.1	0.043	0.020	0.018	0.023	0.008	0.011	0.026	0.034	672	801	0.00004	0.00004
Cape Wrath SPA	0.51	0.1	0.288	0.137	0.132	0.142	0.063	0.067	0.194	0.209	7244	7008	0.00003	0.00003
Copinsay SPA	0.46	0.1	0.052	0.025	0.021	0.028	0.010	0.013	0.032	0.042	592	706	0.00005	0.00006
East Caithness Cliffs SPA*	0.46	0.1	5.596	-	2.298	3.043	3.800	-	6.097	3.043	48958	58362	0.00012	0.00005
Fair Isle SPA	0.61	0.1	0.052	0.025	0.028	0.020	0.013	0.010	0.042	0.030	896	582	0.00005	0.00005
Farne Islands SPA	0.46	0.1	0.831	0.394	0.341	0.452	0.162	0.214	0.503	0.666	7166	8543	0.00007	0.00008
Forth Islands SPA*	0.46	0.1	1.750	-	0.718	0.951	1.000	-	1.718	0.951	13244	15788	0.00013	0.00006
Foula SPA	0.61	0.1	0.028	0.013	0.015	0.011	0.007	0.005	0.023	0.016	850	552	0.00003	0.00003
Fowlsheugh SPA*	0.46	0.1	11.418	-	4.688	6.210	0***	-	4.688	6.210	30966	36914	0.00015	0.00017
Hoy SPA	0.46	0.1	0.039	0.018	0.016	0.021	0.008	0.010	0.024	0.031	532	634	0.00004	0.00005
Marwick Head SPA	0.46	0.1	0.165	0.078	0.068	0.090	0.032	0.043	0.100	0.132	2878	3431	0.00003	0.00004
North Caithness Cliffs SPA	0.46	0.1	0.901	0.427	0.370	0.490	0.175	0.232	0.545	0.722	11142	13282	0.00005	0.00005
Noss SPA	0.61	0.1	0.006	0.003	0.003	0.002	0.002	0.001	0.005	0.003	172	112	0.00003	0.00003
Rousay SPA	0.46	0.1	0.040	0.019	0.016	0.022	0.008	0.010	0.024	0.032	660	787	0.00004	0.00004
St Abb's Head to Fast Castle SPA*	0.46	0.1	1.268	-	0.521	0.689	0***	-	0.521	0.689	9158	10917	0.00006	0.00006
Sumburgh Head SPA	0.61	0.1	0.085	0.040	0.046	0.033	0.022	0.016	0.068	0.049	1932	1254	0.00004	0.00004
Troup, Pennan and Lion's Heads SPA*	0.46	0.1	10.094	-	4.144	5.489	4.800	-	8.944	5.489	27344	32597	0.00033	0.00017

Population	Proportion of population adult (a)	Sabbatical rate (b)	Breeding season collision mortality (c)	Breeding season distributional response mortality (d)	Adult collision mortality excluding sabbatical birds (e) = a * (1-b) * c	Immature collision mortality (f) = (1-a) * c	Adult distributional response mortality excluding sabbatical birds (g) = a * (1-b) * d	Immature distributional response mortality (h) = (1-a) * d	Total adult mortality excluding sabbatical birds (i) = e + g	Total immature mortality (j) = f + h	Adult breeding population size (k)	Immature population size (l) = (k/a) * (1-a)	Adult breeding season mortality rate (m) = i/k	Immature breeding season mortality rate (n) = j/l
West Westray SPA	0.46	0.1	0.270	0.128	0.111	0.147	0.053	0.070	0.164	0.217	4838	5767	0.00003	0.00004
All other colonies	0.49	0.1	8.449	4.006	3.749	4.284	1.777	2.031	5.526	6.315	36801	37846	0.00015	0.00017
Regional**	-	-	61.733	5.334	25.662	33.220	17.139	2.734	42.802	35.953	233139	268181	0.00018	0.00013

*Source: (a) See Section 2.6.2.1 and Table 5.1, (b) See Section 2.6.1.2 (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.5, (d) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.5, (k) See Table 2.6 and Table C5.2, *SeabORD used: (g) is calculated as the percent additional adult mortality from SeabORD (Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) converted to a proportion by dividing by 100, and then multiplied by (k) **Regional row, columns (c) – (l) are column sums. ***SeabORD predicted a positive impact so this was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024).*

Table 5.2: Predicted non-breeding season impacts for adult and immature kittiwake – higher distributional response mortality rate scenario (collision plus distributional response assuming 3% mortality rate of displaced birds).

Population	Adult mortality							Immature mortality						Adult non-breeding mortality rate (ac) = u/k	Immature non-breeding mortality rate (ad) = ab/l
	Autumn migration collision mortality (o)	Autumn migration distributional response mortality (p)	Spring migration collision mortality (q)	Spring migration distributional response mortality (r)	Collision mortality excluding sabbatical birds (s) = (o + q) * (1-b)	Distributional response mortality excluding sabbatical birds (t) = (p + r) * (1-b)	Total mortality sabbatical birds (u) = s + t	Autumn migration collision mortality (v)	Autumn migration distributional response mortality (w)	Spring migration collision mortality (x)	Spring migration distributional response mortality (y)	Immature collision mortality (z) = v + x	Immature distributional response mortality (aa) = w + y	Total mortality (ab) = z + aa		
Buchan Ness to Collieston Coast SPA	0.017	0.009	0.200	0.162	0.196	0.154	0.350	0.010	0.006	0.092	0.074	0.102	0.080	0.182	0.00001	0.00001
Calf of Eday SPA	0.001	0.001	0.008	0.007	0.008	0.007	0.015	0.001	0.001	0.008	0.007	0.009	0.007	0.017	0.00002	0.00002
Cape Wrath SPA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.008	0.007	0.009	0.007	0.017	0.00000	0.00000
Copinsay SPA	0.001	0.001	0.008	0.007	0.008	0.007	0.015	0.001	0.001	0.008	0.007	0.009	0.007	0.017	0.00003	0.00002
East Caithness Cliffs SPA	0.055	0.030	0.643	0.521	0.628	0.496	1.123	0.032	0.018	0.284	0.230	0.316	0.248	0.563	0.00002	0.00001
Fair Isle SPA	0.001	0.001	0.008	0.007	0.008	0.007	0.015	0.001	0.001	0.008	0.007	0.009	0.007	0.017	0.00002	0.00003
Farne Islands SPA	0.005	0.003	0.058	0.047	0.057	0.045	0.102	0.003	0.002	0.025	0.020	0.028	0.022	0.050	0.00001	0.00001
Forth Islands SPA	0.004	0.002	0.050	0.041	0.048	0.038	0.087	0.003	0.002	0.025	0.020	0.028	0.022	0.050	0.00001	0.00000
Foula SPA	0.000	0.000	0.008	0.007	0.008	0.006	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00002	0.00000
Fowlsheugh SPA	0.012	0.007	0.150	0.122	0.146	0.116	0.262	0.008	0.004	0.067	0.054	0.074	0.058	0.133	0.00001	0.00000
Hoy SPA	0.001	0.001	0.008	0.007	0.008	0.007	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00003	0.00000
Marwick Head SPA	0.001	0.001	0.008	0.007	0.008	0.007	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00001	0.00000

Population	Adult mortality							Immature mortality							Adult non-breeding mortality rate (ac) = u/k	Immature non-breeding mortality rate (ad) = ab/l
	Autumn migration collision mortality (o)	Autumn migration distributional response mortality (p)	Spring migration collision mortality (q)	Spring migration distributional response mortality (r)	Collision mortality excluding sabbatical birds (s) = (o + q) * (1-b)	Distributional response mortality excluding sabbatical birds (t) = (p + r) * (1-b)	Total mortality excluding sabbatical birds (u) = s + t	Autumn migration collision mortality (v)	Autumn migration distributional response mortality (w)	Spring migration collision mortality (x)	Spring migration distributional response mortality (y)	Immature collision mortality (z) = v + x	Immature distributional response mortality (aa) = w + y	Total mortality (ab) = z + aa		
North Caithness Cliffs SPA	0.014	0.008	0.159	0.128	0.155	0.123	0.278	0.009	0.005	0.075	0.061	0.084	0.066	0.149	0.00002	0.00001
Noss SPA	0.001	0.001	0.008	0.007	0.008	0.007	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00009	0.00000
Rousay SPA	0.003	0.002	0.025	0.020	0.025	0.020	0.045	0.001	0.001	0.008	0.007	0.009	0.007	0.017	0.00007	0.00002
St Abb's Head to Fast Castle SPA	0.005	0.003	0.058	0.047	0.057	0.045	0.102	0.003	0.002	0.025	0.020	0.028	0.022	0.050	0.00001	0.00000
Sumburgh Head SPA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00000	0.00000
Troup, Pennan and Lion's Heads SPA	0.021	0.011	0.234	0.189	0.229	0.181	0.410	0.012	0.007	0.108	0.088	0.121	0.095	0.215	0.00001	0.00001
West Westray SPA	0.016	0.009	0.192	0.155	0.187	0.148	0.335	0.009	0.005	0.083	0.068	0.093	0.073	0.166	0.00007	0.00003
All other colonies	0.095	0.053	1.118	0.906	1.092	0.863	1.955	0.056	0.031	0.492	0.399	0.548	0.430	0.978	0.00005	0.00003
Regional*	0.252	0.139	2.946	2.386	2.879	2.273	5.151	0.149	0.082	1.319	1.068	1.468	1.150	2.618	0.00002	0.00001

*Source: (o) – (r) and (v) – (y) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.5, *Regional row, columns (o) – (ab) are column sums.*

Table 5.3: Annual predicted impact mortality rates for adults and immatures, reduction in productivity and percentage point change in annual adult survival for kittiwake – higher distributional response mortality rate scenario (collision plus distributional response assuming 3% mortality rate of displaced birds). Numbers in bold are those that exceed the NatureScot threshold for running PVA (NatureScot, 2023a).

Population	Total adult mortality rate (ae) = m + ac	Baseline adult annual survival rate (%) (af)	Impact adult annual survival rate (%) (ag) = af – (ae*100)	Percentage point change in adult survival rate (ah) = af - ag	Total immature mortality rate (ai) = n + ad	Reduction in productivity (aj)	Adult mortality (individuals) (ak) = ae * k
Buchan Ness to Collieston Coast SPA	0.00051	85.4	85.349	**0.051**	0.00035	0.00094	13.908
Calf of Eday SPA	0.00006	85.4	85.394	0.006	0.00006	-	0.041
Cape Wrath SPA	0.00003	85.4	85.397	0.003	0.00003	-	0.194
Copinsay SPA	0.00008	85.4	85.392	0.008	0.00008	-	0.047
East Caithness Cliffs SPA	0.00015	85.4	85.385	0.015	0.00006	0.00022	7.221
Fair Isle SPA	0.00006	85.4	85.394	0.006	0.00008	-	0.057
Farne Islands SPA	0.00008	85.4	85.392	0.008	0.00008	-	0.605
Forth Islands SPA	0.00014	85.4	85.386	0.014	0.00006	0.00012	1.805
Foula SPA	0.00004	85.4	85.396	0.004	0.00003	-	0.036
Fowlsheugh SPA	0.00016	85.4	85.384	0.016	0.00017	0.00090	4.950

Population	Total adult mortality rate (ae) = m + ac	Baseline adult annual survival rate (%) (af)	Impact adult annual survival rate (%) (ag) = af – (ae*100)	Percentage point change in adult survival rate (ah) = af - ag	Total immature mortality rate (ai) = n + ad	Reduction in productivity (aj)	Adult mortality (individuals) (ak) = ae * k
Hoy SPA	0.00007	85.4	85.393	0.007	0.00005	-	0.038
Marwick Head SPA	0.00004	85.4	85.396	0.004	0.00004	-	0.115
North Caithness Cliffs SPA	0.00007	85.4	85.393	0.007	0.00007	-	0.823
Noss SPA	0.00011	85.4	85.389	0.011	0.00003	-	0.020
Rousay SPA	0.00010	85.4	85.390	0.010	0.00006	-	0.069
St Abb's Head to Fast Castle SPA	0.00007	85.4	85.393	0.007	0.00007	0.00070	0.622
Sumburgh Head SPA	0.00004	85.4	85.396	0.004	0.00004	-	0.068
Troup, Pennan and Lion's Heads SPA	0.00034	85.4	85.366	**0.034**	0.00018	0.00060	9.354
West Westray SPA	0.00010	85.4	85.390	0.010	0.00007	-	0.499
All other colonies	0.00020	85.4	85.380	**0.020**	0.00019	-	7.481
Regional*	0.00021	85.4	85.379	**0.021**	0.00014	0.00057	47.953

*Source: (af) Horswill and Robinson, 2015, (aj) Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report – percent additional chick mortality from SeabORD converted to a proportion by dividing by 100, *Regional row, column (aj) is a weighted average by population size.*

Table 5.4: Partitioning of predicted breeding season impacts among adults and immatures for kittiwake – lower distributional response mortality rate scenario (collision plus distributional response assuming 1% mortality rate of displaced birds).

Population	Proportion of population adult (a)	Sabbatical rate (b)	Breeding season collision mortality (c)	Breeding season distributional response mortality (d)	Adult collision mortality excluding sabbatical birds (e) = a * (1-b) * c	Immature collision mortality (f) = (1-a) * c	Adult distributional response mortality excluding sabbatical birds (g) = a * (1-b) * d	Immature distributional response mortality (h) = (1-a) * d	Total adult mortality excluding sabbatical birds (i) = e + g	Total immature mortality (j) = f + h	Adult breeding population size (k)	Immature population size (l) = (k/a) * (1-a)	Adult breeding season mortality rate (m) = i/k	Immature breeding season mortality rate (n) = j/l
Buchan Ness to Collieston Coast SPA*	0.46	0.1	20.357	-	8.358	11.071	5.200	-	13.558	11.071	27094	32299	0.00050	0.00034
Calf of Eday SPA	0.46	0.1	0.043	0.007	0.018	0.023	0.003	0.004	0.020	0.027	672	801	0.00003	0.00003
Cape Wrath SPA	0.51	0.1	0.288	0.046	0.132	0.142	0.021	0.022	0.153	0.164	7244	7008	0.00002	0.00002
Copinsay SPA	0.46	0.1	0.052	0.008	0.021	0.028	0.003	0.004	0.025	0.033	592	706	0.00004	0.00005
East Caithness Cliffs SPA*	0.46	0.1	5.596	-	2.298	3.043	3.800	-	6.097	3.043	48958	58362	0.00012	0.00005
Fair Isle SPA	0.61	0.1	0.052	0.008	0.028	0.020	0.004	0.003	0.033	0.024	896	582	0.00004	0.00004
Farne Islands SPA	0.46	0.1	0.831	0.131	0.341	0.452	0.054	0.071	0.395	0.524	7166	8543	0.00006	0.00006

Population	Proportion of population adult (a)	Sabbatical rate (b)	Breeding season collision mortality (c)	Breeding season distributional response mortality (d)	Adult collision mortality excluding sabbatical birds (e) = a * (1-b) * c	Immature collision mortality (f) = (1-a) * c	Adult distributional response mortality excluding sabbatical birds (g) = a * (1-b) * d	Immature distributional response mortality (h) = (1-a) * d	Total adult mortality excluding sabbatical birds (i) = e + g	Total immature mortality (j) = f + h	Adult breeding population size (k)	Immature population size (l) = (k/a) * (1-a)	Adult breeding season mortality rate (m) = i/k	Immature breeding season mortality rate (n) = j/l
Forth Islands SPA*	0.46	0.1	1.750	-	0.718	0.951	1.000	-	1.718	0.951	13244	15788	0.00013	0.00006
Foula SPA	0.61	0.1	0.028	0.004	0.015	0.011	0.002	0.002	0.018	0.013	850	552	0.00002	0.00002
Fowlsheugh SPA*	0.46	0.1	11.418	-	4.688	6.210	0***	-	4.688	6.210	30966	36914	0.00015	0.00017
Hoy SPA	0.46	0.1	0.039	0.006	0.016	0.021	0.003	0.003	0.018	0.024	532	634	0.00003	0.00004
Marwick Head SPA	0.46	0.1	0.165	0.026	0.068	0.090	0.011	0.014	0.079	0.104	2878	3431	0.00003	0.00003
North Caithness Cliffs SPA	0.46	0.1	0.901	0.142	0.370	0.490	0.058	0.077	0.428	0.568	11142	13282	0.00004	0.00004
Noss SPA	0.61	0.1	0.006	0.001	0.003	0.002	0.001	0.000	0.004	0.003	172	112	0.00002	0.00002
Rousay SPA	0.46	0.1	0.040	0.006	0.016	0.022	0.003	0.003	0.019	0.025	660	787	0.00003	0.00003
St Abb's Head to Fast Castle SPA*	0.46	0.1	1.268	-	0.521	0.689	0***	-	0.521	0.689	9158	10917	0.00006	0.00006
Sumburgh Head SPA	0.61	0.1	0.085	0.013	0.046	0.033	0.007	0.005	0.054	0.039	1932	1254	0.00003	0.00003
Troup, Pennan and Lion's Heads SPA*	0.46	0.1	10.094	-	4.144	5.489	4.800	-	8.944	5.489	27344	32597	0.00033	0.00017
West Westray SPA	0.46	0.1	0.270	0.043	0.111	0.147	0.018	0.023	0.129	0.170	4838	5767	0.00003	0.00003
All other colonies	0.49	0.1	8.449	1.336	3.749	4.284	0.593	0.677	4.341	4.961	36801	37846	0.00012	0.00013
Regional**	-	-	61.733	1.779	25.662	33.220	15.580	0.912	41.242	34.131	233139	268181	0.00018	0.00013

*Source: (a) See Annex D and Table 5.1, (b) See Section 2.6.1.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.5, (d) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.5, (k) See Table 2.6 and Table C5.2. SeabORD rows: (g) is calculated as the percent additional adult mortality from SeabORD (Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) converted to a proportion by dividing by 100, and then multiplied by (k) **Regional row, columns (c) – (l) are column sums. ***SeabORD predicted a positive impact so this was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024).*

Table 5.5: Predicted non-breeding season impacts for adult and immature kittiwake – lower distributional response mortality rate scenario (collision plus distributional response assuming 1% mortality rate of displaced birds).

Population	Adult mortality							Immature mortality							Adult non-breeding mortality rate (ac) = u/k	Immature non-breeding mortality rate (ad) = ab/l
	Autumn migration collision mortality (o)	Autumn migration distributional response mortality (p)	Spring migration collision mortality (q)	Spring migration distributional response mortality (r)	Collision mortality excluding sabbatical birds (s) = (o + q) * (1-b)	Distributional response mortality excluding sabbatical birds (t) = (p + r) * (1-b)	Total mortality excluding sabbatical birds (u) = s + t	Autumn migration collision mortality (v)	Autumn migration distributional response mortality (w)	Spring migration collision mortality (x)	Spring migration distributional response mortality (y)	Immature collision mortality (z) = v + x	Immature distributional response mortality (aa) = w + y	Total mortality (ab) = z + aa		
Buchan Ness to Collieston Coast SPA	0.017	0.003	0.200	0.054	0.196	0.051	0.247	0.010	0.002	0.092	0.025	0.102	0.027	0.129	0.00001	0.00000
Calf of Eday SPA	0.001	0.000	0.008	0.002	0.008	0.002	0.011	0.001	0.000	0.008	0.002	0.009	0.002	0.012	0.00002	0.00001
Cape Wrath SPA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.008	0.002	0.009	0.002	0.012	0.00000	0.00000
Copinsay SPA	0.001	0.000	0.008	0.002	0.008	0.002	0.011	0.001	0.000	0.008	0.002	0.009	0.002	0.012	0.00002	0.00002
East Caithness Cliffs SPA	0.055	0.010	0.643	0.173	0.628	0.165	0.793	0.032	0.006	0.284	0.077	0.316	0.082	0.398	0.00002	0.00001
Fair Isle SPA	0.001	0.000	0.008	0.002	0.008	0.002	0.011	0.001	0.000	0.008	0.002	0.009	0.002	0.012	0.00001	0.00002
Farne Islands SPA	0.005	0.001	0.058	0.016	0.057	0.015	0.072	0.003	0.001	0.025	0.007	0.028	0.007	0.035	0.00001	0.00000
Forth Islands SPA	0.004	0.001	0.050	0.014	0.048	0.013	0.061	0.003	0.001	0.025	0.007	0.028	0.007	0.035	0.00000	0.00000
Foula SPA	0.000	0.000	0.008	0.002	0.008	0.002	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00001	0.00000
Fowlsheugh SPA	0.012	0.002	0.150	0.041	0.146	0.038	0.185	0.008	0.001	0.067	0.018	0.074	0.019	0.094	0.00001	0.00000
Hoy SPA	0.001	0.000	0.008	0.002	0.008	0.002	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00002	0.00000
Marwick Head SPA	0.001	0.000	0.008	0.002	0.008	0.002	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00000	0.00000
North Caithness Cliffs SPA	0.014	0.003	0.159	0.043	0.155	0.041	0.196	0.009	0.002	0.075	0.020	0.084	0.022	0.105	0.00002	0.00001
Noss SPA	0.001	0.000	0.008	0.002	0.008	0.002	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00006	0.00000
Rousay SPA	0.003	0.001	0.025	0.007	0.025	0.007	0.032	0.001	0.000	0.008	0.002	0.009	0.002	0.012	0.00005	0.00001
St Abb's Head to Fast Castle SPA	0.005	0.001	0.058	0.016	0.057	0.015	0.072	0.003	0.001	0.025	0.007	0.028	0.007	0.035	0.00001	0.00000
Sumburgh Head SPA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00000	0.00000
Troup, Pennan and Lion's Heads SPA	0.021	0.004	0.234	0.063	0.229	0.060	0.289	0.012	0.002	0.108	0.029	0.121	0.031	0.152	0.00001	0.00000
West Westray SPA	0.016	0.003	0.192	0.052	0.187	0.049	0.236	0.009	0.002	0.083	0.023	0.093	0.024	0.117	0.00005	0.00002
All other colonies	0.095	0.017	1.118	0.302	1.092	0.287	1.379	0.056	0.010	0.492	0.133	0.548	0.143	0.691	0.00004	0.00002
Regional*	0.252	0.045	2.946	0.794	2.879	0.756	3.634	0.149	0.027	1.319	0.356	1.468	0.382	1.850	0.00002	0.00001

*Source: (o) – (r) and (v) – (y) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.5, *Regional row, columns (o) – (ab) are column sums.*

Table 5.6: **Annual predicted impact mortality rates for adults and immatures, reduction in productivity and percentage point change in annual adult survival for kittiwake – lower distributional response mortality rate scenario (collision plus distributional response assuming 1% mortality rate of displaced birds).. Numbers in bold are those that exceed the NatureScot threshold for running PVA (NatureScot, 2023a).**

Population	Total adult mortality rate (ae) = m + ac	Baseline adult annual survival rate (%) (af)	Impact adult annual survival rate (%) (ag) = af – (ae*100)	Percentage point change in adult survival rate (ah) = af - ag	Total immature mortality rate (ai) = n + ad	Reduction in productivity (aj)	Adult mortality (individuals) (ak) = ae * k
Buchan Ness to Collieston Coast SPA	0.00051	85.4	85.349	**0.051**	**0.00035**	**0.00094**	13.805
Calf of Eday SPA	0.00005	85.4	85.395	0.005	0.00005	-	0.031
Cape Wrath SPA	0.00002	85.4	85.398	0.002	0.00003	-	0.153
Copinsay SPA	0.00006	85.4	85.394	0.006	0.00006	-	0.035
East Caithness Cliffs SPA	0.00014	85.4	85.386	0.014	0.00006	0.00022	6.890
Fair Isle SPA	0.00005	85.4	85.395	0.005	0.00006	-	0.043
Farne Islands SPA	0.00007	85.4	85.393	0.007	0.00007	-	0.467
Forth Islands SPA	0.00013	85.4	85.387	0.013	0.00006	0.00012	1.780
Foula SPA	0.00003	85.4	85.397	0.003	0.00002	-	0.027
Fowlsheugh SPA	0.00016	85.4	85.384	0.016	0.00017	0.00090	4.873
Hoy SPA	0.00005	85.4	85.395	0.005	0.00004	-	0.029
Marwick Head SPA	0.00003	85.4	85.397	0.003	0.00003	-	0.089
North Caithness Cliffs SPA	0.00006	85.4	85.394	0.006	0.00005	-	0.625
Noss SPA	0.00008	85.4	85.392	0.008	0.00002	-	0.014
Rousay SPA	0.00008	85.4	85.392	0.008	0.00005	-	0.050
St Abb's Head to Fast Castle SPA	0.00006	85.4	85.394	0.006	0.00007	0.00070	0.592
Sumburgh Head SPA	0.00003	85.4	85.397	0.003	0.00003	-	0.054
Troup, Pennan and Lion's Heads SPA	0.00034	85.4	85.366	0.034	**0.00017**	**0.00060**	9.233
West Westray SPA	0.00008	85.4	85.392	0.008	0.00005	-	0.365
All other colonies	0.00016	85.4	85.384	0.016	0.00015	-	5.721
Regional*	0.00019	85.4	85.381	0.019	**0.00013**	**0.00057**	44.876

*Source: (af) Horswill and Robinson, 2015, (aj) Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report – percent additional chick mortality from SeabORD converted to a proportion by dividing by 100, *Regional row, column (aj) is a weighted average by population size.*

A.2. Herring gull

Herring gull has been assessed for collision impacts only. Non-breeding season apportioning was done using breeding season apportioning factors, with a correction factor of 0.675 to account for the fact that 32.5% of the over-winter birds are expected to come from Western UK and overseas (see Volume 3, Appendix 11.4, Ornithology Apportionment Technical Report for details). Therefore, the sum of the impacts from the non-breeding season will not be equal to the total predicted impacts reported in Volume 3, Appendix 11.2 (Ornithology Collision Risk Modelling Technical Report) and Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report).

Table 5.7: Partitioning of predicted breeding season impacts among adults and immatures for herring gull – only scenario (collision - higher distributional response mortality rate scenario and most likely scenario are the same).

Population	Proportion of population adult (a)	Sabbatical rate (b)	Breeding season collision mortality (c)	Adult breeding season mortality excluding sabbatical birds (d) = a * (1-b) * c	Immature breeding season mortality (e) = (1-a) * c	Adult breeding population size (f)	Immature population size (g) = (f/a) * (1-a)	Adult breeding season mortality rate (h) = d/f	Immature breeding season mortality rate (i) = e/g
Buchan Ness to Collieston Coast SPA	0.387	0.35	0.834	0.210	0.511	4536	7185	0.00005	0.00007
All other colonies	0.387	0.35	0.020	0.005	0.012	124	196	0.00004	0.00006
Regional*	-	-	0.854	0.215	0.524	4660	7381	0.00005	0.00007

*Source: (a) See Annex D and Table 5.1, (b) See Section 2.6.1.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.2.4, (f) See Table 2.6 and Table C5.2, *Regional row, columns (c) – (g) are column sums.*

Table 5.8: Partitioning of predicted non-breeding season impacts among adults and immatures for herring gull – only scenario (collision - higher distributional response mortality rate scenario and most likely scenario are the same).

Population	Non-breeding season collisions (j)	Adult non-breeding season mortality excluding sabbatical birds (k) = a * j * (1-b)	Immature non-breeding season collisions (l) = j - k	Adult non-breeding season mortality rate (m) = k/f	Immature non-breeding season mortality rate (n) = l/g
Buchan Ness to Collieston Coast SPA	1.139	0.287	0.698	0.00006	0.00010
All other colonies	0.027	0.007	0.017	0.00005	0.00008
Regional*	1.166	0.293	0.715	0.00006	0.00010

*Source: (j) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.2.4, * Regional row, columns (j) – (l) are column sums.*

Table 5.9: Annual predicted impact mortality rates for adults and immatures and percentage point change in annual adult survival for herring gull – only scenario (collision - higher distributional response mortality rate scenario and most likely scenario are the same).

Population	Annual adult mortality rate (o) = h + m	Baseline adult annual survival rate (%) (p)	Impact adult annual survival rate (%) (q) = p - (o*100)	Percentage point change in adult survival rate (r) = p - q	Immature annual mortality rate (s) = i + n	Breeding adult mortality (individuals) (t) = o * f
Buchan Ness to Collieston Coast SPA	0.00011	83.4	83.389	0.011	0.00017	0.50
All other colonies	0.00010	83.4	83.390	0.010	0.00015	0.01
Regional	0.00011	83.4	83.389	0.011	0.00017	0.51

Source: (p) Horswill and Robinson, 2015

A.3. Guillemot

Guillemot has been assessed for distributional response impacts only. Breeding season distributional response impacts were derived using SeabORD for all of the SPA colonies assessed. These colonies are marked with an asterisk in Table 5.10 below. The distributional response impacts for all other colonies were calculated using the distributional response matrix approach. Non-breeding season apportioning was done based on the same apportioning ratios as for the breeding season (see Volume 3, Appendix 11.4, Ornithology Apportionment Technical Report for details).

Table 5.10: Partitioning of breeding season impacts among adults and immatures for guillemot – higher distributional response mortality rate scenario (distributional response assuming 5% mortality rate of displaced birds during the breeding season and 3% during the non-breeding season). Table combines SeabORD estimates for SPA colonies and matrix-based estimates for all other colonies.

Population	Proportion of population that is adult (a)	Sabbatical rate (b)	Breeding season distributional response mortality (c)	Adult additional breeding season mortality excluding sabbatical birds (d) = a * c * (1-b)	Immature additional breeding season mortality (e) = c * (1-a)	Adult breeding population size (f)	Immature population size (g) = (f/a) * (1-a)	Predicted breeding season adult mortality rate (h) = d/f	Predicted breeding season immature mortality rate (i) = e/g
Buchan Ness to Collieston Coast SPA*	0.516	0.07	-	0***	-	40762.8	38220	0	-
Troup, Pennan and Lion's Heads SPA*	0.516	0.07	-	0.100	-	47718.74	44742	0.00000	-
All other colonies	0.516	0.07	9.813	4.710	4.748	2385.2	2236	0.00197	0.00212
Regional**	-	-	9.813	4.810	4.748	90866.74	85199	0.00005	0.00006

*Source: (a) See Annex D and Table 5.1, (b) See Section 2.6.1.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.1, (f) See Table 2.6, *SeabORD used: (d) is calculated as the percent additional adult mortality from SeabORD (Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) converted to a proportion by dividing by 100, and then multiplied by (k), impacts predicted by SeabORD are only to breeding adult survival rate and chicks (incorporated into PVA as productivity) so correction for proportion of adults and sabbatical birds is not required and no impacts are predicted for immatures, **Regional row, columns (c) – (g) are column sums, *** Predicted impacts on survival rate for Buchan Ness to Collieston Coast was greater than 0 i.e. a positive impact (see Volume 3, Appendix 11.3, Ornithology Distributional Responses Technical Report), so this impact was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024).*

Table 5.11: Partitioning of non-breeding season impacts among adults and immatures for guillemot – higher distributional response mortality rate scenario (distributional response assuming 5% mortality rate of displaced birds during the breeding season and 3% during the non-breeding season). All impacts were predicted using the matrix based approach.

Population	Non-breeding season distributional response mortality (j)	Adult non-breeding season mortality excluding sabbatical birds (k) = j * a * (1-b)	Immature non-breeding season mortality (l) = j * (1/a)	Adult non-breeding season mortality rate (m) = k/f	Immature non-breeding season mortality rate (n) = l/g
Buchan Ness to Collieston Coast SPA	129.670	62.238	62.748	0.00153	0.00164
Troup, Pennan and Lion's Heads SPA	78.538	37.696	38.005	0.00079	0.00085
All other colonies	5.323	2.555	2.576	0.00107	0.00115
Regional	213.530	102.488	103.328	0.00113	0.00121

Source: (j) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.1

Table 5.12: Annual predicted impact mortality rates for adults and immatures, reduction in productivity and percentage point change in annual adult survival for guillemot – higher distributional response mortality rate scenario (distributional response assuming 5% mortality rate of displaced birds during the breeding season and 3% during the non-breeding season). Numbers in bold are those that exceed the NatureScot threshold for running PVA (NatureScot, 2023a).

Population	Annual adult additional mortality rate (used in PVA) (o) = h + m	Annual adult survival rate (%) (p)*	Updated annual adult survival rate (%) (q) = p - (o * 100)	Percentage point change in adult survival rate (r) = q - p	Annual immature additional mortality rate (used in PVA) (s) = i + n	Reduction in productivity (used in PVA) (t)	Breeding adult mortality (individuals) (u) = o * f
Buchan Ness to Collieston Coast SPA	0.00153	93.9	93.747	0.153	0.00164	0.00000	62.238
Troup, Pennan and Lion's Heads SPA	0.00079	93.9	93.821	0.079	0.00085	0.00010	37.796
All other colonies	0.00305	93.9	93.595	0.305	0.00327	-	7.264

Population	Annual adult additional mortality rate (used in PVA) (o) = h + m	Annual adult survival rate (%) (p)*	Updated annual adult survival rate (%) (q) = p - (o * 100)	Percentage point change in adult survival rate (r) = q - p	Annual immature additional mortality rate (used in PVA) (s) = i + n	Reduction in productivity (used in PVA) (t)	Breeding adult mortality (individuals) (u) = o * f
Regional*	0.00118	93.9	93.782	0.118	0.00127	0.00005	107.298

*Source: (p) Horswill and Robinson, 2015, (t) Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) – percent additional chick mortality from SeabORD converted to a proportion by dividing by 100. In this case, predicted impacts on chick survival rate for Buchan Ness to Collieston Coast was greater than 0 i.e. a positive impact (see Volume 3, Appendix 11.3, Ornithology Distributional Responses Technical Report), so this impact was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024), *Regional row, column (t) is a weighted average by population size.*

Table 5.13: Partitioning of breeding season impacts among adults and immatures for guillemot – lower distributional response mortality rate scenario (distributional response assuming 3% mortality rate of displaced birds during the breeding season and 1% during the non-breeding season). Table combines SeabORD estimates for SPA colonies and matrix-based estimates for all other colonies.

Population	Proportion of population that is adult (a)	Sabbatical rate (b)	Breeding season distributional response mortality (c)	Adult additional breeding season mortality excluding sabbatical birds (d) = a * c * (1-b)	Immature additional breeding season mortality (e) = c * (1-a)	Adult breeding population size (f)	Immature population size (g) = (f/a) * (1-a)	Predicted breeding season adult mortality rate (h) = d/f	Predicted breeding season immature mortality rate (i) = e/g
Buchan Ness to Collieston Coast SPA*	0.516	0.07	-	0***	-	40762.8	38220	0	-
Troup, Pennan and Lion's Heads SPA*	0.516	0.07	-	0.100	-	47718.74	44742	0.00000	-
All other colonies	0.516	0.07	5.888	2.826	2.849	2385.2	2236	0.00118	0.00127
Regional**	-	-	5.888	2.926	2.849	90866.74	85199	0.00003	0.00003

*Source: (a) See Annex D and Table 5.1, (b) See Section 2.6.1.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.1, (f) See Table 2.6, *SeabORD used: (d) is calculated as the percent additional adult mortality from SeabORD (Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) converted to a proportion by dividing by 100, and then multiplied by (k), impacts predicted by SeabORD are only to breeding adult survival rate and chicks (incorporated into PVA as productivity) so correction for proportion of adults and sabbatical birds is not required and no impacts are predicted for immatures, **Regional row, columns (c) – (g) are column sums, *** Predicted impacts on survival rate for Buchan Ness to Collieston Coast was greater than 0 i.e. a positive impact (see Volume 3, Appendix 11.3, Ornithology Distributional Responses Technical Report), so this impact was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024).*

Table 5.14: Partitioning of non-breeding season impacts among adults and immatures for guillemot – lower distributional response mortality rate scenario (distributional response assuming 3% mortality rate of displaced birds during the breeding season and 1% during the non-breeding season). All impacts were predicted using the matrix based approach.

Population	Non-breeding season distributional response (j)	Adult non-breeding season mortality excluding sabbatical birds (k) = j * a * (1-b)	Immature non-breeding season mortality (l) = j * (1/a)	Adult non-breeding season mortality rate (m) = k/f	Immature non-breeding season mortality rate (n) = l/g
Buchan Ness to Collieston Coast SPA	43.225	20.747	20.917	0.00051	0.00055
Troup, Pennan and Lion's Heads SPA	26.180	12.566	12.669	0.00026	0.00028
All other colonies	1.774	0.852	0.859	0.00036	0.00038
Regional	71.180	34.164	34.444	0.00038	0.00040

Source: (j) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.1

Table 5.15: Percentage point change in predicted mortality rate for guillemot and impact rates used for PVA – lower distributional response mortality rate scenario (distributional response assuming 3% mortality rate of displaced birds during the breeding season and 1% during the non-breeding season).

Population	Annual adult additional mortality rate (used in PVA) (o) = h + m	Annual adult survival rate (%) (p)*	Updated annual adult survival rate (%) (q) = p - (o * 100)	Percentage point change in adult survival rate (r) = q - p	Annual immature additional mortality rate (used in PVA) (s) = i + n	Reduction in productivity (used in PVA) (t)**	Breeding adult mortality (individuals) (u) = o * f
Buchan Ness to Collieston Coast SPA	0.00051	93.9	93.849	0.051	0.00055	0.00000	20.747
Troup, Pennan and Lion's Heads SPA	0.00027	93.9	93.873	0.027	0.00028	0.00010	12.666
All other colonies	0.00154	93.9	93.746	0.154	0.00166	-	3.677
Regional	0.00041	93.9	93.859	0.041	0.00044	0.00005	37.090

*Source: (p) Horswill and Robinson, 2015, (t) Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) – percent additional chick mortality from SeabORD converted to a proportion by dividing by 100. In this case, predicted impacts on chick survival rate for Buchan Ness to Collieston Coast was greater than 0 i.e. a positive impact (see Volume 3, Appendix 11.3, Ornithology Distributional Responses Technical Report), so this impact was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor , NatureScot, 17th May, 2024), *Regional row, column (t) is a weighted average by population size.*

A.4. Razorbill

Razorbill has been assessed for distributional response impacts only. Breeding season distributional response impacts were derived using SeabORD for all of the SPA colonies assessed. These colonies are marked with an asterisk in Table 5.16 below. The distributional response impacts for all other colonies were calculated using the distributional response matrix approach. Non-breeding season apportioning was done using Furness, 2015 (see Volume 3, Appendix 11.4, Ornithology Apportionment Technical Report for details).

Table 5.16: Partitioning of breeding season impacts among adults and immatures for razorbill – higher distributional response mortality rate scenario (distributional response assuming 5% mortality rate of displaced birds during the breeding season and 3% during the non-breeding season). Table combines SeabORD estimates for SPA colonies and matrix-based estimates for all other colonies.

Population	Proportion of population that is adult (a)	Sabbatical rate (b)	Breeding season distributional response mortality (c)	Adult additional breeding season mortality excluding sabbatical birds (d) = a * c * (1-b)	Immature additional breeding season mortality (e) = c * (1-a)	Adult breeding population size (f)	Immature population size (g) = (f/a) * (1-a)	Predicted breeding season adult mortality rate (h) = d/f	Predicted breeding season immature mortality rate (i) = e/g
Troup, Pennan and Lion's Heads SPA*	0.559	0.07	-	0.800	-	8801.12	6947	0.00009	-
Fowlsheugh SPA*	0.559	0.07	-	0.600	-	20869.16	16472	0.00003	-
All other colonies	0.559	0.07	18.798	9.770	8.292	13992.28	11044	0.00070	0.00075
Regional**	-	-	18.798	11.170	8.292	43662.56	34463	0.00026	0.00024

*Source: (a) See Annex D and Table 5.1, (b) See Section 2.6.1.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.2, (f) See Table 2.6 and Table C5.2 * SeabORD used: (d) is calculated as the percent additional adult mortality from SeabORD (Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) converted to a proportion by dividing by 100, and then multiplied by (k), impacts predicted by SeabORD are only to breeding adult survival rate and chicks (incorporated into PVA as productivity) so correction for proportion of adults and sabbatical birds is not required and no impacts are predicted for immatures, **Regional row, columns (c) – (g) are column sums and column (h) is a weighted average based on population size.*

Table 5.17: Predicted non-breeding season impacts for adult and immature razorbill – higher distributional response mortality rate scenario (distributional response assuming 5% mortality rate of displaced birds during the breeding season and 3% during the non-breeding season).

Population	Adult non-breeding season impacts				Immature non-breeding season impacts				Adult non-breeding season mortality rate (r) = m / f	Immature non-breeding season mortality rate (s) = q / g
	Autumn migration distributional response (j)	Winter period distributional response (k)	Spring migration period distributional response (l)	Total non-breeding season distributional response (m) = (j + k + l) * (1-b)	Autumn migration distributional response (n)	Winter period distributional response (o)	Spring migration period distributional response (p)	Total non-breeding season distributional response (q) = (n + o + p) * (1-b)		
Troup, Pennan and Lion's Heads SPA	0.150	0.004	0.0126	0.155	0.100	0.001	0.0084	0.109	0.00002	0.00002
Fowlsheugh SPA	0.300	0.008	0.0252	0.309	0.200	0.002	0.0168	0.218	0.00001	0.00001
All other colonies	0.850	0.020	0.0714	0.875	0.575	0.005	0.0483	0.628	0.00006	0.00006
Regional*	1.299	0.032	0.109	1.339	0.875	0.008	0.074	0.956	0.00003	0.00003

*Source: (l) – (k) and (m) – (n) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.2, * Regional row, columns (j) – (o) are column sums.*

Table 5.18: Annual predicted impact mortality rates for adults and immatures, reduction in productivity and percentage point change in annual adult survival for razorbill – higher distributional response mortality rate scenario (distributional response assuming 5% mortality rate of displaced birds during the breeding season and 3% during the non-breeding season). Numbers in bold are those that exceed the NatureScot threshold for running PVA (NatureScot, 2023a).

Population	Annual adult additional mortality rate (used in PVA) (t) = h + r	Annual adult survival rate (%) (u)	Updated annual adult survival rate (%) (v) = u - (t * 100)	Percentage point change in adult survival rate (w) = u - v	Annual immature additional mortality rate (used in PVA) (x) = i + s	Reduction in productivity (used in PVA) (y)	Breeding adult mortality (individuals) (z) = t * f
Troup, Pennan and Lion's Heads SPA	0.00011	89.5	89.489	0.011	0.10911	0.00009	0.955
Fowlsheugh SPA	0.00004	89.5	89.496	0.004	0.00001	0.00027	0.909
All other colonies	0.00076	89.5	89.424	0.076	0.00081	-	10.646
Regional*	0.00029	89.5	89.471	0.029	0.00027	0.00022	12.510

*Source: (u) Horswill and Robinson, 2015, (y) Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) – percent additional chick mortality from SeabORD converted to a proportion by dividing by 100, *Regional row, column (y) is a weighted average by population size.*

Table 5.19: Partitioning of breeding season impacts among adults and immatures for razorbill – lower distributional response mortality rate scenario (distributional response assuming 3% mortality rate of displaced birds during the breeding season and 1% during the non-breeding season). Table combines SeabORD estimates for SPA colonies and matrix-based estimates for all other colonies.

Population	Proportion of population that is adult (a)	Sabbatical rate (b)	Breeding season distributional response mortality* (c)	Adult additional breeding season mortality excluding sabbatical birds (d) = a * c * (1-b)	Immature additional breeding season mortality (e) = c * (1-a)	Adult breeding population size (f)	Immature population size (g) = (f/a) * (1-a)	Predicted breeding season adult mortality rate (h) = d/f	Predicted breeding season immature mortality rate (i) = e/g
Troup, Pennan and Lion's Heads SPA	0.559	0.07	-	0.800	-	8801.12	6947	0.00009	-
Fowlsheugh SPA	0.559	0.07	-	0.600	-	20869.16	16472	0.00003	-
All other colonies	0.559	0.07	11.280	5.863	4.976	13992.28	11044	0.00042	0.00045
Regional	-	-	11.280	7.263	4.976	43662.56	34463	0.00017	0.00014

Source: (a) See Annex D and Table 5.1, (b) See Section 2.6.1.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.2, (f) See Table 2.6 and Table C5.2 SeabORD used: (d) is calculated as the percent additional adult mortality from SeabORD (Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) converted to a proportion by dividing by 100, and then multiplied by (k), impacts predicted by SeabORD are only to breeding adult survival rate and chicks (incorporated into PVA as productivity) so correction for proportion of adults and sabbatical birds is not required and no impacts are predicted for immatures, **Regional row, columns (c) – (g) are column sums and column (h) is a weighted average based on population size.*

Table 5.20: Predicted non-breeding season impacts for adult and immature razorbill – lower distributional response mortality rate scenario (distributional response assuming 3% mortality rate of displaced birds during the breeding season and 1% during the non-breeding season).

Population	Adult non-breeding season impacts				Immature non-breeding season impacts				Adult non-breeding season mortality rate (r) = m / f	Immature non-breeding season mortality rate (s) = q / g
	Autumn migration distributional response (j)	Winter period distributional response (k)	Spring migration period distributional response (l)	Total non-breeding season distributional response (m) = (j + k + l) * (1-b)	Autumn migration distributional response (n)	Winter period distributional response (o)	Spring migration period distributional response (p)	Total non-breeding season distributional response (q) = (n + o + p) * (1-b)		
Troup, Pennan and Lion's Heads SPA	0.050	0.001	0.0042	0.052	0.033	0.000	0.0028	0.036	0.00001	0.00001
Fowlsheugh SPA	0.100	0.003	0.0084	0.103	0.067	0.001	0.0056	0.073	0.00000	0.00000
All other colonies	0.283	0.007	0.0238	0.292	0.192	0.002	0.0161	0.209	0.00002	0.00002
Regional*	0.433	0.011	0.036	0.446	0.292	0.003	0.025	0.319	0.00001	0.00001

*Source: (l) – (k) and (m) – (n) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.2, * Regional row, columns (j) – (o) are column sums.*

Table 5.21: Annual predicted impact mortality rates for adults and immatures, reduction in productivity and percentage point change in annual adult survival for razorbill – lower distributional response mortality rate scenario (distributional response assuming 3% mortality rate of displaced birds during the breeding season and 1% during the non-breeding season). Numbers in bold are those that exceed the NatureScot threshold for running PVA (NatureScot, 2023a).

Population	Annual adult additional mortality rate (used in PVA) (t) = h + r	Annual adult survival rate (%) (u)	Updated annual adult survival rate (%) (v) = u - (t * 100)	Percentage point change in adult survival rate (w) = u - v	Annual immature additional mortality rate (used in PVA) (x) = i + s	Reduction in productivity (used in PVA) (y)	Breeding adult mortality (individuals) (z) = t * f
Troup, Pennan and Lion's Heads SPA	0.00010	89.5	89.490	0.010	0.00001	0.00009	0.851
Fowlsheugh SPA	0.00003	89.5	89.497	0.003	0.00000	0.00027	0.703
All other colonies	0.00044	89.5	89.456	0.044	0.00047	-	6.155
Regional*	0.00018	89.5	89.482	0.018	0.00015	0.00022	7.709

*Source: (u) Horswill and Robinson, 2015, (y) Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) – percent additional chick mortality from SeabORD converted to a proportion by dividing by 100, *Regional row, column (y) is a weighted average by population size.*

A.5. Puffin

Puffin has been assessed for distributional response impacts only. Breeding season distributional response impacts were derived using SeabORD for 3 out of the 6 SPA colonies assessed. These colonies are marked with an asterisk in Table 5.22 below. The distributional response impacts for all other colonies were calculated using the distributional response matrix approach. Non-breeding season impacts were not assessed for puffin due to their wide-ranging behaviour during the non-breeding season.

Table 5.22: Partitioning of breeding season impacts among adults and immatures for puffin – higher distributional response mortality rate scenario (distributional response assuming 5% mortality rate of displaced birds during the breeding season and 3% during the non-breeding season). Table combines SeabORD estimates for SPA colonies and matrix-based estimates for all other colonies.

Population	Proportion of population that is adult (a)	Sabbatical rate (b)	Breeding season distributional response mortality (c)	Adult additional breeding season mortality excluding sabbatical birds (d) = a * c * (1-b)	Immature additional breeding season mortality (e) = c * (1-a)	Adult breeding population size (f)	Immature population size (g) = (f/a) * (1-a)	Predicted breeding season adult mortality rate (h) = d/f	Predicted breeding season immature mortality rate (i) = e/g
Fair Isle SPA	0.544	0.07	1.337	0.676	0.610	13332	11175	0.00005	0.00005

Population	Proportion of population that is adult (a)	Sabbatical rate (b)	Breeding season distributional response mortality (c)	Adult additional breeding season mortality excluding sabbatical birds (d) = a * c * (1-b)	Immature additional breeding season mortality (e) = c * (1-a)	Adult breeding population size (f)	Immature population size (g) = (f/a) * (1-a)	Predicted breeding season adult mortality rate (h) = d/f	Predicted breeding season immature mortality rate (i) = e/g
North Caithness Cliffs SPA	0.526	0.07	0.792	0.387	0.376	5438	4903	0.00007	0.00008
Coquet Island SPA *	0.526	0.07	-	1.800	-	50058	45134	0.00004	-
Farne Islands SPA *	0.616	0.07	-	4.200	-	87504	54624	0.00005	-
Forth Islands SPA *	0.526	0.07	-	10.200	-	90291	81410	0.00011	-
Hoy SPA	0.526	0.07	0.112	0.055	0.053	860	775	0.00006	0.00007
All other colonies	0.526	0.07	2.926	1.431	1.387	15146	13656	0.00009	0.00010
Regional	-	-	5.167	18.750	2.426	262629	211677	0.00007	0.00001

*Source: (a) See Annex D and Table 5.1, (b) See Section 2.6.1.2 (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.3, (f) See Table 2.6 and Table C5.2 * SeabORD used: (d) is calculated as the percent additional adult mortality from SeabORD (Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) converted to a proportion by dividing by 100, and then multiplied by (k), SeabORD predicted impacts are only to breeding adult survival rate and chicks (incorporated into PVA as productivity) so correction for proportion of adults and sabbatical birds is not required and no impacts are predicted for immatures. For SeabORD rows, (h) is calculated directly from the SeabORD output as percent adult additional mortality divided by 100, **Regional row, columns (c) – (g) are column sums and column (h) is a weighted average based on population size.*

Table 5.23: Annual predicted impact mortality rates for adults and immatures, reduction in productivity and percentage point change in annual adult survival for puffin – higher distributional response mortality rate scenario (distributional response assuming 5% mortality rate of displaced birds during the breeding season and 3% during the non-breeding season).

Population	Annual adult additional mortality rate (used in PVA) (j) = h	Annual adult survival rate (%) (k)	Updated annual adult survival rate (%) (l) = k - (j * 100)	Percentage point change in adult survival rate (m) = l - k	Annual immature additional mortality rate (used in PVA) (n) = i	Reduction in productivity (used in PVA) (o)**	Breeding adult mortality (individuals) (p) = j * f
Fair Isle SPA	0.00005	90.6	90.595	0.005	0.00005	-	0.676
North Caithness Cliffs SPA	0.00007	90.6	90.593	0.007	0.00008	-	0.387
Coquet Island SPA	0.00004	90.6	90.596	0.004	-	0***	1.800
Farne Islands SPA	0.00005	90.6	90.595	0.005	-	0.00002	4.200
Forth Islands SPA	0.00011	90.6	90.589	0.011	-	0.00013	10.200
Hoy SPA	0.00006	90.6	90.594	0.006	0.00007	-	0.055
All other colonies	0.00009	90.6	90.591	0.009	0.00010	-	1.431
Regional**	0.00007	90.6	90.593	0.007	0.00001	0.00006	18.750

*Source: (k) Horswill and Robinson, 2015, (o) Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) – percent additional chick mortality from SeabORD converted to a proportion by dividing by 100, *SeabORD predicted positive impacts so 0 was used as a precautionary approach as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024), **Regional row, column (o) is a weighted average by population size, ***SeabORD predicted a positive impact so this was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024).*

Table 5.24: Partitioning of breeding season impacts among adults and immatures for puffin – lower distributional response mortality rate scenario. Table combines SeabORD estimates for SPA colonies and matrix-based estimates for all other colonies.

Population	Proportion of population that is adult (a)	Sabbatical rate (b)	Breeding season distributional response mortality (c)	Adult additional breeding season mortality excluding sabbatical birds (d) = a * c * (1-b)	Immature additional breeding season mortality (e) = c * (1-a)	Adult breeding population size (f)	Immature population size (g) = (f/a) * (1-a)	Predicted breeding season adult mortality rate (h) = d/f	Predicted breeding season immature mortality rate (i) = e/g
Fair Isle SPA	0.544	0.07	0.802	0.406	0.366	13332	11175	0.00003	0.00003
North Caithness Cliffs SPA	0.526	0.07	0.475	0.232	0.225	5438	4903	0.00004	0.00005
Coquet Island SPA *	0.526	0.07	-	1.800	-	50058	45134	0.00004	-
Farne Islands SPA *	0.616	0.07	-	4.200	-	87504	54624	0.00005	-
Forth Islands SPA *	0.526	0.07	-	10.200	-	90291	81410	0.00011	-
Hoy SPA	0.526	0.07	0.067	0.033	0.032	860	775	0.00004	0.00004
All other colonies	0.526	0.07	1.756	0.859	0.833	15146	13656	0.00006	0.00006
Regional	-	-	3.101	17.730	1.456	262629	211677	0.00007	0.00001

*Source: (a) See Annex D and Table 5.1, (b) See Section 2.6.1.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.1.3, (f) See Table 2.6 and Table C5.2, * SeabORD used: (d) is calculated as the percent additional adult mortality from SeabORD (Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) converted to a proportion by dividing by 100, and then multiplied by (k), SeabORD predicted impacts are only to breeding adult survival rate and chicks (incorporated into PVA as productivity) so correction for proportion of adults and sabbatical birds is not required and no impacts are predicted for immatures. For SeabORD rows, (h) is calculated directly from the SeabORD output as percent adult additional mortality divided by 100, **Regional row, columns (c) – (g) are column sums and column (h) is a weighted average based on population size.*

Table 5.25: Annual predicted impact mortality rates for adults and immatures, reduction in productivity and percentage point change in annual adult survival for puffin – lower distributional response mortality rate scenario.

Population	Annual adult additional mortality rate (used in PVA) (j) = h	Annual adult survival rate (%) (k)	Updated annual adult survival rate (%) (l) = k - (j * 100)	Percentage point change in adult survival rate (m) = l - k	Annual immature additional mortality rate (used in PVA) (n) = i	Reduction in productivity (used in PVA) (o)**	Breeding adult mortality (individuals) (p) = j * f
Fair Isle SPA	0.00003	90.6	90.597	0.003	0.00003	-	0.406
North Caithness Cliffs	0.00004	90.6	90.596	0.004	0.00005	-	0.232
Coquet Island SPA *	0.00004	90.6	90.596	0.004	-	0***	1.800
Farne Islands SPA *	0.00005	90.6	90.595	0.005	-	0.00002	4.200
Forth Islands SPA *	0.00011	90.6	90.589	0.011	-	0.00013	10.200
Hoy SPA	0.00004	90.6	90.596	0.004	0.00004	-	0.033
All other colonies	0.00006	90.6	90.594	0.006	0.00006	-	0.859
Regional	0.00007	90.6	90.593	0.007	0.00001	0.00006	17.730

*Source: (k) Horswill and Robinson, 2015, (o) Volume 3, Appendix 11.3 (Ornithology Distributional Responses Technical Report) – percent additional chick mortality from SeabORD converted to a proportion by dividing by 100, *SeabORD predicted positive impacts so 0 was used as a precautionary approach as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024), **Regional row, column (o) is a weighted average by population size, ***SeabORD predicted a positive impact so this was assumed to be 0 as agreed with NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor, NatureScot, 17th May, 2024).*

A.6. Gannet

Gannet has been assessed for both collision and distributional response impacts. All gannet distributional response impacts were calculated using the distributional response matrix approach. Non-breeding season apportioning was done using Furness, 2015 (see Volume 3, Appendix 11.4, Ornithology Apportionment Technical Report for details).

Table 5.26: Partitioning of predicted breeding season impacts among adults and immatures for gannet – higher distributional response mortality rate scenario (collision plus distributional response assuming 3% mortality rate of displaced birds).

Population	Proportion of population adult (a)	Sabbatical rate (b)	Breeding season collision mortality (c)	Breeding season distributional response mortality (d)	Adult collision mortality excluding sabbatical birds (e) = a * (1-b) * c	Immature collision mortality (f) = (1-a) * c	Adult distributional response mortality excluding sabbatical birds (g) = a * (1-b) * d	Immature distributional response mortality (h) = (1-a) * d	Total adult mortality excluding sabbatical birds (i) = e + g	Total immature mortality (j) = f + h	Adult breeding population size (k)	Immature population size (l) = (k/a) * (1-a)	Adult breeding season mortality rate (m) = i/k	Immature breeding season mortality rate (n) = j/l
Fair Isle SPA	0.550	0.1	0.208	0.272	0.103	0.094	0.135	0.123	0.238	0.217	9654	7912	0.00002	0.00003
Flamborough and Filey coast SPA	0.550	0.1	0.386	0.505	0.191	0.174	0.250	0.228	0.441	0.401	30466	24968	0.00001	0.00002
Forth Islands SPA	0.550	0.1	5.958	7.798	2.947	2.684	3.857	3.512	6.804	6.196	150518	123357	0.00005	0.00005
Hermaness, Saxa Vord and Valla Field SPA	0.550	0.1	0.480	0.628	0.237	0.216	0.311	0.283	0.548	0.499	59124	48455	0.00001	0.00001
North Rona and Sula Sgeir SPA	0.546	0.1	0.173	0.227	0.085	0.079	0.111	0.103	0.196	0.182	18990	15808	0.00001	0.00001
Noss SPA	0.550	0.1	0.331	0.433	0.164	0.149	0.214	0.195	0.378	0.344	24670	20218	0.00002	0.00002
St Kilda SPA	0.546	0.1	0.544	0.712	0.267	0.247	0.350	0.323	0.617	0.570	120580	100373	0.00001	0.00001
Sule Skerry and Sule Stack SPA	0.550	0.1	0.275	0.359	0.136	0.124	0.178	0.162	0.313	0.285	18130	14858	0.00002	0.00002
All other colonies	0.549	0.1	1.234	1.615	0.610	0.557	0.798	0.729	1.408	1.285	26446	21731	0.00005	0.00006
Regional*	-	-	9.589	12.550	4.740	4.323	6.203	5.657	10.943	9.980	458578	377680	0.00002	0.00003

*Source: (a) See Section 2.6.2.1 and Table C.1, (b) See Section 2.6.2.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.6 (d) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.6 (k) See Tables 2.5 and B.3, *Regional row, columns (c) – (l) are column sums.*

Table 5.27: Predicted non-breeding season impacts for adult and immature gannet – higher distributional response mortality rate scenario (collision plus distributional response assuming 3% mortality rate of displaced birds).

Population	Adult mortality							Immature mortality							Adult non-breeding mortality rate (ac) = u/k	Immature non-breeding mortality rate (ad) = ab/l
	Autumn migration collision mortality (o)	Autumn migration distributional response mortality (p)	Spring migration collision mortality (q)	Spring migration distributional response mortality (r)	Collision mortality excluding sabbatical birds (s) = (o + q) * (1-b)	Distributional response mortality excluding sabbatical birds (t) = (p + r) * (1-b)	Total mortality excluding sabbatical birds (u) = s + t	Autumn migration collision mortality (v)	Autumn migration distributional response mortality (w)	Spring migration collision mortality (x)	Spring migration distributional response mortality (y)	Immature collision mortality (z) = v + x	Immature distributional response mortality (aa) = w + y	Total mortality (ab) = z + aa		
Fair Isle SPA	0.032	0.174	0.010	0.034	0.038	0.188	0.226	0.025	0.137	0.005	0.016	0.030	0.153	0.183	0.00002	0.00002
Flamborough and Filey coast SPA	0.111	0.598	0.029	0.097	0.125	0.625	0.750	0.081	0.436	0.013	0.045	0.094	0.481	0.575	0.00002	0.00002
Forth Islands SPA	0.560	3.025	0.144	0.488	0.634	3.162	3.796	0.408	2.204	0.067	0.226	0.475	2.430	2.905	0.00003	0.00002
Hermaness, Saxa Vord and Valla Field SPA	0.196	1.058	0.063	0.214	0.233	1.145	1.378	0.159	0.859	0.029	0.100	0.188	0.959	1.147	0.00002	0.00002
North Rona and Sula Sgeir SPA	0.009	0.050	0.000	0.000	0.008	0.045	0.053	0.016	0.087	0.000	0.000	0.016	0.087	0.103	0.00000	0.00001
Noss SPA	0.078	0.423	0.025	0.086	0.093	0.458	0.551	0.065	0.349	0.012	0.039	0.076	0.388	0.464	0.00002	0.00002
St Kilda SPA	0.060	0.324	0.000	0.000	0.054	0.291	0.345	0.097	0.523	0.000	0.000	0.097	0.523	0.620	0.00000	0.00001
Sule Skerry and Sule Stack SPA	0.005	0.025	0.000	0.000	0.004	0.022	0.027	0.007	0.037	0.000	0.000	0.007	0.037	0.044	0.00000	0.00000
All other colonies	0.060	0.324	0.016	0.053	0.068	0.339	0.407	0.044	0.237	0.007	0.025	0.051	0.262	0.313	0.00002	0.00001
Regional*	1.111	6.001	0.287	0.972	1.258	6.276	7.533	0.901	4.868	0.133	0.451	1.034	5.319	6.353	0.00002	0.00002

*Source: (o) – (r) and (v) – (y) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.6, * Regional row, columns (l) – (u) are column sums.*

Table 5.28: Annual predicted impact mortality rates for adults and immatures and percentage point change in annual adult survival for gannet – higher distributional response mortality rate scenario (collision plus distributional response assuming 3% mortality rate of displaced birds).

Population	Total adult mortality rate (ae) = m + ac	Baseline adult annual survival rate (%) (af)	Impact adult annual survival rate (%) (ag) = af – (ae*100)	Percentage point change in adult survival rate (ah) = af - ag	Total immature mortality rate (ai) = n + ad	Breeding adult mortality (individuals) (aj) = ae * k
Fair Isle SPA	0.00005	91.9	91.895	0.005	0.00005	0.464
Flamborough and Filey coast SPA	0.00004	91.9	91.896	0.004	0.00004	1.191
Forth Islands SPA	0.00007	91.9	91.893	0.007	0.00007	10.600

Population	Total adult mortality rate (ae) = m + ac	Baseline adult annual survival rate (%) (af)	Impact adult annual survival rate (%) (ag) = af – (ae*100)	Percentage point change in adult survival rate (ah) = af - ag	Total immature mortality rate (ai) = n + ad	Breeding adult mortality (individuals) (aj) = ae * k
Hermaness, Saxa Vord and Valla Field SPA	0.00003	91.9	91.897	0.003	0.00003	1.926
North Rona and Sula Sgeir SPA	0.00001	91.9	91.899	0.001	0.00002	0.249
Noss SPA	0.00004	91.9	91.896	0.004	0.00004	0.929
St Kilda SPA	0.00001	91.9	91.899	0.001	0.00001	0.962
Sule Skerry and Sule Stack SPA	0.00002	91.9	91.898	0.002	0.00002	0.340
All other colonies	0.00007	91.9	91.893	0.007	0.00007	1.815
Regional	0.00004	91.9	91.896	0.004	0.00004	18.476

Source: (af) Horswill and Robinson, 2015

Table 5.29: Partitioning of predicted breeding season impacts among adults and immatures for gannet – lower distributional response mortality rate scenario (collision plus distributional response assuming 1% mortality rate of displaced birds).

Population	Proportion of population adult (a)	Sabbatical rate (b)	Breeding season collision mortality (c)	Breeding season distributional response mortality (d)	Adult collision mortality excluding sabbatical birds (e) = a * (1-b) * c	Immature collision mortality (f) = (1-a) * c	Adult distributional response mortality excluding sabbatical birds (g) = a * (1-b) * d	Immature distributional response mortality (h) = (1-a) * d	Total adult mortality excluding sabbatical birds (i) = e + g	Total immature mortality (j) = f + h	Adult breeding population size (k)	Immature population size (l) = (k/a) * (1-a)	Adult breeding season mortality rate (m) = i/k	Immature breeding season mortality rate (n) = j/l
Fair Isle SPA	0.550	0.1	0.208	0.091	0.103	0.094	0.045	0.041	0.148	0.135	9654	7912	0.00002	0.00002
Flamborough and Filey coast SPA	0.550	0.1	0.386	0.168	0.191	0.174	0.083	0.076	0.274	0.250	30466	24968	0.00001	0.00001
Forth Islands SPA	0.550	0.1	5.958	2.597	2.947	2.684	1.285	1.170	4.232	3.853	150518	123357	0.00003	0.00003
Hermaness, Saxa Vord and Valla Field SPA	0.550	0.1	0.480	0.209	0.237	0.216	0.104	0.094	0.341	0.310	59124	48455	0.00001	0.00001
North Rona and Sula Sgeir SPA	0.546	0.1	0.173	0.075	0.085	0.079	0.037	0.034	0.122	0.113	18990	15808	0.00001	0.00001
Noss SPA	0.550	0.1	0.331	0.144	0.164	0.149	0.071	0.065	0.235	0.214	24670	20218	0.00001	0.00001
St Kilda SPA	0.546	0.1	0.544	0.237	0.267	0.247	0.116	0.108	0.384	0.355	120580	100373	0.00000	0.00000
Sule Skerry and Sule Stack SPA	0.550	0.1	0.275	0.120	0.136	0.124	0.059	0.054	0.195	0.178	18130	14858	0.00001	0.00001

Population	Proportion of population adult (a)	Sabbatical rate (b)	Breeding season collision mortality (c)	Breeding season distributional response mortality (d)	Adult collision mortality excluding sabbatical birds (e) = a * (1-b) * c	Immature collision mortality (f) = (1-a) * c	Adult distributional response mortality excluding sabbatical birds (g) = a * (1-b) * d	Immature distributional response mortality (h) = (1-a) * d	Total adult mortality excluding sabbatical birds (i) = e + g	Total immature mortality (j) = f + h	Adult breeding population size (k)	Immature population size (l) = (k/a) * (1-a)	Adult breeding season mortality rate (m) = i/k	Immature breeding season mortality rate (n) = j/l
All other colonies	0.550	0.1	1.234	0.538	0.611	0.555	0.266	0.242	0.877	0.798	26446	21638	0.00003	0.00004
Regional*	-	-	9.589	4.180	4.741	4.321	2.067	1.884	6.808	6.205	458578	377587	0.00001	0.00002

*Source: (a) See Section 2.6.2.1 and Table C.1, (b) See Section 2.6.2.2, (c) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.6 (d) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.6 (k) See Tables 2.5 and B.3, *Regional row, columns (c) – (l) are column sums.*

Table 5.30: Predicted non-breeding season impacts for adult and immature gannet – lower distributional response mortality rate scenario (collision plus distributional response assuming 1% mortality rate of displaced birds).

Population	Adult mortality							Immature mortality							Adult non-breeding mortality rate (ac) = u/k	Immature non-breeding mortality rate (ad) = ab/l
	Autumn migration collision mortality (o)	Autumn migration distributional response mortality (p)	Spring migration collision mortality (q)	Spring migration distributional response mortality (r)	Collision mortality excluding sabbatical birds (s) = (o + q) * (1-b)	Distributional response mortality excluding sabbatical birds (t) = (p + r) * (1-b)	Total mortality excluding sabbatical birds (u) = s + t	Autumn migration collision mortality (v)	Autumn migration distributional response mortality (w)	Spring migration collision mortality (x)	Spring migration distributional response mortality (y)	Immature collision mortality (z) = v + x	Immature distributional response mortality (aa) = w + y	Total mortality (ab) = z + aa		
Fair Isle SPA	0.032	0.058	0.010	0.011	0.038	0.063	0.101	0.025	0.046	0.005	0.005	0.030	0.051	0.081	0.00001	0.00001
Flamborough and Filey coast SPA	0.111	0.199	0.029	0.032	0.125	0.208	0.334	0.081	0.145	0.013	0.015	0.094	0.160	0.254	0.00001	0.00001
Forth Islands SPA	0.560	1.008	0.144	0.163	0.634	1.054	1.688	0.408	0.735	0.067	0.075	0.475	0.810	1.285	0.00001	0.00001
Hermaness, Saxa Vord and Valla Field SPA	0.196	0.353	0.063	0.071	0.233	0.382	0.615	0.159	0.286	0.029	0.033	0.188	0.320	0.508	0.00001	0.00001
North Rona and Sula Sgeir SPA	0.009	0.017	0.000	0.000	0.008	0.015	0.023	0.016	0.029	0.000	0.000	0.016	0.029	0.045	0.00000	0.00000
Noss SPA	0.078	0.141	0.025	0.029	0.093	0.153	0.246	0.065	0.116	0.012	0.013	0.076	0.129	0.205	0.00001	0.00001
St Kilda SPA	0.060	0.108	0.000	0.000	0.054	0.097	0.151	0.097	0.174	0.000	0.000	0.097	0.174	0.271	0.00000	0.00000
Sule Skerry and Sule Stack SPA	0.005	0.008	0.000	0.000	0.004	0.007	0.012	0.007	0.012	0.000	0.000	0.007	0.012	0.019	0.00000	0.00000

Population	Adult mortality								Immature mortality						Adult non-breeding mortality rate (ac) = u/k	Immature non-breeding mortality rate (ad) = ab/l
	Autumn migration collision mortality (o)	Autumn migration distributional response mortality (p)	Spring migration collision mortality (q)	Spring migration distributional response mortality (r)	Collision mortality excluding sabbatical birds (s) = (o + q) * (1-b)	Distributional response mortality excluding sabbatical birds (t) = (p + r) * (1-b)	Total mortality excluding sabbatical birds (u) = s + t	Autumn migration collision mortality (v)	Autumn migration distributional response mortality (w)	Spring migration collision mortality (x)	Spring migration distributional response mortality (y)	Immature collision mortality (z) = v + x	Immature distributional response mortality (aa) = w + y	Total mortality (ab) = z + aa		
All other colonies	0.060	0.108	0.016	0.018	0.068	0.113	0.181	0.044	0.079	0.007	0.008	0.051	0.087	0.138	0.00001	0.00001
Regional*	1.111	2.000	0.287	0.324	1.258	2.092	3.350	0.901	1.623	0.133	0.150	1.034	1.773	2.807	0.00001	0.00001

*Source: (o) – (r) and (v) – (y) Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report), Section 3.3.3.6, * Regional row, columns (l) – (u) are column sums.*

Table 5.31: Annual predicted impact mortality rates for adults and immatures and percentage point change in annual adult survival for gannet – lower distributional response mortality rate scenario (collision plus distributional response assuming 1% mortality rate of displaced birds).

Population	Total adult mortality rate (ae) = m + ac	Baseline adult annual survival rate (%) (af)	Impact adult annual survival rate (%) (ag) = af – (ae*100)	Percentage point change in adult survival rate (ah) = af - ag	Total immature mortality rate (ai) = n + ad	Breeding adult mortality (individuals) (aj) = ae * k
Fair Isle SPA	0.00003	91.9	91.897	0.003	0.00003	0.249
Flamborough and Filey coast SPA	0.00002	91.9	91.898	0.002	0.00002	0.608
Forth Islands SPA	0.00004	91.9	91.896	0.004	0.00004	5.919
Hermaness, Saxa Vord and Valla Field SPA	0.00002	91.9	91.898	0.002	0.00002	0.956
North Rona and Sula Sgeir SPA	0.00001	91.9	91.899	0.001	0.00001	0.145
Noss SPA	0.00002	91.9	91.898	0.002	0.00002	0.481
St Kilda SPA	0.00000	91.9	91.900	0.000	0.00001	0.535
Sule Skerry and Sule Stack SPA	0.00001	91.9	91.899	0.001	0.00001	0.207
All other colonies	0.00004	91.9	91.896	0.004	0.00004	1.058
Regional	0.00002	91.9	91.898	0.002	0.00002	10.157

Source: (af) Horswill and Robinson, 2015

B. Calculation of cumulative mortality rates

Annex B is available as a separate spreadsheet which outlines how cumulative impact numbers were derived from those provided by Royal HaskoningDHV.

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C. Additional demographic rates used to calculate percentage point change in mortality

Table C5.1: Productivity rates used to calculate percentage changes in breeding adult mortality rates for species and site combinations for which PVA modelling was not carried out and an explanation for their selection. Values are means, and numbers in brackets represent the standard deviations used. All values are taken from Horswill and Robinson, 2015, in line with NatureScot guidance (NatureScot, 2023a)

Species	Population	Productivity Rate	Rate used	Explanation
Kittiwake	Calf of Eday SPA	0.819 (0.332)	East	SPA lies to the East of the line separating the Celtic Sea and Greater North Sea OSPAR regions (Horswill and Robinson, 2015, Appendix S4)
	Copinsay SPA			
	Hoy SPA			
	Marwick Head SPA			
	Rousay SPA			
	Fair Isle SPA	0.408 (0.477)	Shetland	Fair Isle falls within the Shetland cluster (Horswill and Robinson, 2015, Appendix S4)
	Foula SPA	0.408 (0.477)	Shetland	SPA is within Shetland
	Noss SPA			
	Sumburgh Head SPA			
Puffin	Hoy SPA	0.617 (0.151)	National average	No region/colony specific estimates are provided for these SPA populations
	Fair Isle SPA	0.570 (0.141)	Fair Isle	Colony-specific estimate is available
Gannet	St Kilda SPA	0.710 (0.105)	West	SPA lies to the West of the line separating the Celtic Sea and Greater North Sea OSPAR regions (Horswill and Robinson, 2015, Appendix S1)

Source: Horswill and Robinson, 2015

Table C5.2: Population sizes and the associated year of the count for species and sites for which PVA modelling was not carried out. Superscript numbers indicate whether the population count was derived from [1]Burnell et al., 2023, [2]SMP, 2024, or [3]a combination of Burnell et al., 2023 and SMP, 2024. More details as to why the counts were derived in this way are provided in Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report). Where counts were collected over several years, the midpoint (rounded up) of the range of years was used for PVA modelling. Where this is the case, years are marked with an asterisk.

Species	SPA	Initial population size (breeding adults)	Year of population count
Kittiwake	Calf of Eday[1]	672	2017*
	Copinsay[2]	592	2023
	Fair Isle[1]	896	2021
	Foula[1]	850	2021
	Hoy[1]	532	2016
	Marwick Head[2]	2878	2023
	Noss[2]	172	2023
	Rousay[3]	660	2019*
	Sumburgh Head[1]	1932	2019*
Puffin	Fair Isle[1]	13332	2015
	Hoy[1]	860	2017*
Gannet	St Kilda[1]	120580	2013

*Source: Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report). *Single asterisks indicate where counts were taken over several years so that the year used for the analysis represents the midpoint of the counts, or where an indicative year is taken for a regional population count. **Guillemot and razorbill counts have been multiplied by 1.34, a widely applied correction factor to get from counted individuals to breeding adults in these species (e.g. SSE Renewables, 2022b) - Volume 3, Appendix 11.4 (Ornithology Apportionment Technical Report).*

D. Stable age structures

The deterministic stable age structures calculated from the population projection matrix underlying the NEPVA tool are presented in Table 5.1. Tables Table D5.2, Table D5.3 and Table D5.4 show comparisons among different methods of deriving the stable age structure. Based on these comparisons, it was determined that Natural Power's batch process script was suitable to derive stable age structures for all species-parameter combination required for the assessment, as confirmed by NatureScot (email communication from Caitlin Cunningham, Marine Sustainability Advisor at NatureScot, 17th May 2024).

Table 5.1: Stable age structures derived for species and regions under consideration. Regions represent differing values for productivity – see Section 2.4 and Tables Table 2.5 and Annex D.

Age class (years)	Kittiwake				Herring gull	Guillemot	Razorbill	Puffin			Gannet		
	East	West	Shetland	National	National	North	National	Fair Isle	Farne Islands	National	East	West	National
0 – 1	0.187	0.163	0.124	0.170	0.178	0.162	0.159	0.155	0.128	0.162	0.192	0.194	0.192
1 – 2	0.143	0.128	0.101	0.132	0.141	0.088	0.102	0.113	0.094	0.117	0.081	0.082	0.081
2 – 3	0.118	0.108	0.090	0.111	0.117	0.068	0.066	0.082	0.070	0.085	0.067	0.067	0.067
3 – 4	0.097	0.092	0.079	0.093	0.097	0.060	0.060	0.060	0.052	0.062	0.059	0.059	0.059
4 – 5	-	-	-	-	0.080	0.055	0.054	0.047	0.041	0.048	0.052	0.053	0.052
5 – 6	-	-	-	-	-	0.050	-	-	-	-	-	-	-
Adult	0.456	0.508	0.606	0.493	0.387	0.516	0.559	0.544	0.616	0.526	0.550	0.546	0.549

Source: See Annex D

Table D5.2: Population age structures calculated for kittiwake at the Buchan Ness and Collieston Coast SPA by Natural Power versus as extracted from a deterministic and a stochastic NEPVA run

Age class	NP deterministic	NEVPA deterministic	NEVPA stochastic*
0 – 1 years	0.187	0.187	0.178
1 – 2 years	0.143	0.143	0.140
2 – 3 years	0.118	0.118	0.118
3 – 4 years	0.097	0.097	0.093
Adult	0.456	0.456	0.471

** Example run including 1000 iterations of 42 years of simulations, with a starting seed of 2468. These values will vary slightly if the seed, length of run, number of iterations, or population size is varied i.e. this represents a single snapshot realisation of the average population structure.*

Table D5.3: Population age structures calculated for guillemot at the Buchan Ness and Collieston Coast SPA by Natural Power versus as extracted from a deterministic and a stochastic NEPVA run

Age class	NP deterministic	NEVPA deterministic	NEVPA stochastic*
0 – 1 years	0.162	0.162	0.161
1 – 2 years	0.088	0.088	0.090
2 – 3 years	0.068	0.068	0.068
3 – 4 years	0.060	0.060	0.060
4 – 5 years	0.055	0.055	0.055
5 – 6 years	0.050	0.050	0.051
Adult	0.516	0.516	0.516

** Example run including 1000 iterations of 42 years of simulations, with a starting seed of 2468. These values will vary slightly if the seed, length of run, number of iterations, or population size is varied i.e. this represents a single snapshot realisation of the average population structure*

Table D5.4: Population age structures calculated for puffin at the Coquet Island SPA by Natural Power versus as extracted from a deterministic and a stochastic NEPVA run

Age class	NP deterministic	NEVPA deterministic	NEVPA stochastic*
0 – 1 years	0.162	0.162	0.160
1 – 2 years	0.117	0.117	0.118
2 – 3 years	0.085	0.085	0.083
3 – 4 years	0.062	0.062	0.062
4 – 5 years	0.048	0.048	0.047
Adult	0.526	0.526	0.530

** Example run including 1000 iterations of 42 years of simulations, with a starting seed of 2468. These values will vary slightly if the seed, length of run, number of iterations, or population size is varied i.e. this represents a single snapshot realisation of the average population structure.*

E. Results of PVA modelling including additional years of impact to represent the construction phase

PVA modelling was re-run with including an additional three years of impact prior to the operational phase to provide a crude indication of how construction phase impacts may change key metrics (see Section 2.7.1). The results of this additional analysis are presented in Table E5.1

Table E5.1: Counterfactual population sizes (CPS) and counterfactual growth rates (CGR) for PVAs carried out including an additional three years of impact (2029 – 2031) to indicate possible effects of the construction phase. Values are median values with 95% confidence intervals in brackets.

Species	Population	Scenario	2057 (25 years operation)		2067 (35 years operation – intended lease period		2082 (50 years operation)	
			CPS	CGR	CPS	CGR	CPS	CGR
Kittiwake	Buchan Ness to Collieston Coast SPA	Higher	0.978 (0.954 - 1.000)	0.999 (0.998 - 1.000)	0.971 (0.945 - 0.997)	0.999 (0.999 - 1.000)	0.960 (0.933 - 0.988)	0.999 (0.999 - 1.000)
		Lower	0.978 (0.954 - 1.000)	0.999 (0.998 - 1.000)	0.971 (0.945 - 0.998)	0.999 (0.999 - 1.000)	0.960 (0.933 - 0.988)	0.999 (0.999 - 1.000)
	Troup, Pennan and Lion's Heads SPA	Higher	0.986 (0.962 - 1.010)	1.000 (0.999 - 1.000)	0.982 (0.956 - 1.010)	1.000 (0.999 - 1.000)	0.975 (0.947 - 1.000)	1.000 (0.999 - 1.000)
		Lower	0.987 (0.963 - 1.010)	1.000 (0.999 - 1.000)	0.982 (0.957 - 1.010)	1.000 (0.999 - 1.000)	0.975 (0.948 - 1.000)	1.000 (0.999 - 1.000)
	Regional	Higher	0.989 (0.979 - 0.999)	1.000 (0.999 - 1.000)	0.985 (0.974 - 0.997)	1.000 (0.999 - 1.000)	0.980 (0.968 - 0.992)	1.000 (0.999 - 1.000)
		Lower	0.990 (0.979 - 1.000)	1.000 (0.999 - 1.000)	0.986 (0.974 - 0.997)	1.000 (0.999 - 1.000)	0.981 (0.968 - 0.993)	1.000 (0.999 - 1.000)
Guillemot	Buchan Ness to Collieston Coast SPA	Higher	0.950 (0.935 - 0.965)	0.998 (0.998 - 0.999)	0.934 (0.918 - 0.950)	0.998 (0.998 - 0.999)	0.911 (0.895 - 0.927)	0.998 (0.998 - 0.999)
		Lower	0.983 (0.968 - 0.998)	0.999 (0.999 - 1.000)	0.977 (0.962 - 0.993)	0.999 (0.999 - 1.000)	0.969 (0.953 - 0.986)	0.999 (0.999 - 1.000)

Species	Population	Scenario	2057 (25 years operation)		2067 (35 years operation – intended lease period		2082 (50 years operation)	
			CPS	CGR	CPS	CGR	CPS	CGR
	Troup, Pennan and Lion's Heads SPA	Higher	0.974 (0.960 - 0.988)	0.999 (0.999 - 1.000)	0.965 (0.951 - 0.980)	0.999 (0.999 - 0.999)	0.952 (0.937 - 0.968)	0.999 (0.999 - 0.999)
		Lower	0.991 (0.977 - 1.000)	1.000 (0.999 - 1.000)	0.988 (0.973 - 1.000)	1.000 (0.999 - 1.000)	0.983 (0.968 - 0.999)	1.000 (0.999 - 1.000)
	Regional	Higher	0.961 (0.952 - 0.971)	0.999 (0.998 - 0.999)	0.948 (0.938 - 0.959)	0.999 (0.998 - 0.999)	0.930 (0.920 - 0.941)	0.999 (0.998 - 0.999)
		Lower	0.987 (0.976 - 0.996)	1.000 (0.999 - 1.000)	0.982 (0.971 - 0.992)	1.000 (0.999 - 1.000)	0.975 (0.964 - 0.986)	1.000 (0.999 - 1.000)
Razorbill	Regional	Higher	0.990 (0.961 - 1.020)	1.000 (0.999 - 1.000)	0.986 (0.950 - 1.020)	1.000 (0.999 - 1.000)	0.981 (0.936 - 1.030)	1.000 (0.999 - 1.000)
		Lower	0.994 (0.965 - 1.020)	1.000 (0.999 - 1.000)	0.991 (0.956 - 1.030)	1.000 (0.999 - 1.000)	0.988 (0.943 - 1.040)	1.000 (0.999 - 1.000)

Source: NEPVA outputs

F. Population trajectories predicted during PVA modelling

F.1. Project-only

Source: Recreated from outputs from the NEPVA tool

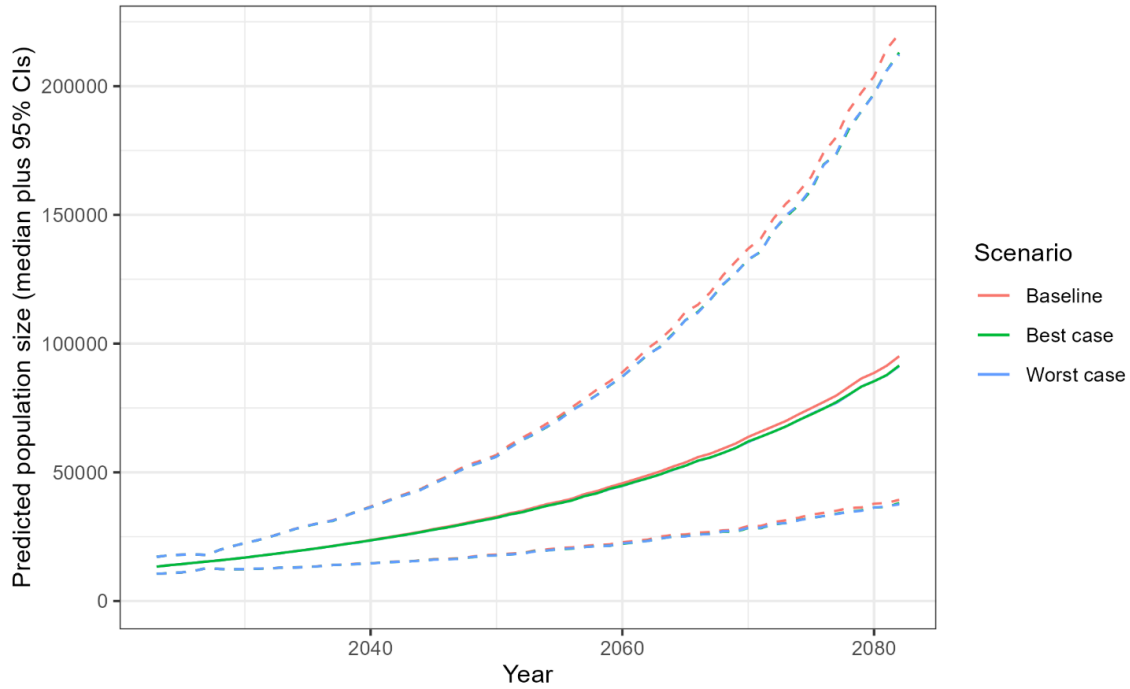

Figure F5.1: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at Buchan Ness to Collieston Coast SPA. Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

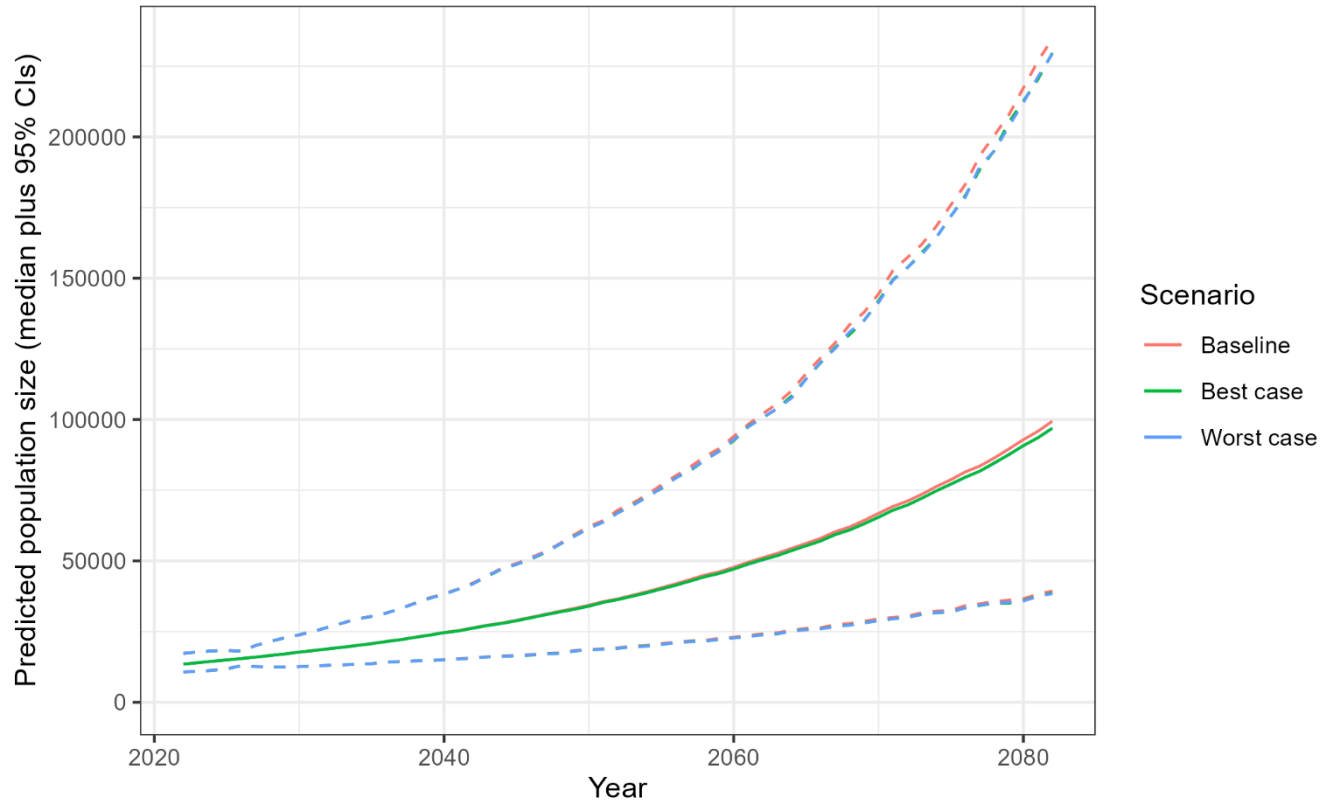

Figure F5.2: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the Troup, Pennan and Lion's Heads SPA. Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

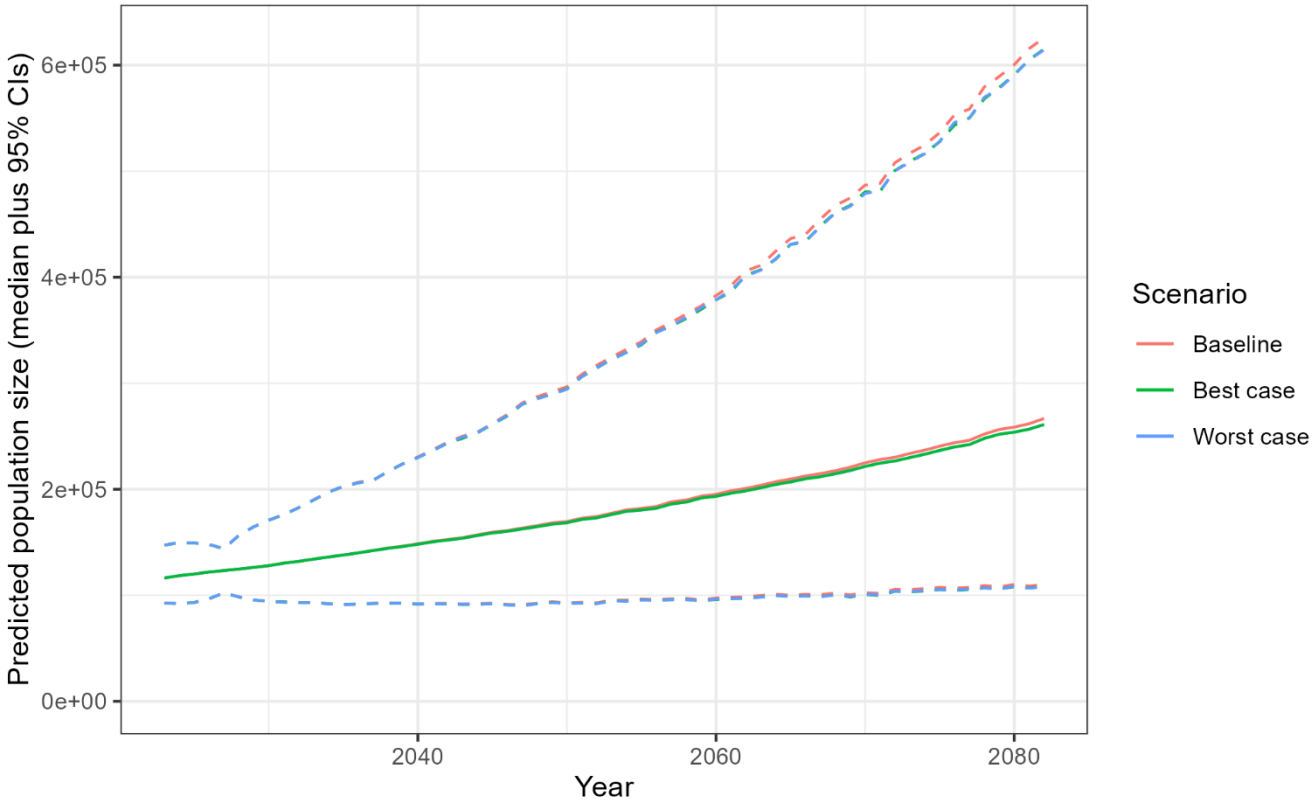

Figure F5.3: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional kittiwake population. Population sizes represent breeding pairs

Source: Recreated from outputs from the NEPVA tool

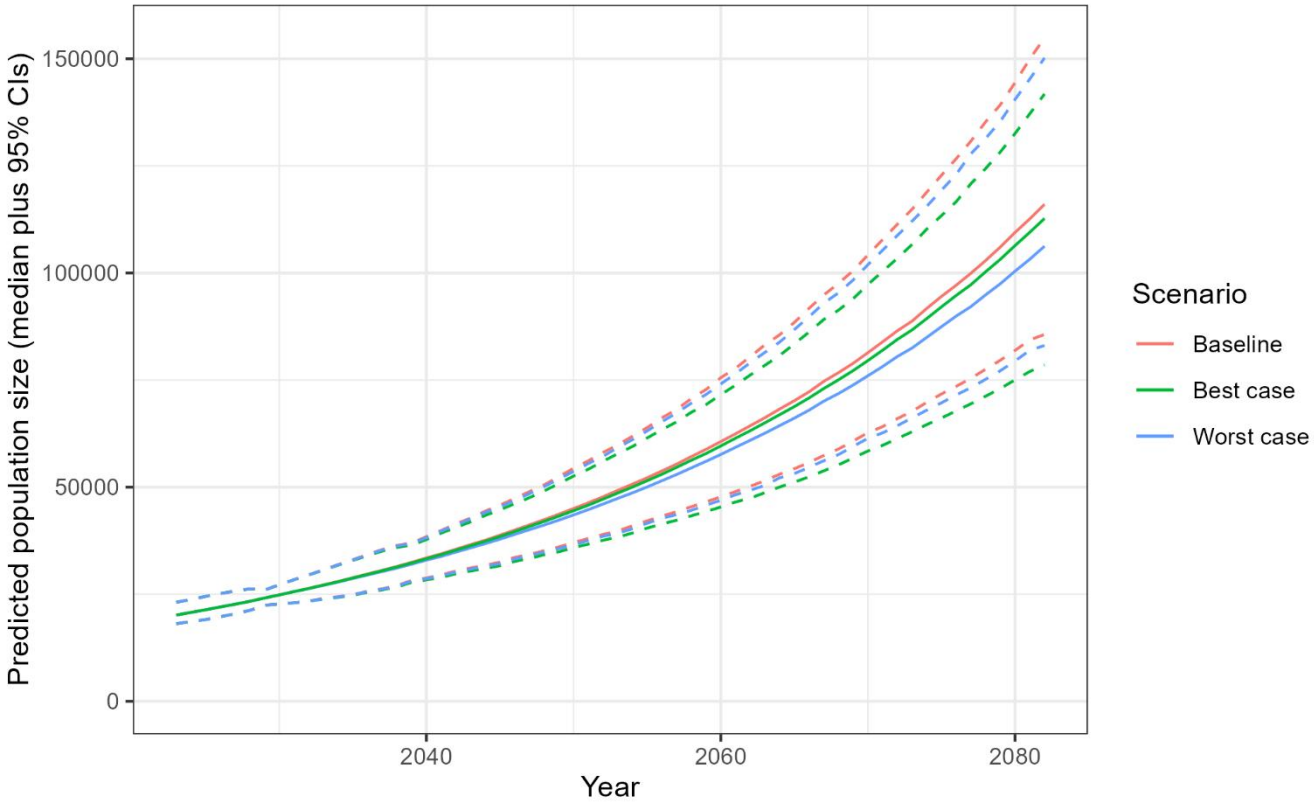

Figure F5.4: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for guillemot at the Buchan Ness to Collieston Coast SPA. Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

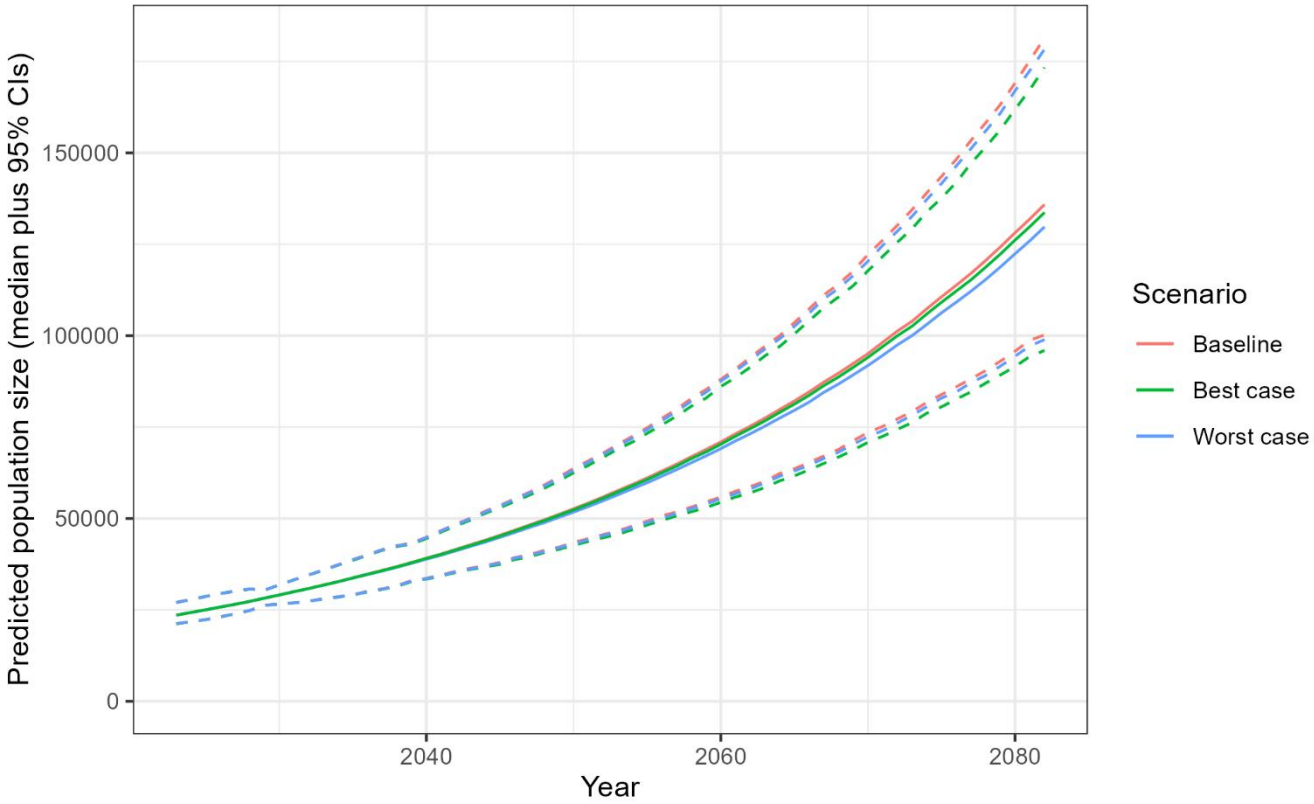

Figure F5.5: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for guillemot at the Troup, Pennan and Lion's Heads SPA. Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

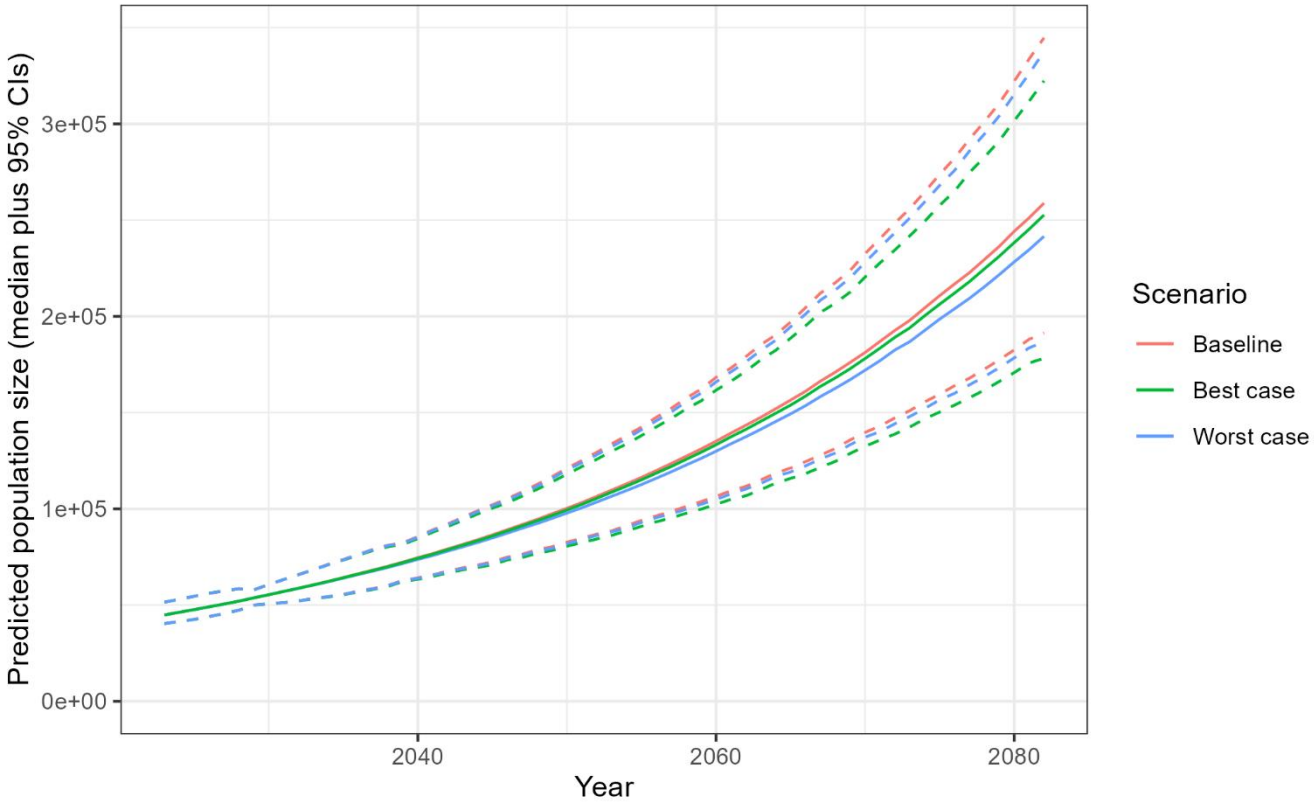

Figure F5.6: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional guillemot population. Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

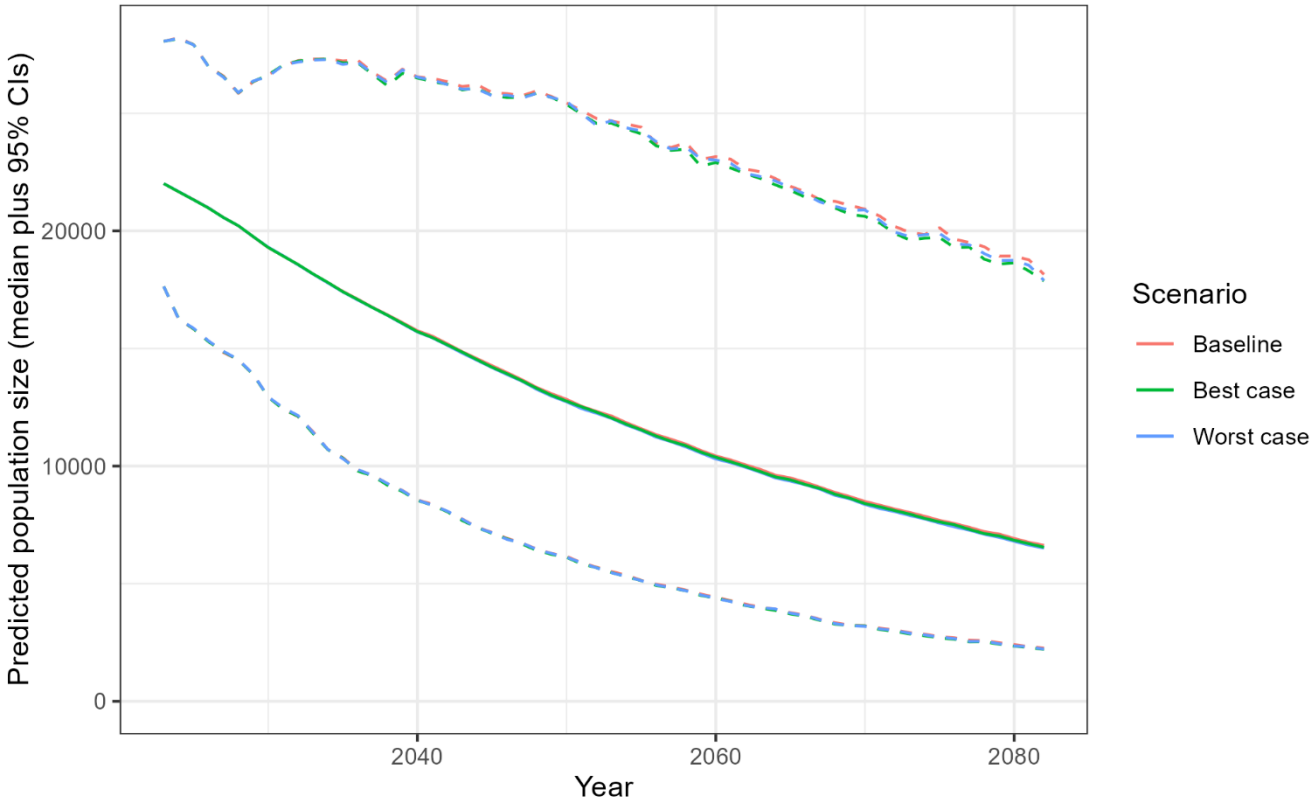

Figure F.7: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional razorbill population. Population sizes represent breeding pairs.

F.2. Cumulative impacts

Source: Recreated from outputs from the NEPVA tool

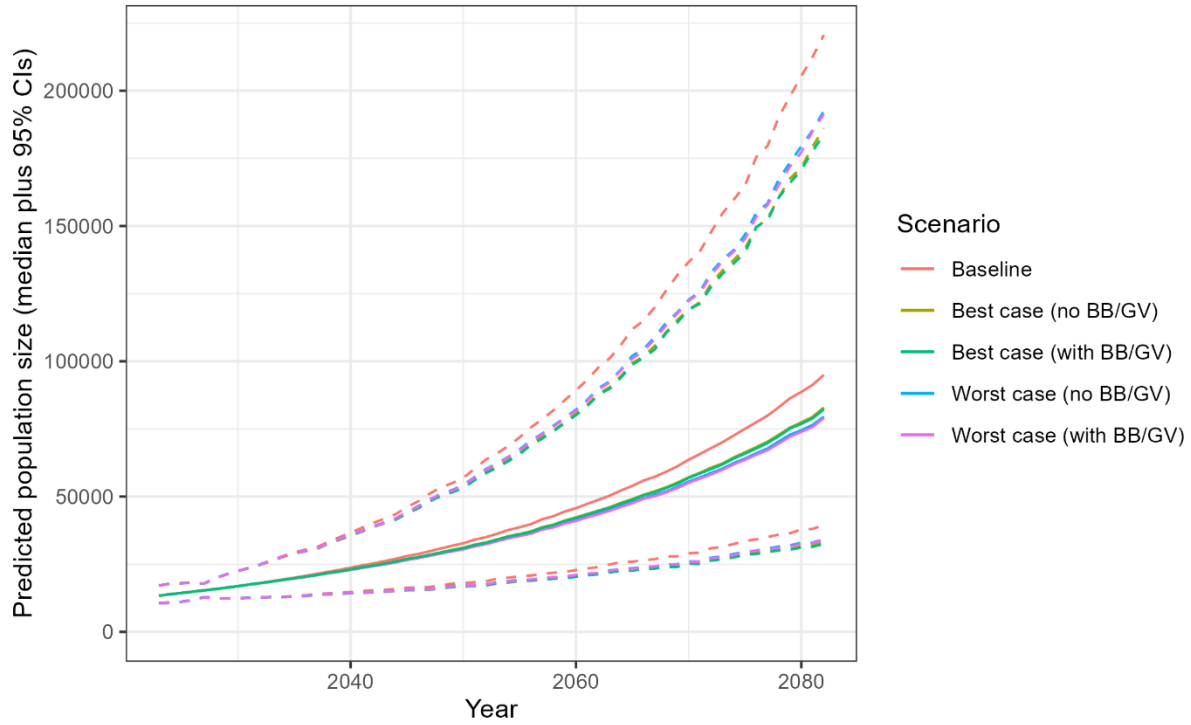

Figure F5.8: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at Buchan Ness to Collieston Coast SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

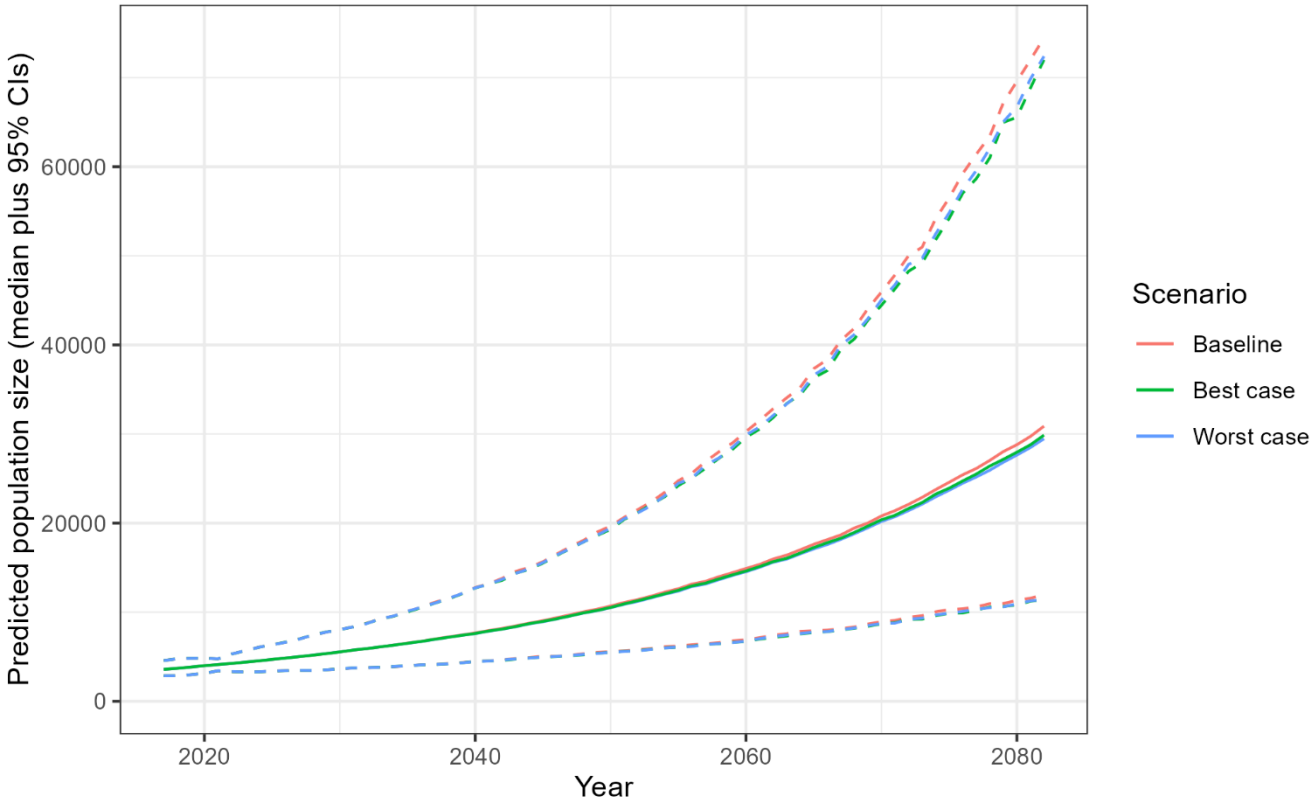

Figure F5.9: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the Cape Wrath SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

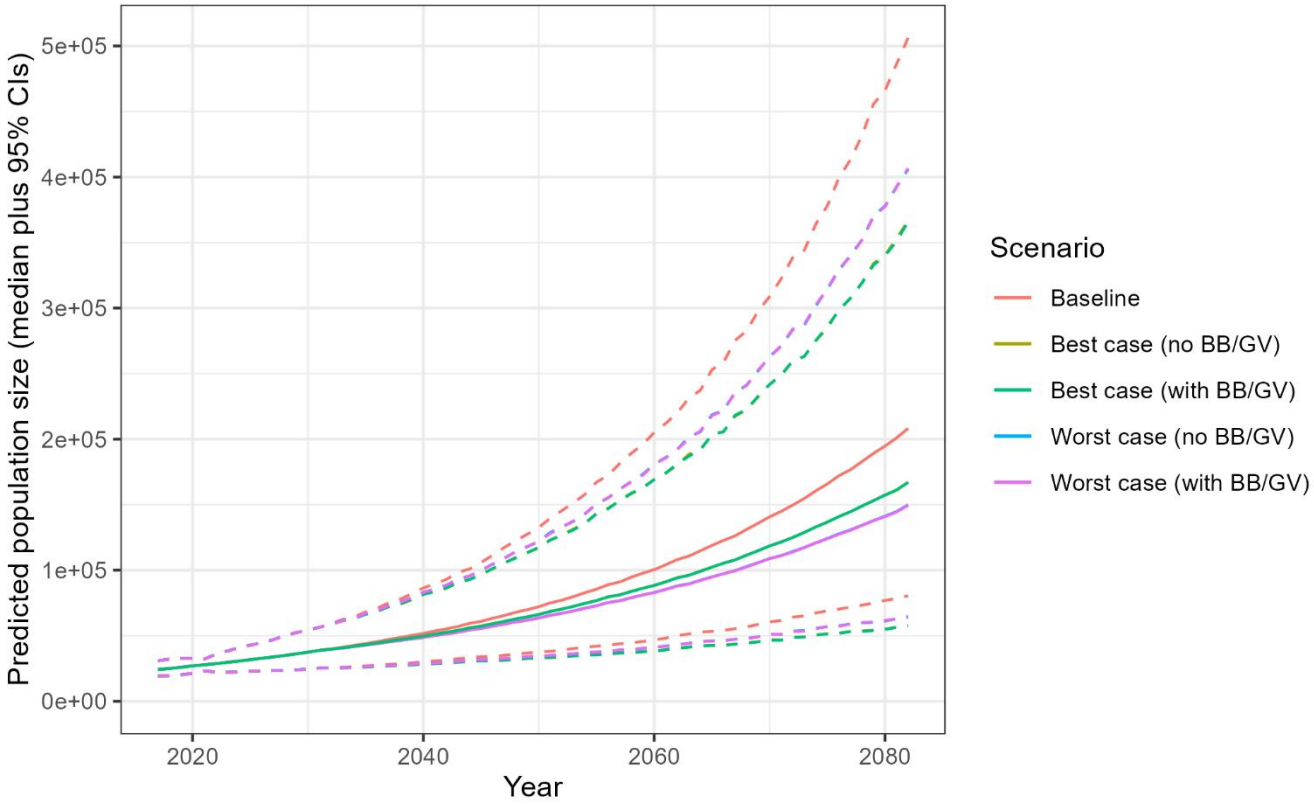

Figure F5.10: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the East Caithness Cliffs SPA (cumulative scenarios). Population sizes represent breeding pairs

Source: Recreated from outputs from the NEPVA tool

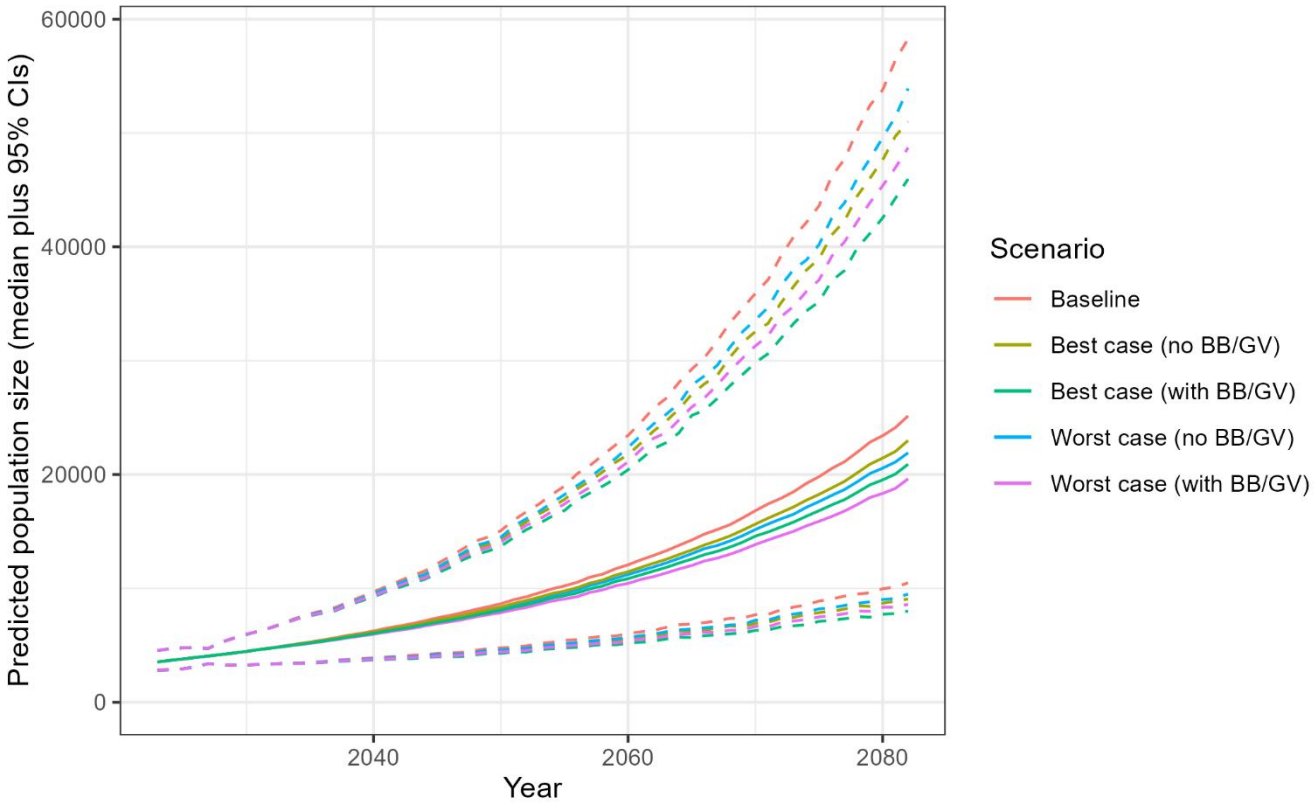

Figure F5.11: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the Farne Islands SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

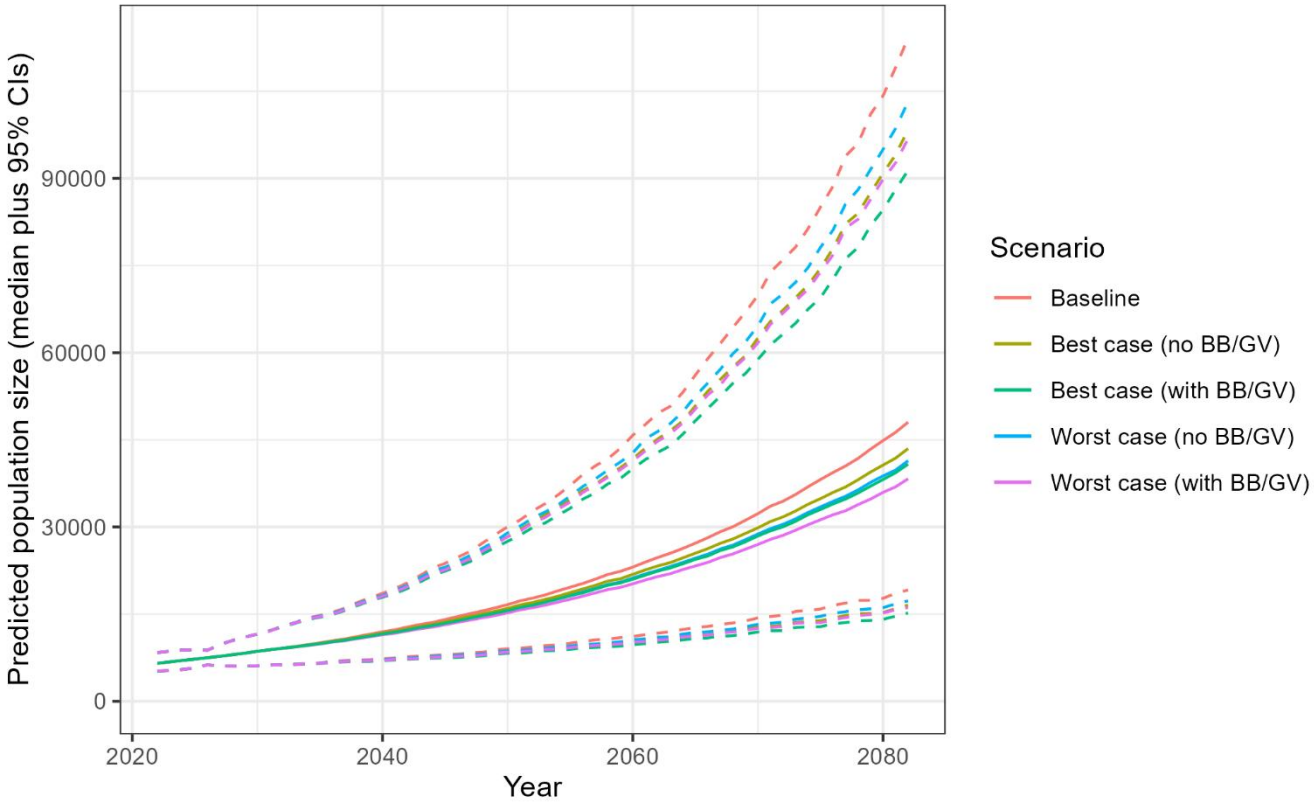

Figure F5.12: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the Forth Islands SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

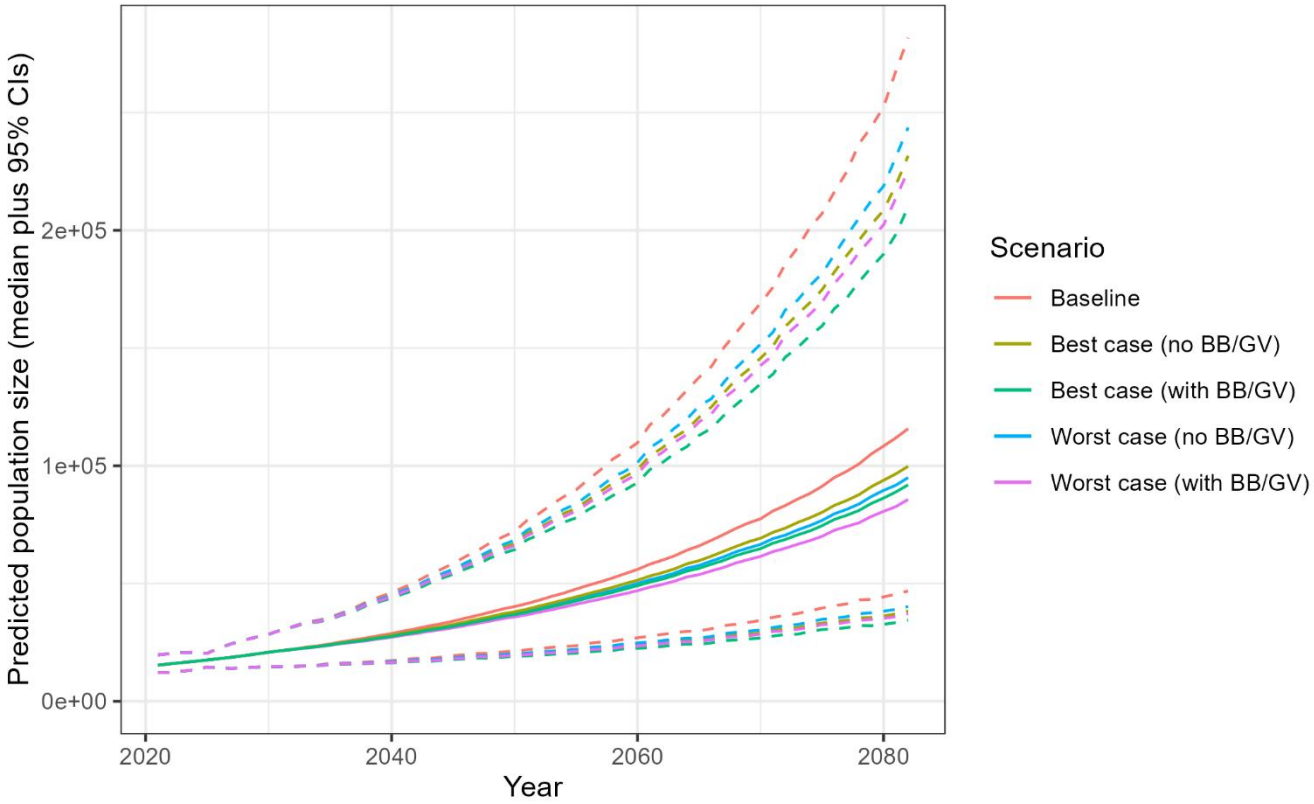

Figure F.13: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the Fowlsheugh SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

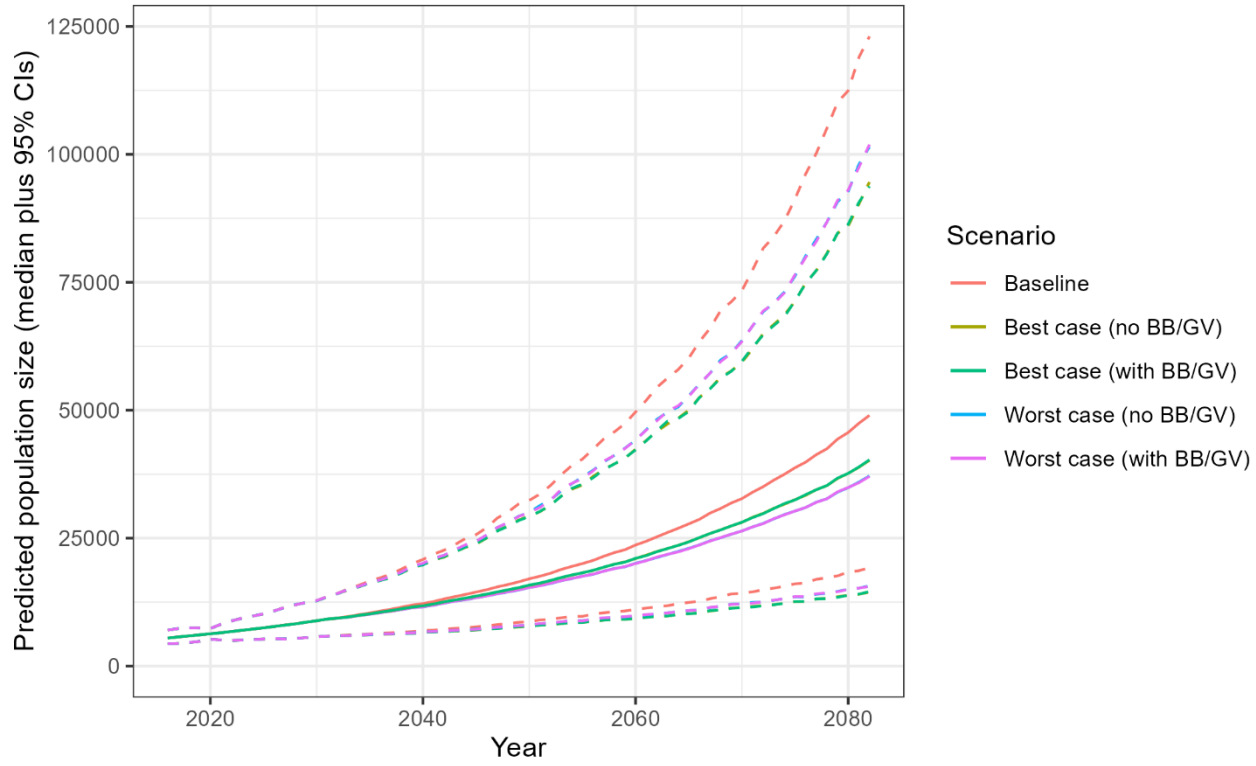

Figure F5.14: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the North Caithness Cliffs SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

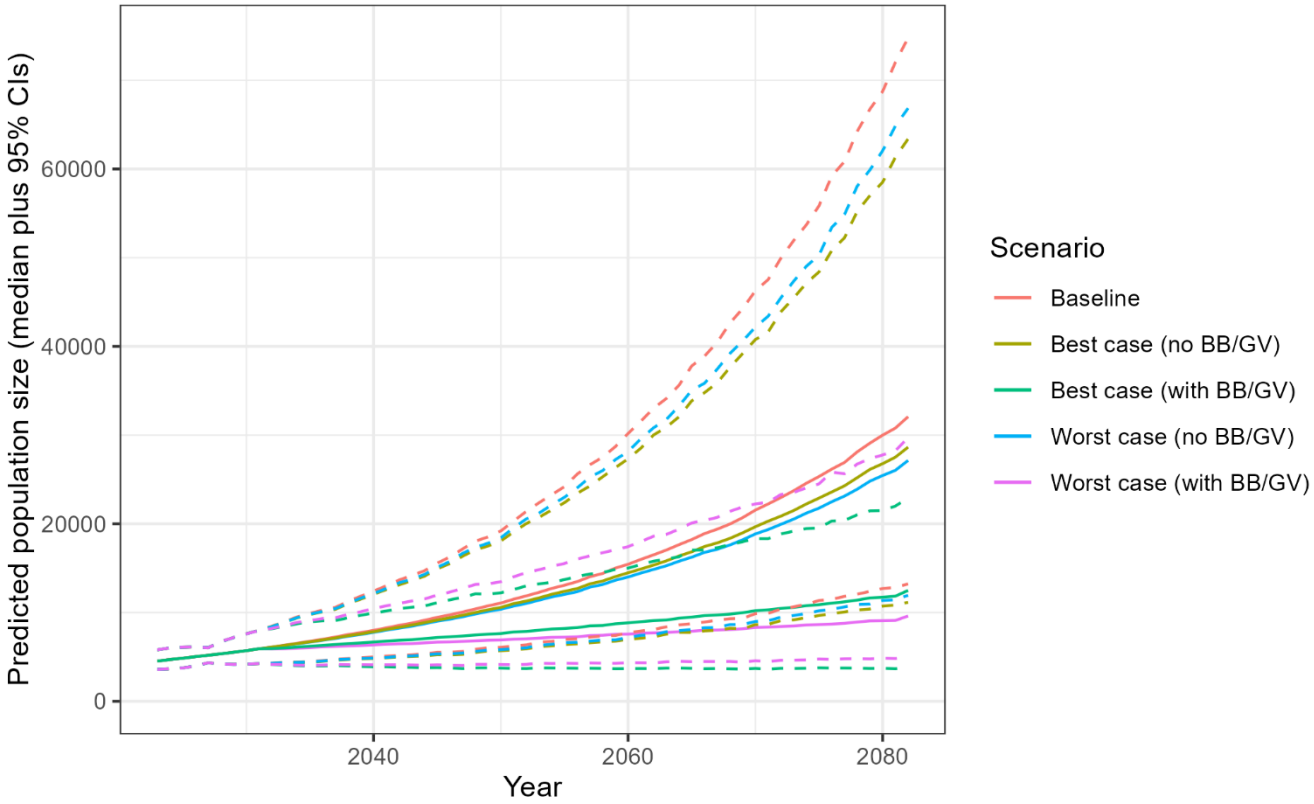

Figure F5.15: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the St Abbs Head to Fast Castle SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

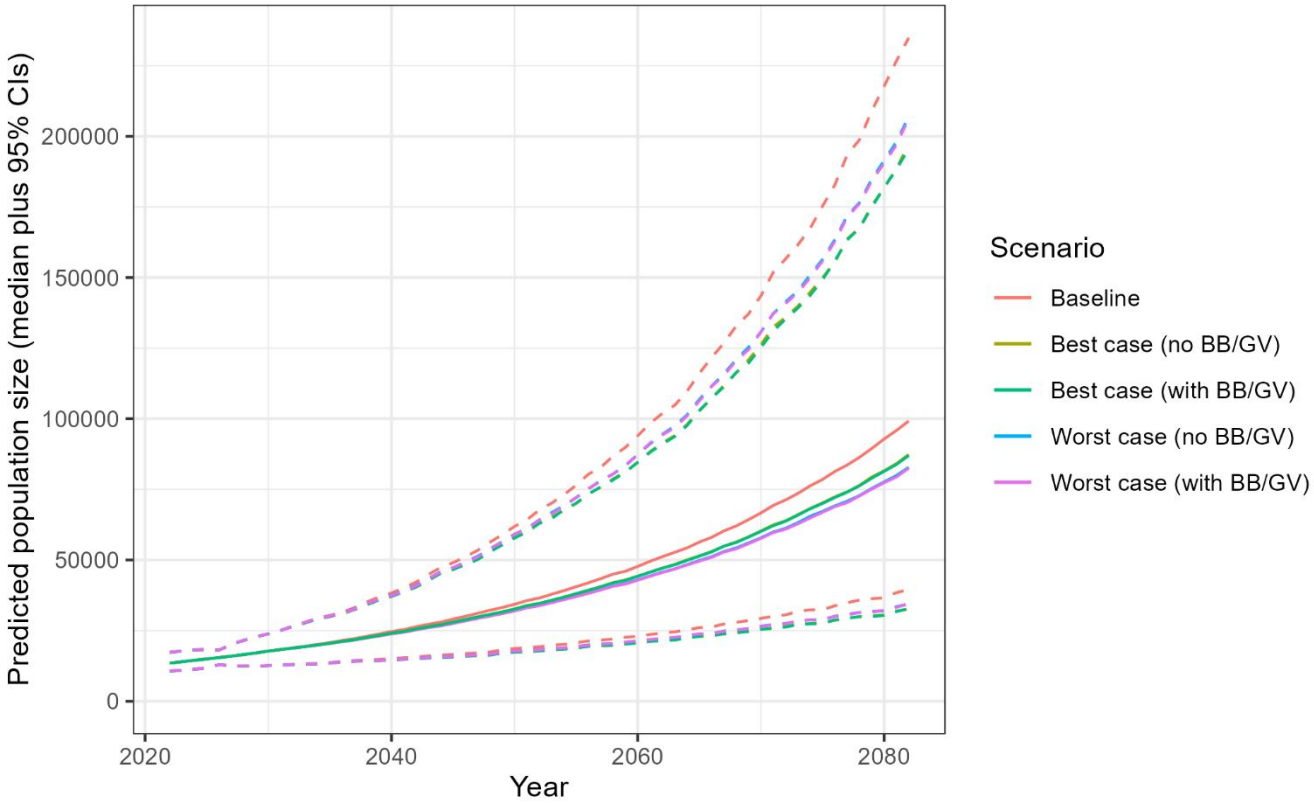

Figure F5.16: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the Troup, Pennan and Lion's Heads SPA (cumulative scenarios). Population sizes represent breeding pairs

Source: Recreated from outputs from the NEPVA tool

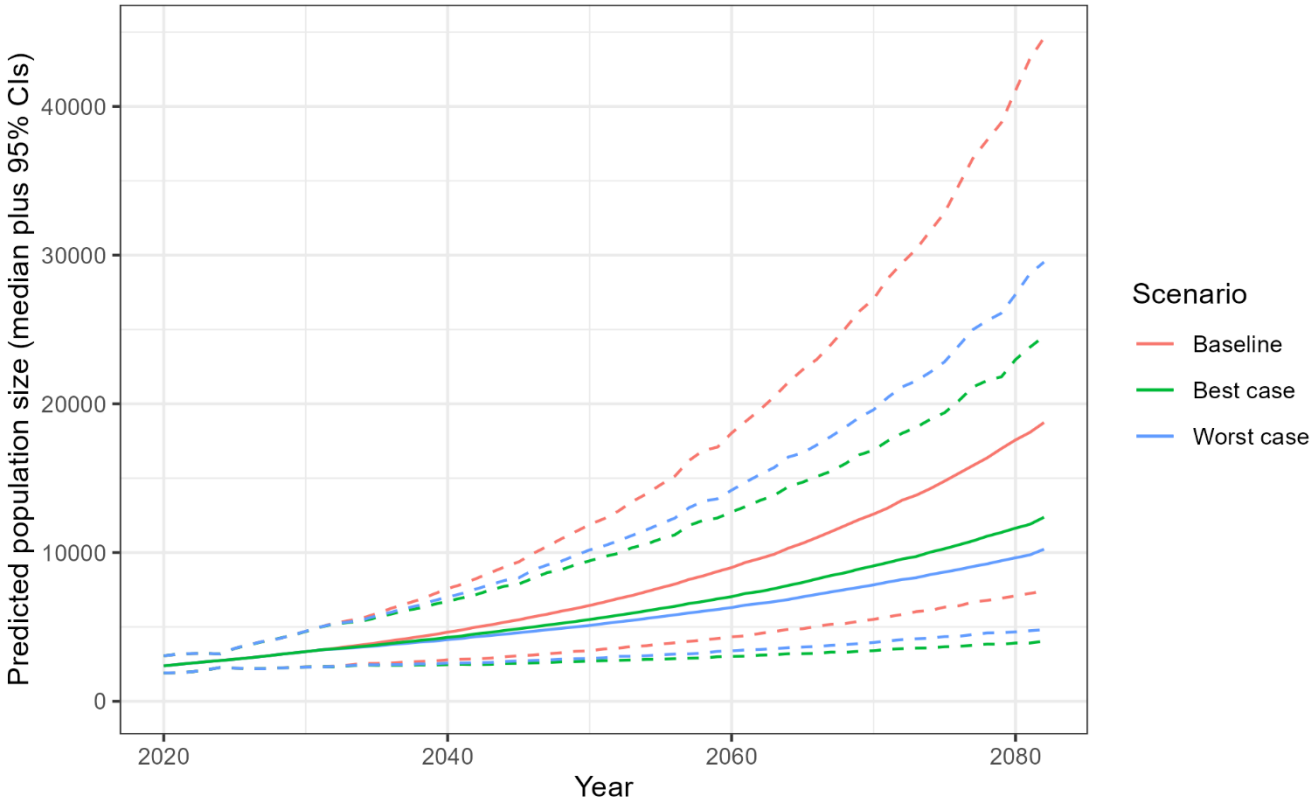

Figure F5.17: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for kittiwake at the West Westray SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

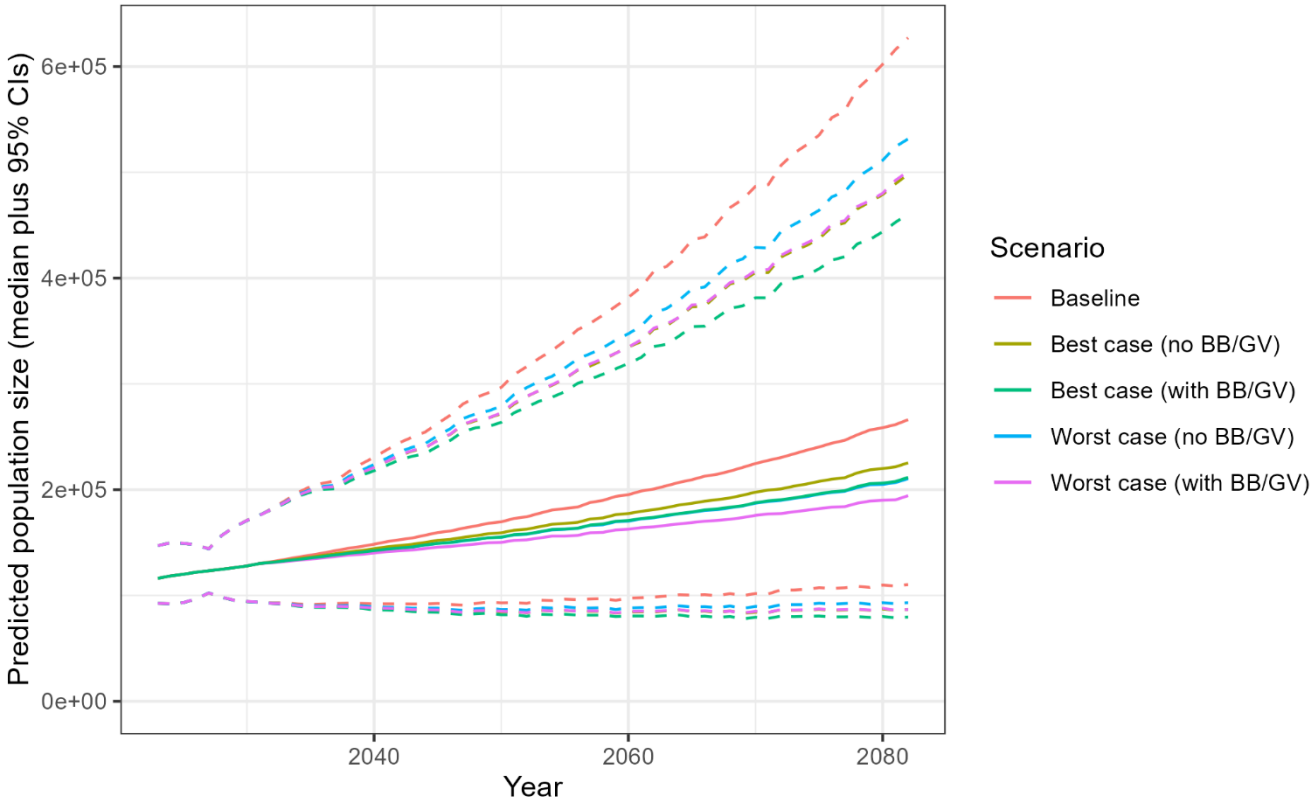

Figure F5.18: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional kittiwake population (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

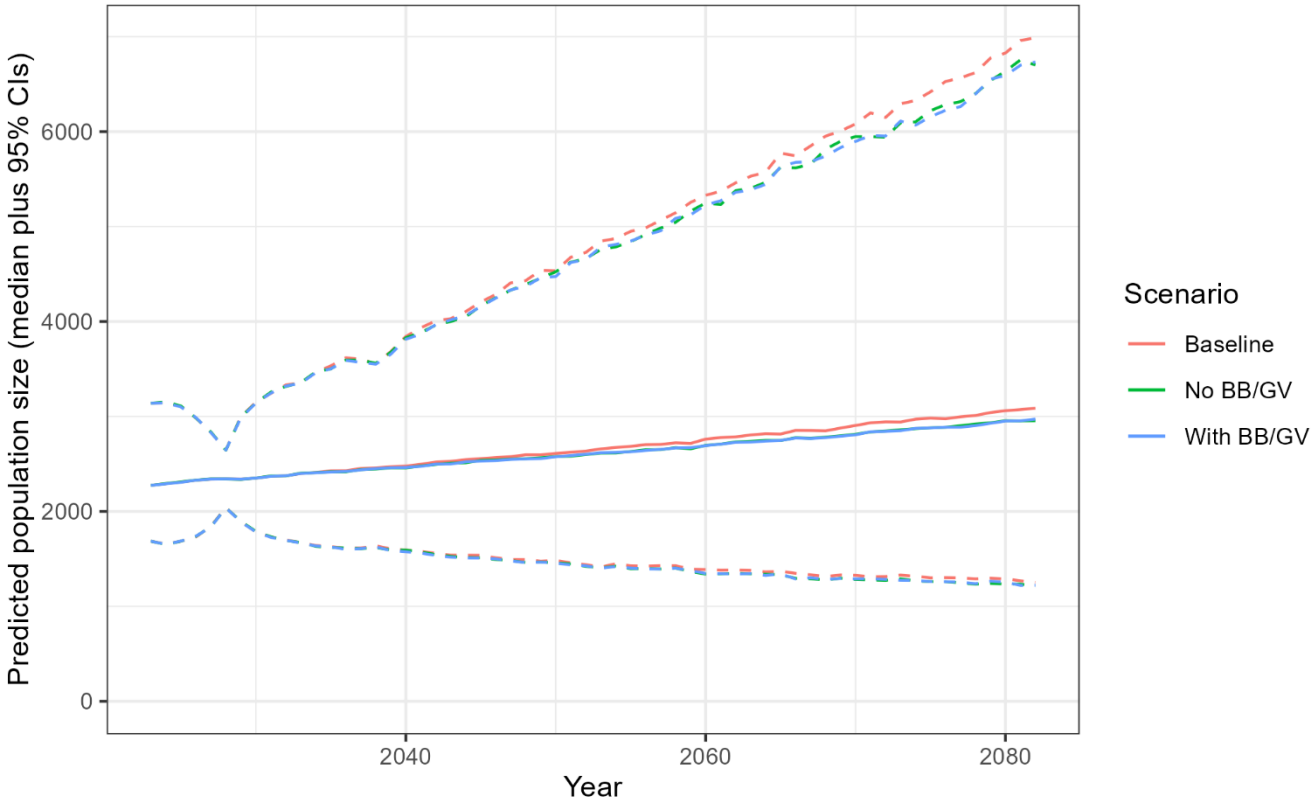

Figure F5.19: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for herring gull at the Buchan Ness to Collieston Coast SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

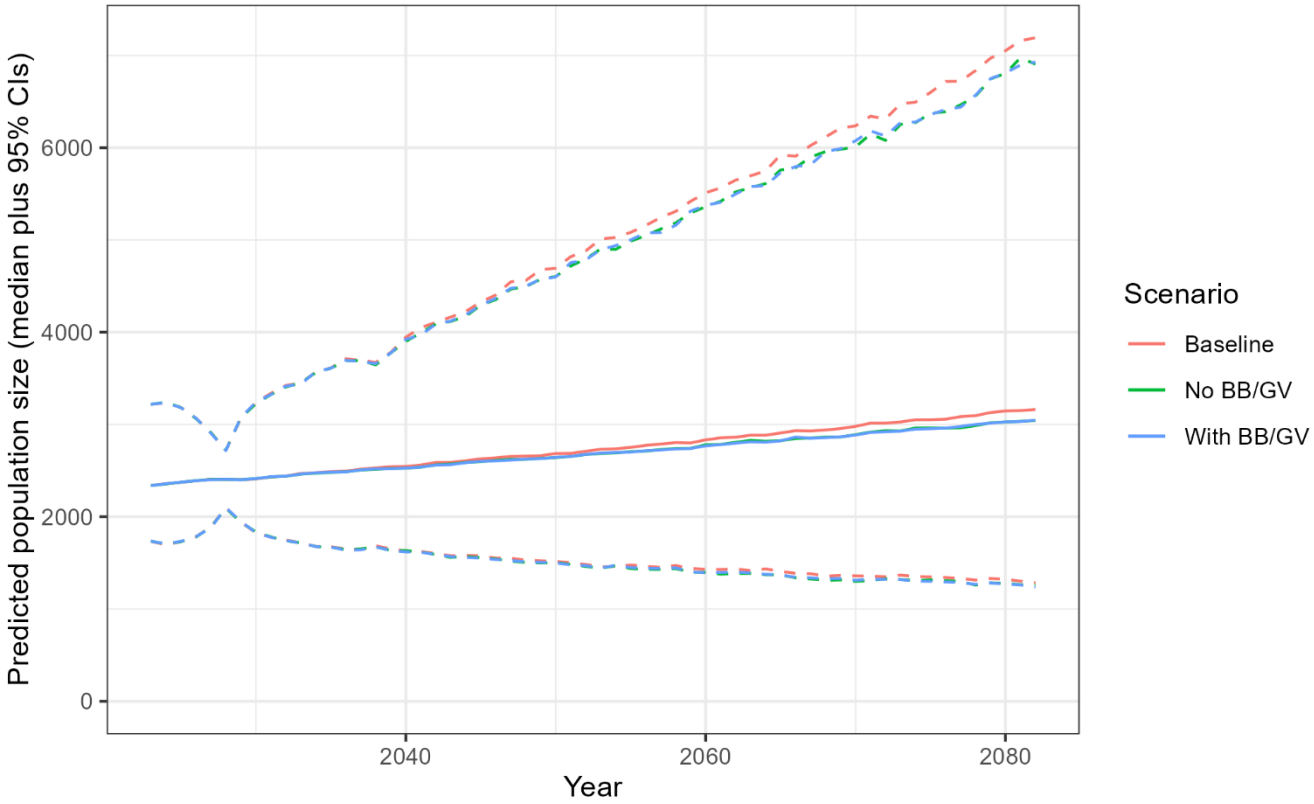

Figure F5.20: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional herring gull population (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

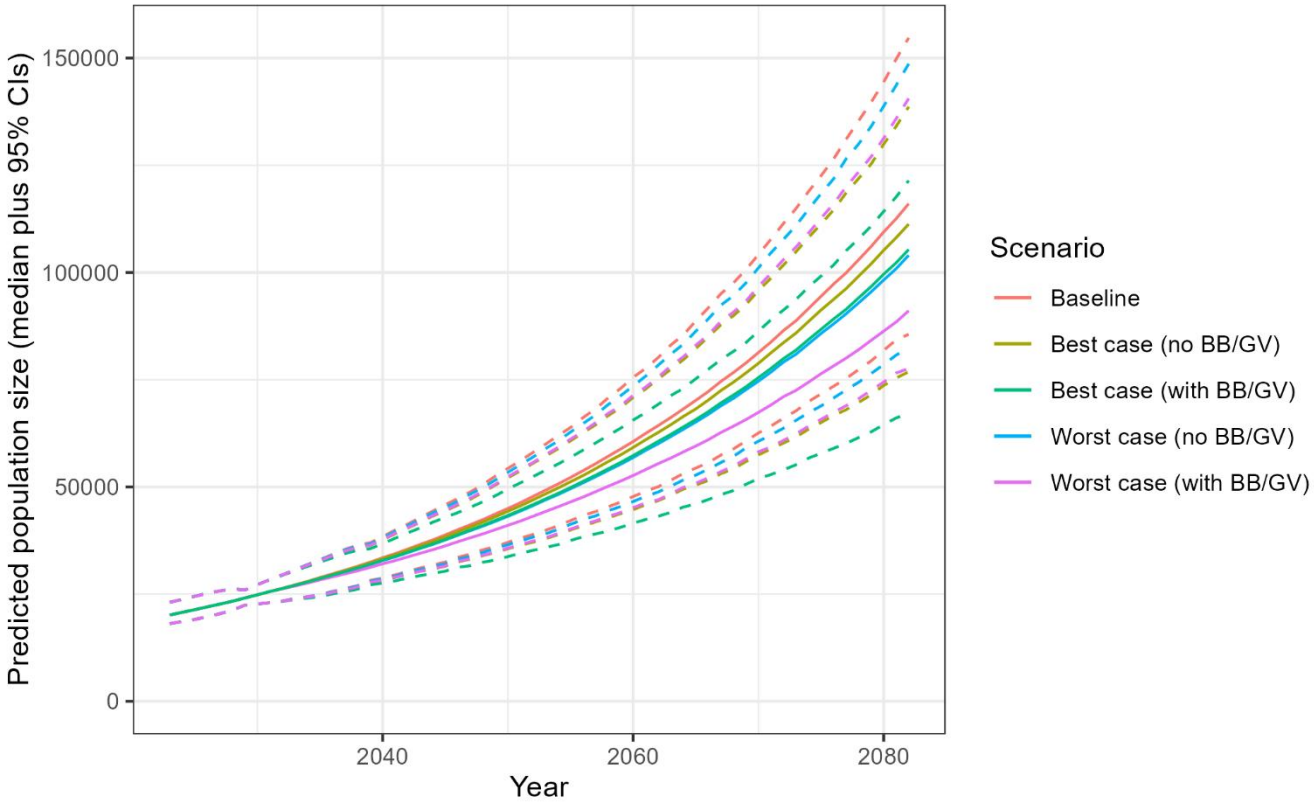

Figure F5.21: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for guillemot at the Buchan Ness to Collieston Coast SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

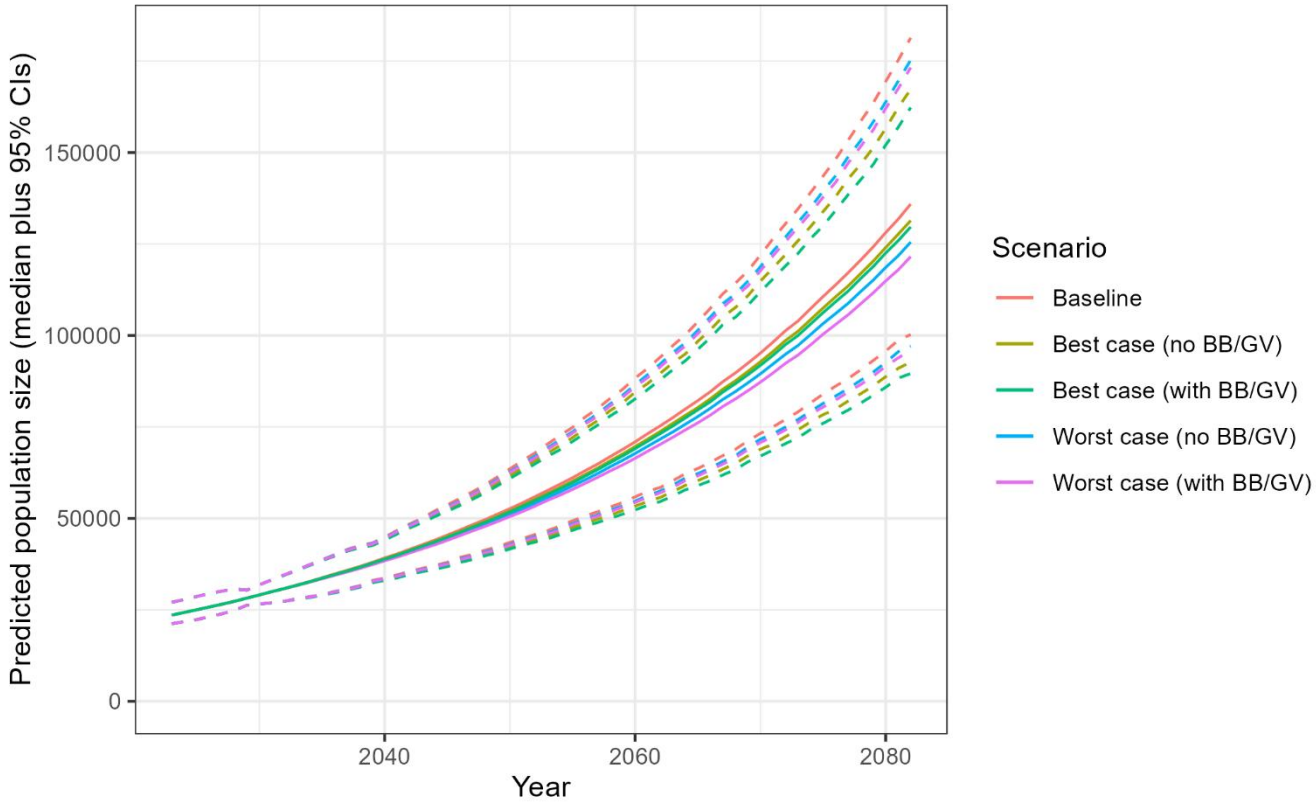

Figure F.22: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for guillemot at the Troup, Pennan and Lion's Heads SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

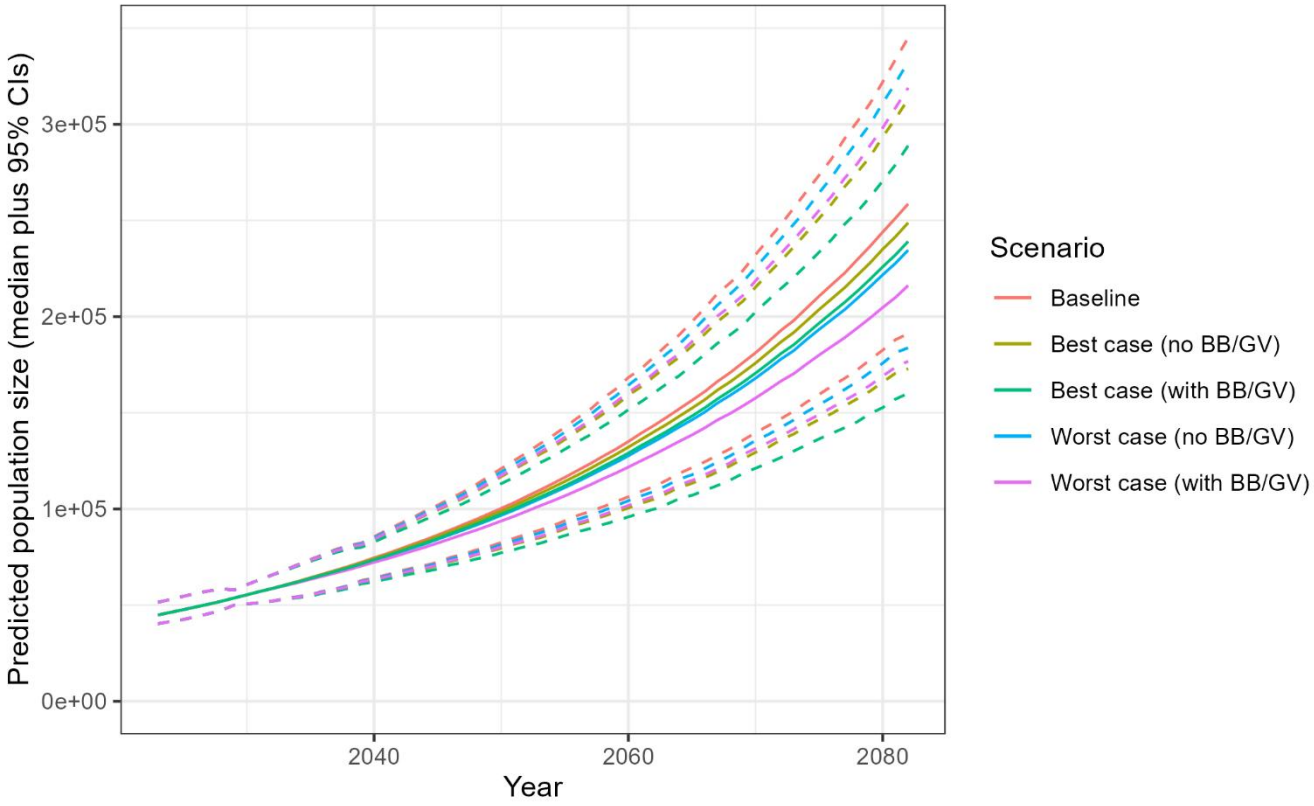

Figure F.23: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional guillemot population (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

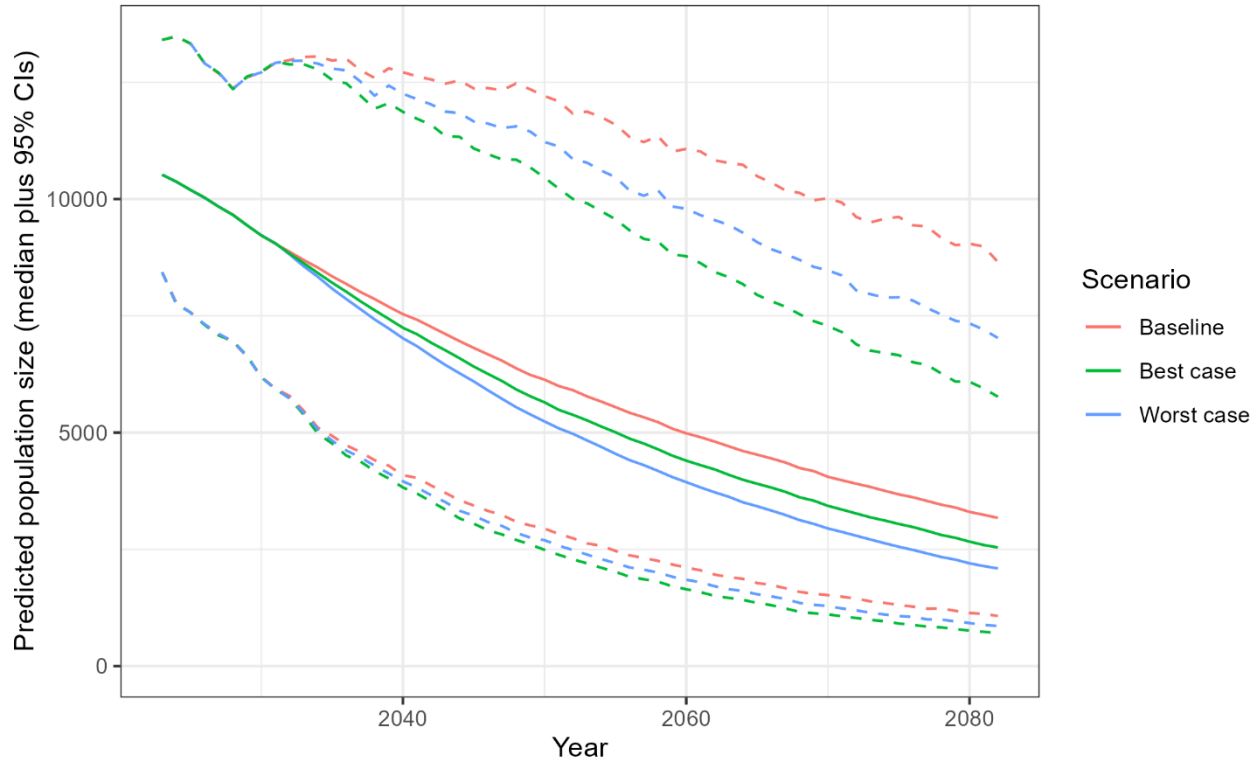

Figure F5.24: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for razorbill at the Fowlsheugh SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

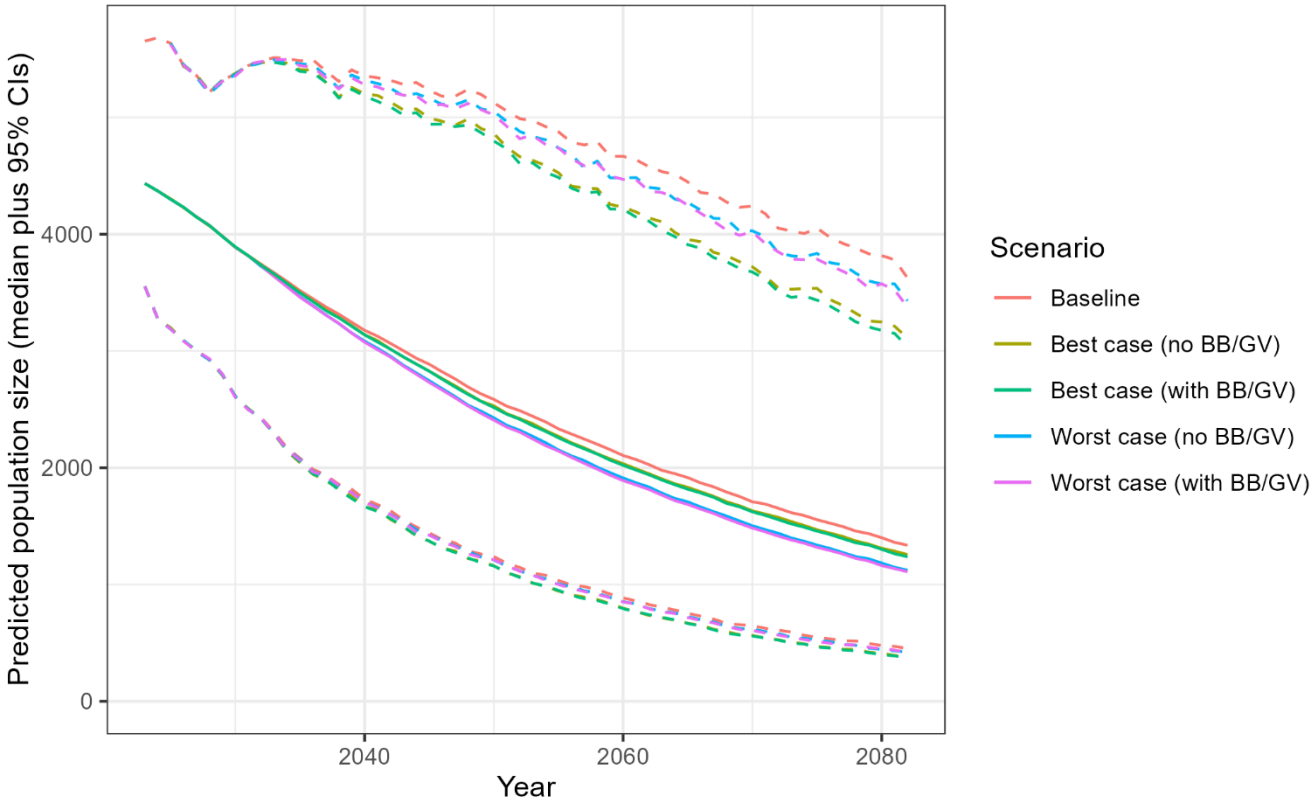

Figure F5.25: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for razorbill at the Troup, Pennan and Lion's Heads SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

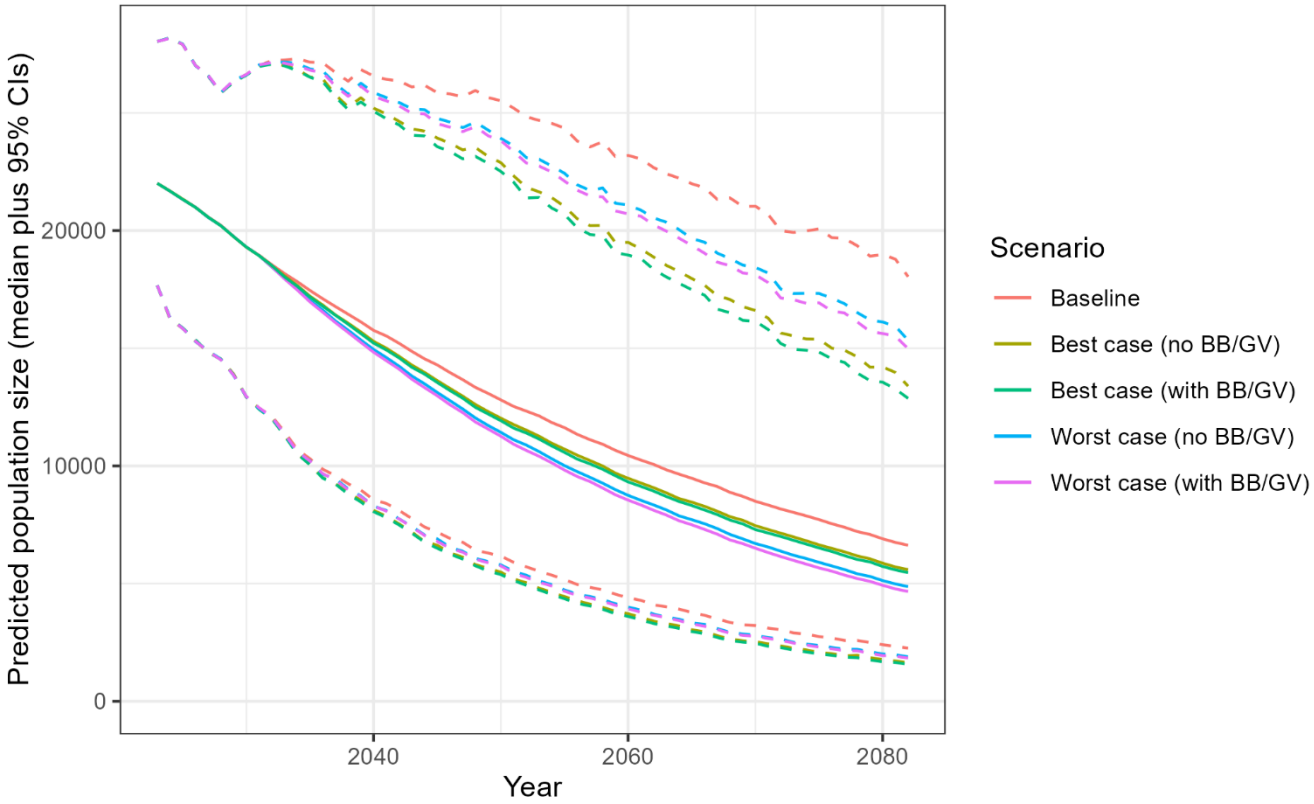

Figure F5.26: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional razorbill population (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

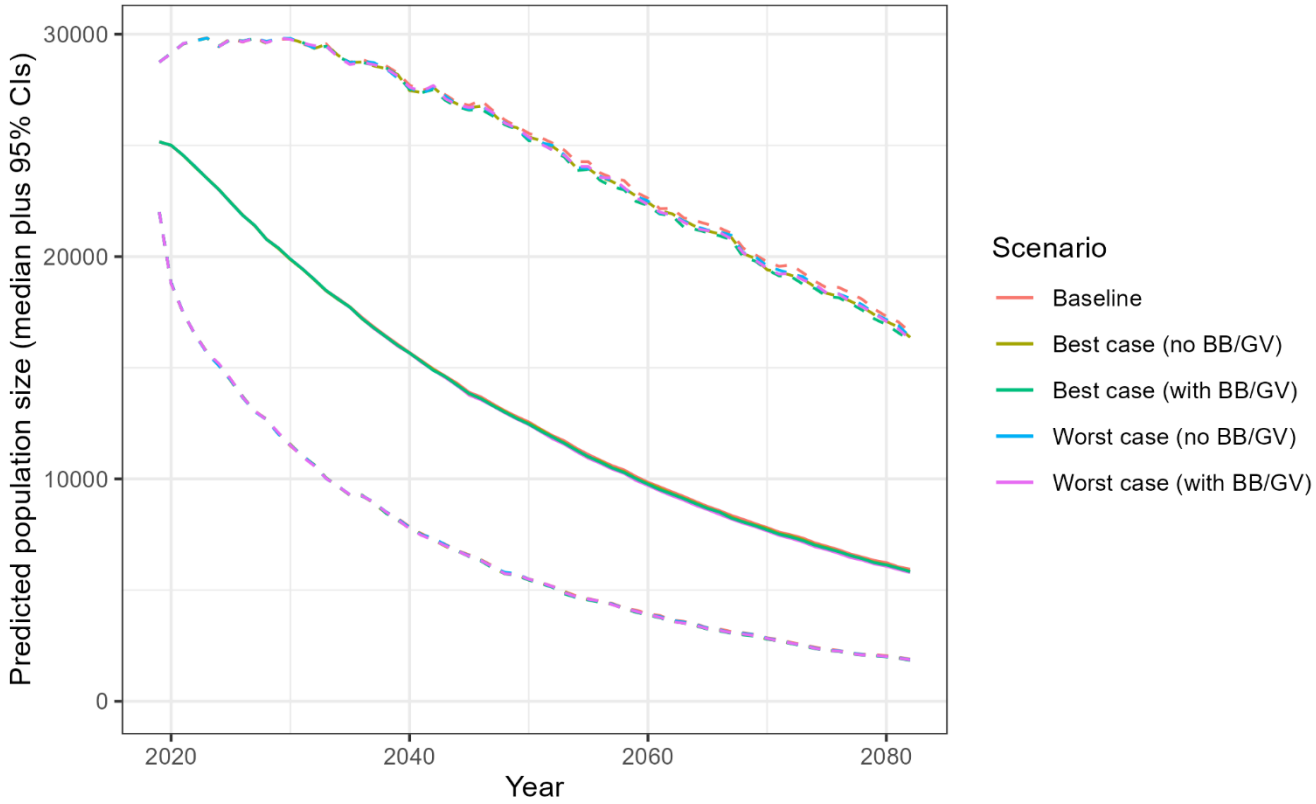

Figure F5.27: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for puffin at the Coquet Island SPA (cumulative scenarios). Population sizes represent breeding pairs

Source: Recreated from outputs from the NEPVA tool

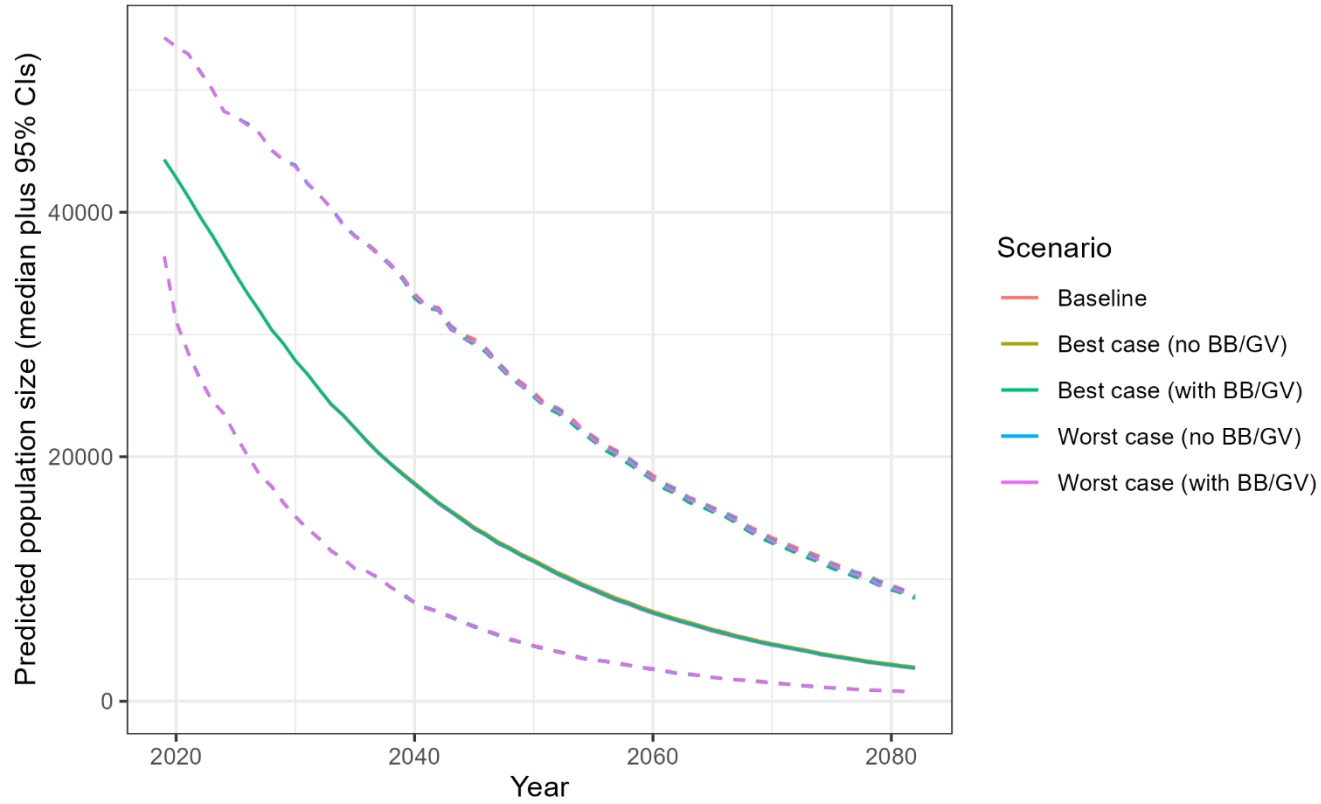

Figure F5.28: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for puffin at the Farne Islands SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

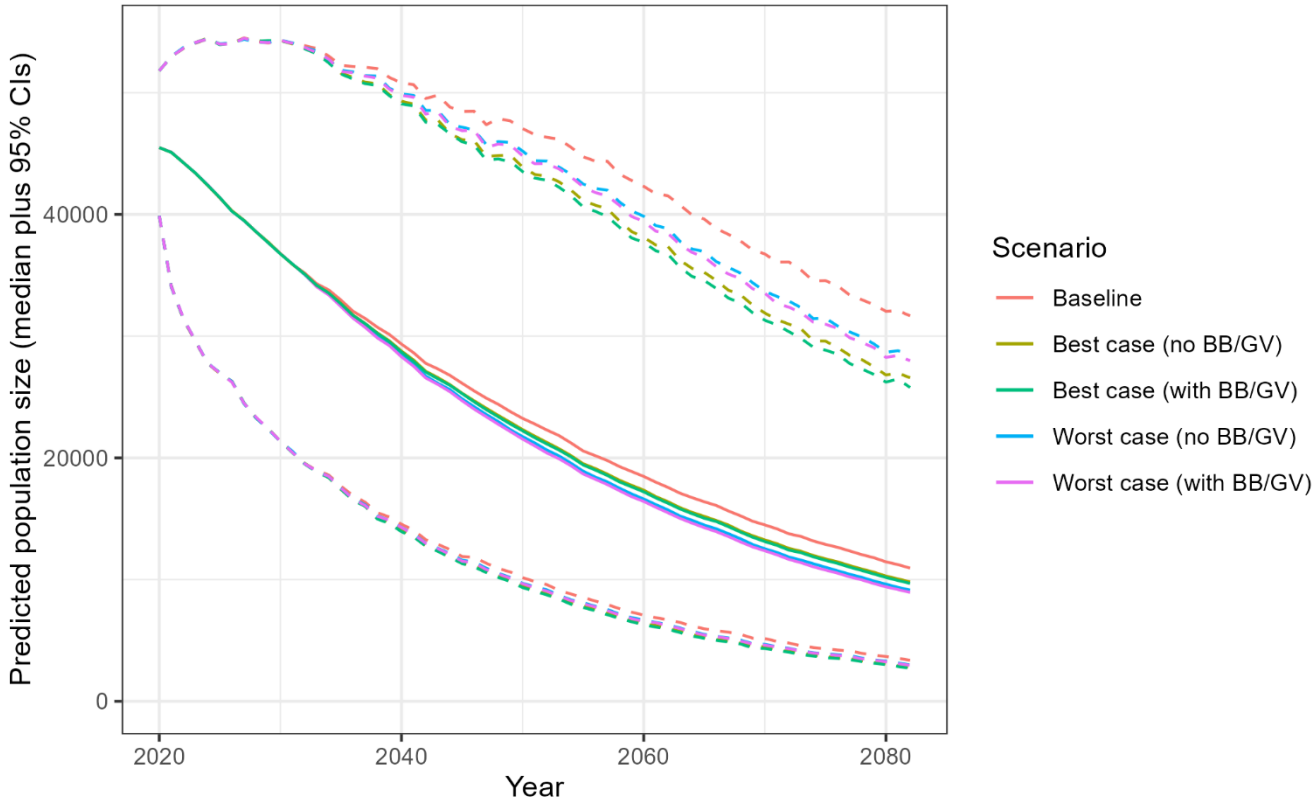

Figure F5.29: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for puffin at the Forth Islands SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

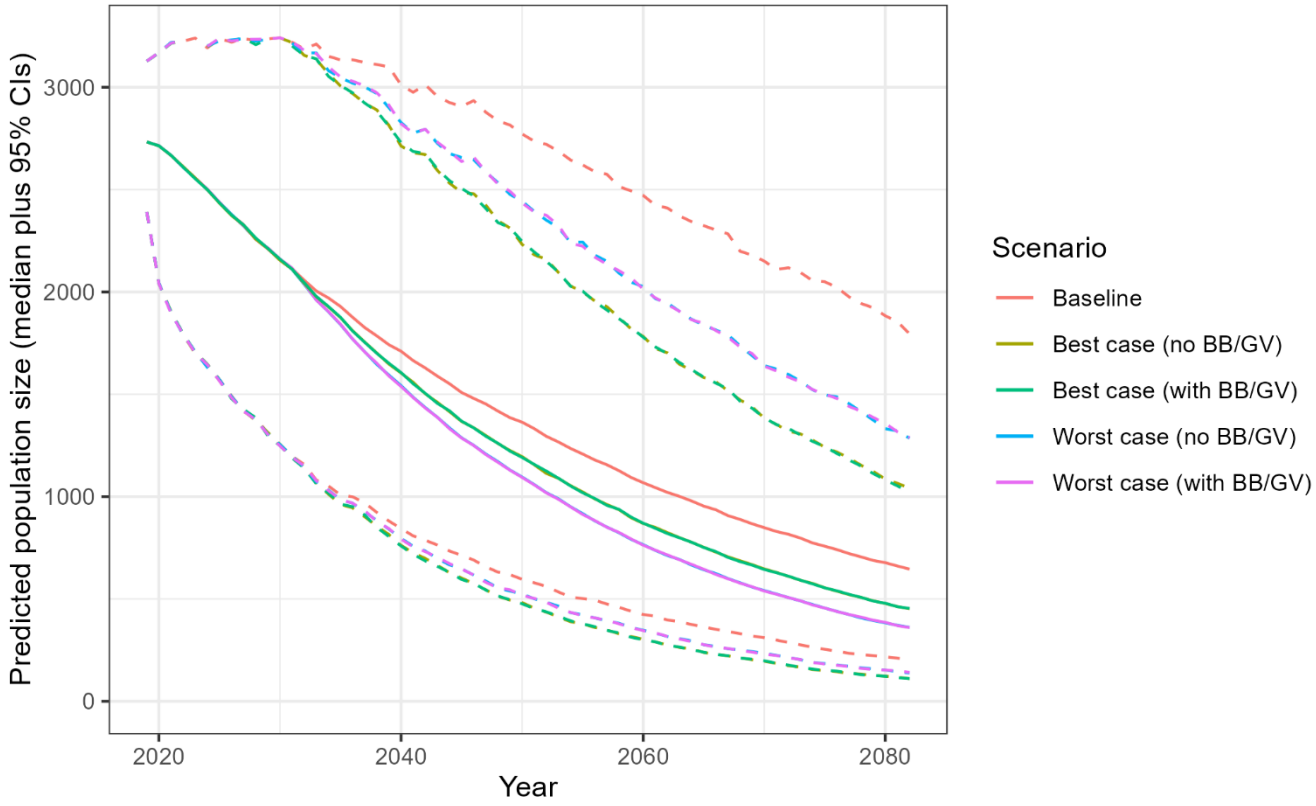

Figure F5.30: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for puffin at the North Caithness Cliffs SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

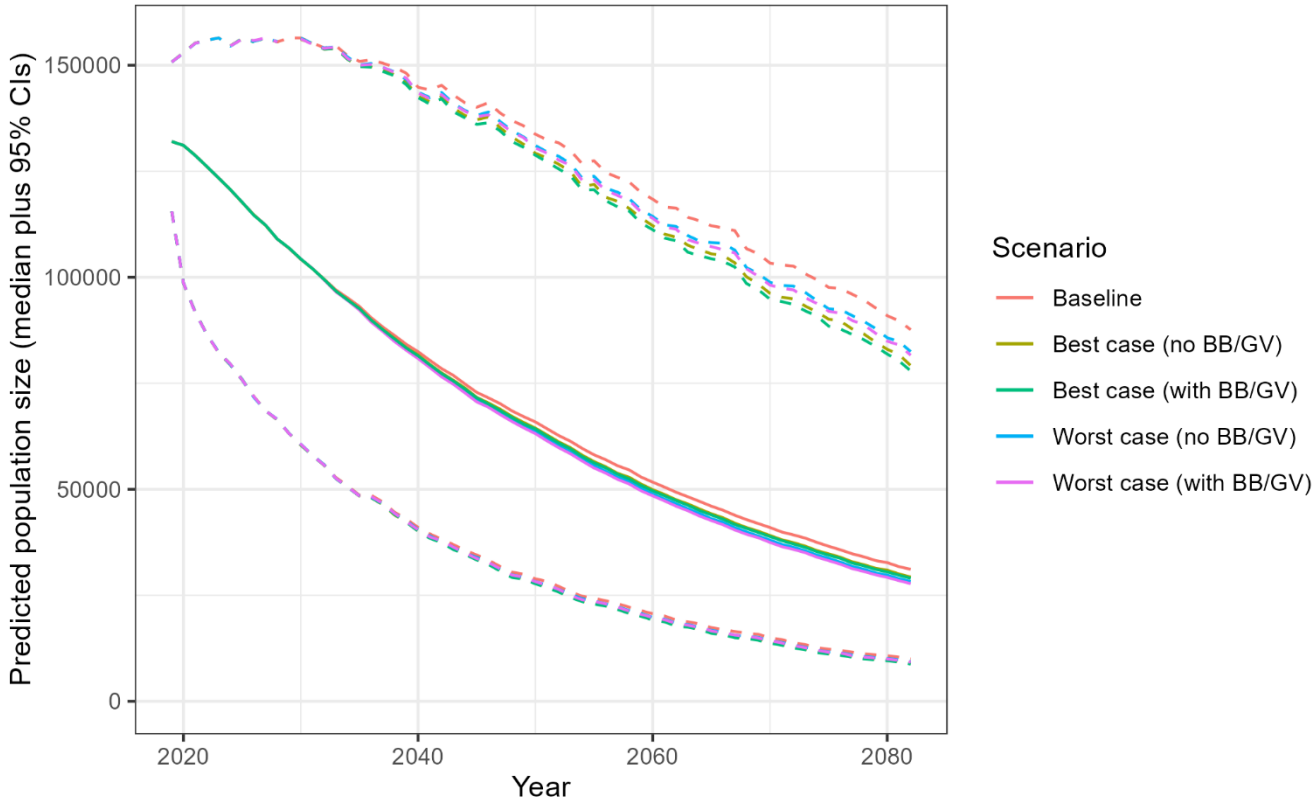

Figure F5.31: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional puffin population (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

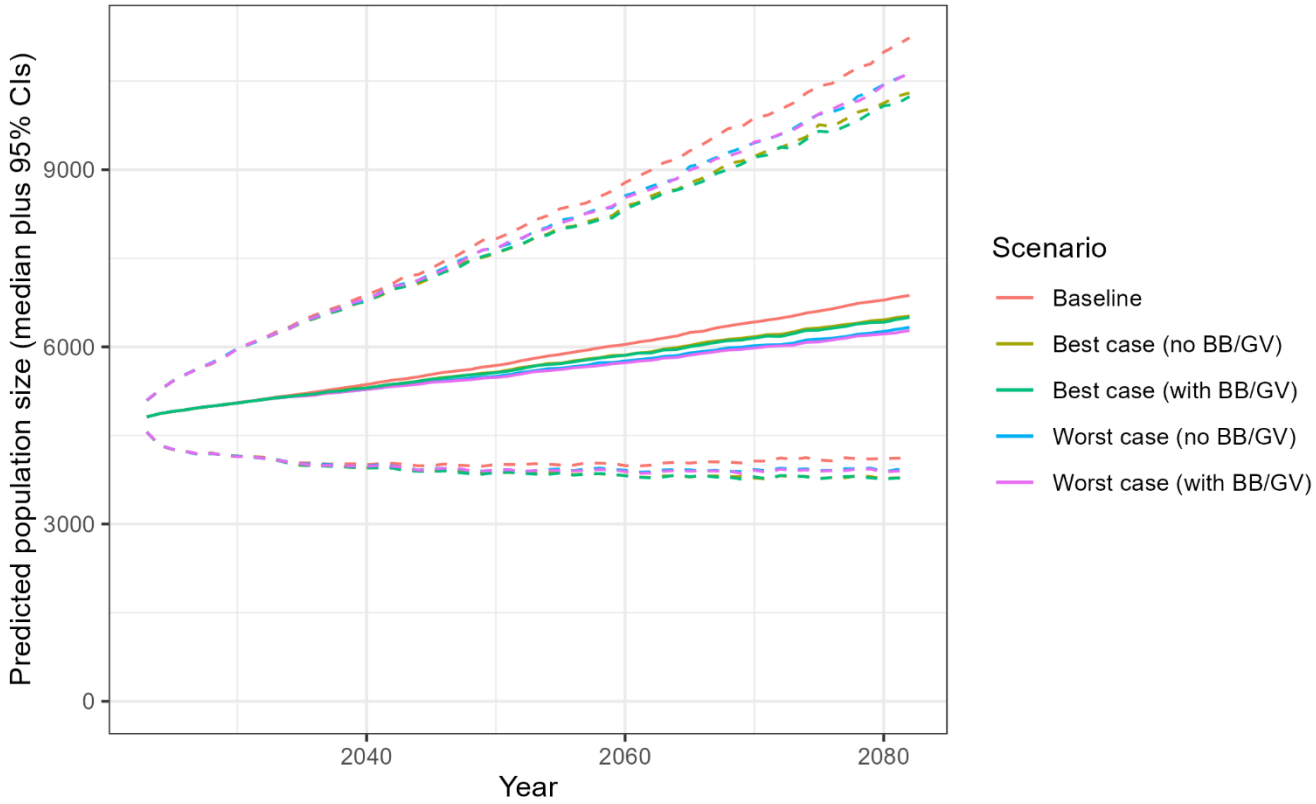

Figure F.32: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for gannet at the Fair Isle SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

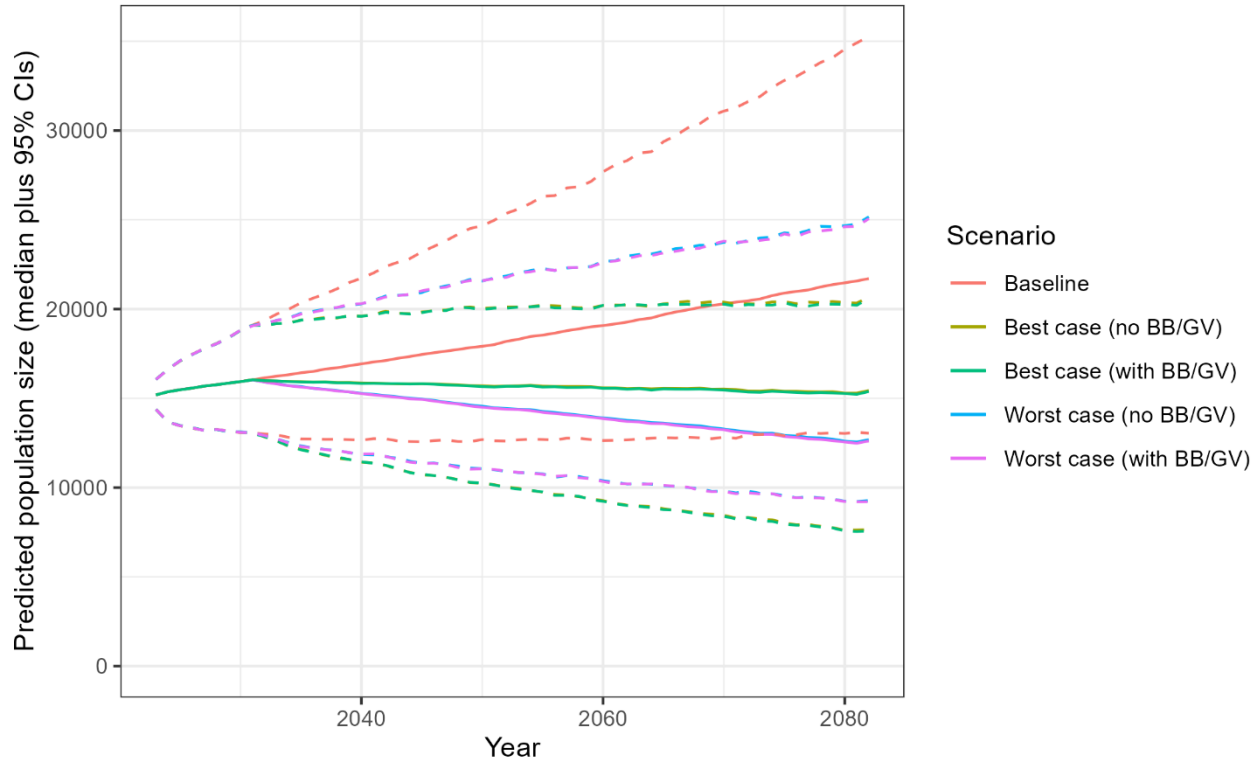

Figure F5.33: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for gannet at the Flamborough Head and Filey Coast SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

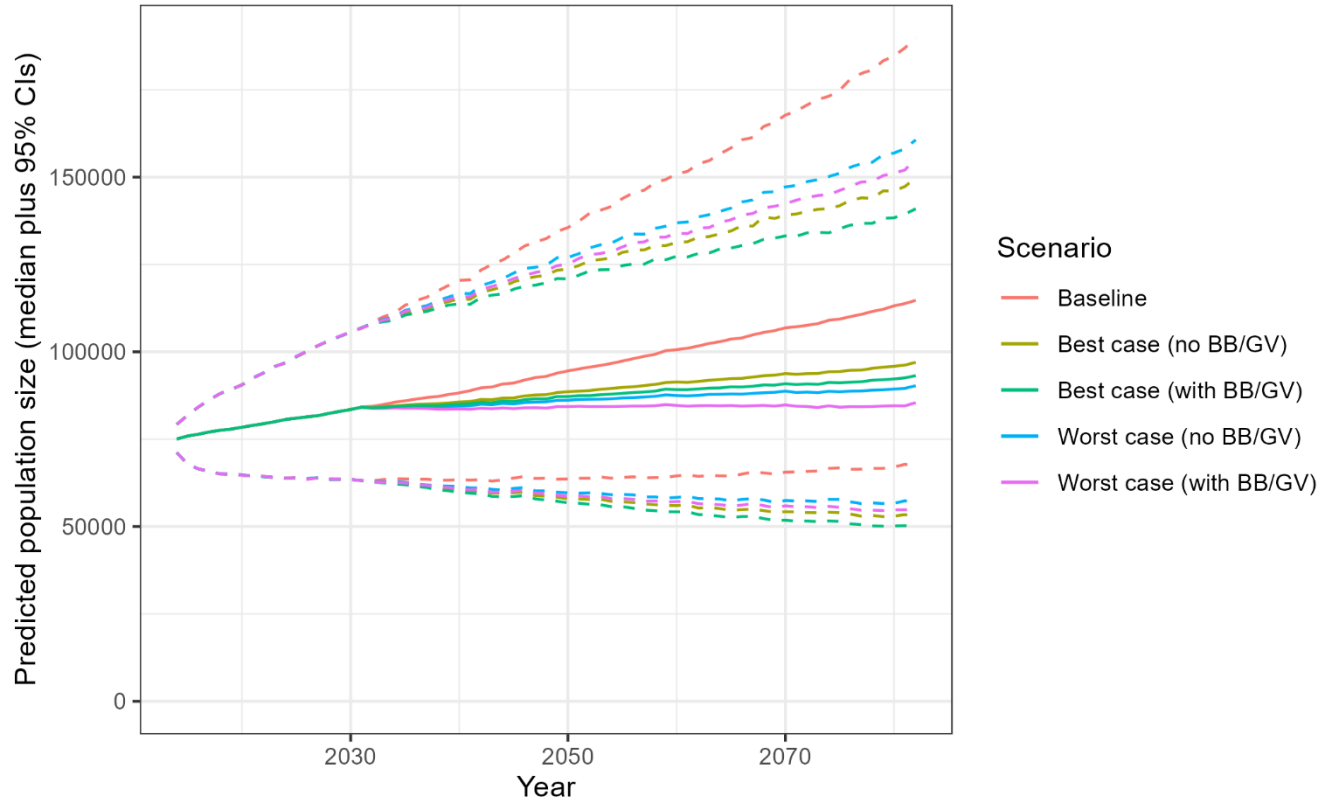

Figure F5.34: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for gannet at the Forth Islands SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

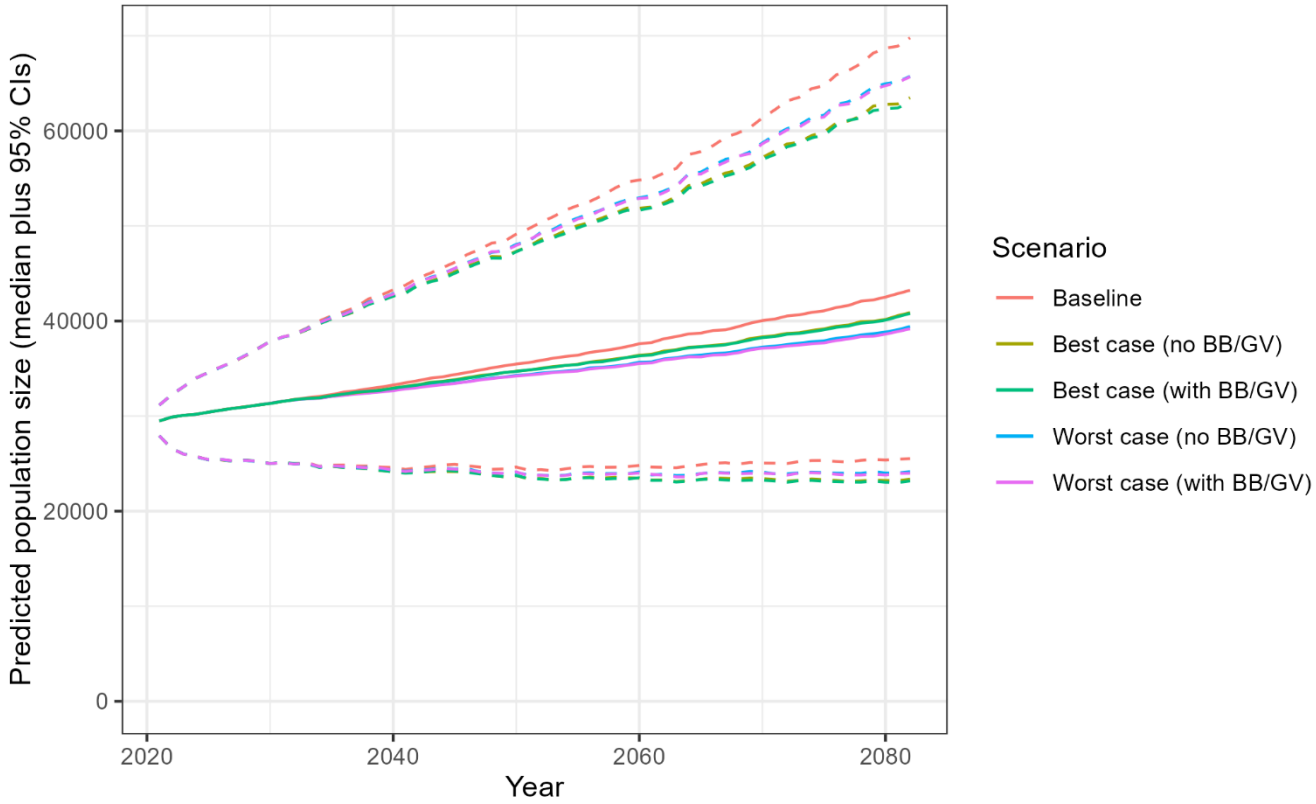

Figure F5.35: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for gannet at the Hermaness, Saxa Vord and Valla Field SPA (cumulative scenarios). Population sizes represent breeding pairs

Source: Recreated from outputs from the NEPVA tool

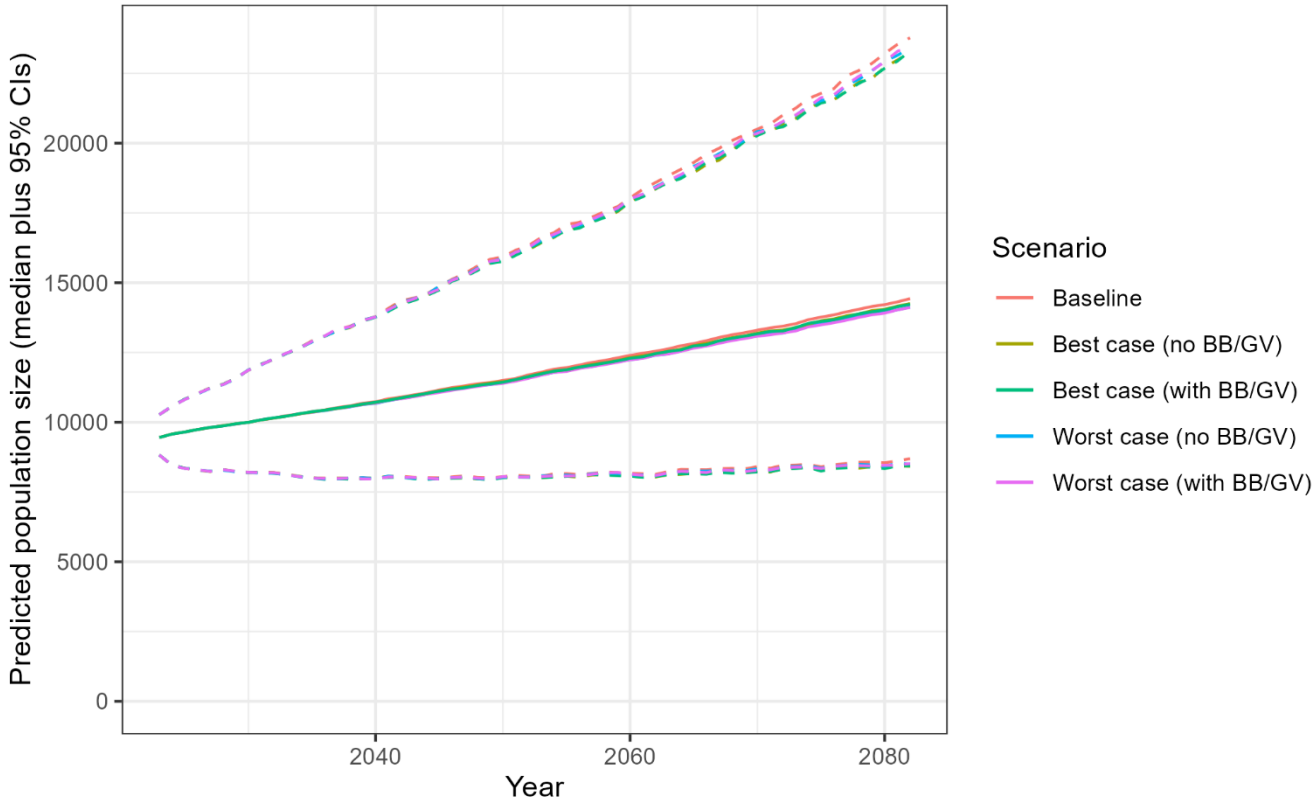

Figure F5.36: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for gannet at the North Rona and Sula Sgeir SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

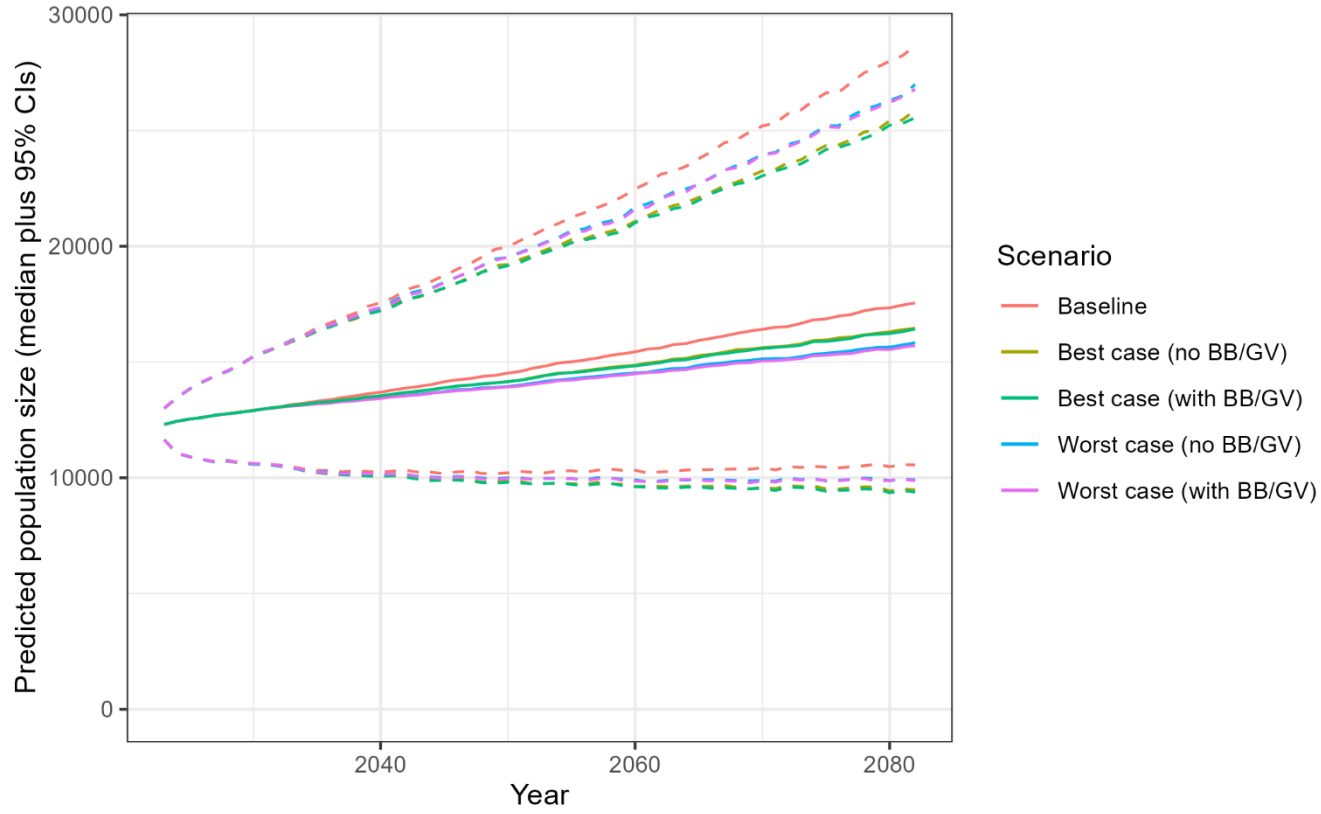

Figure F5.37: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for gannet at the Noss SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

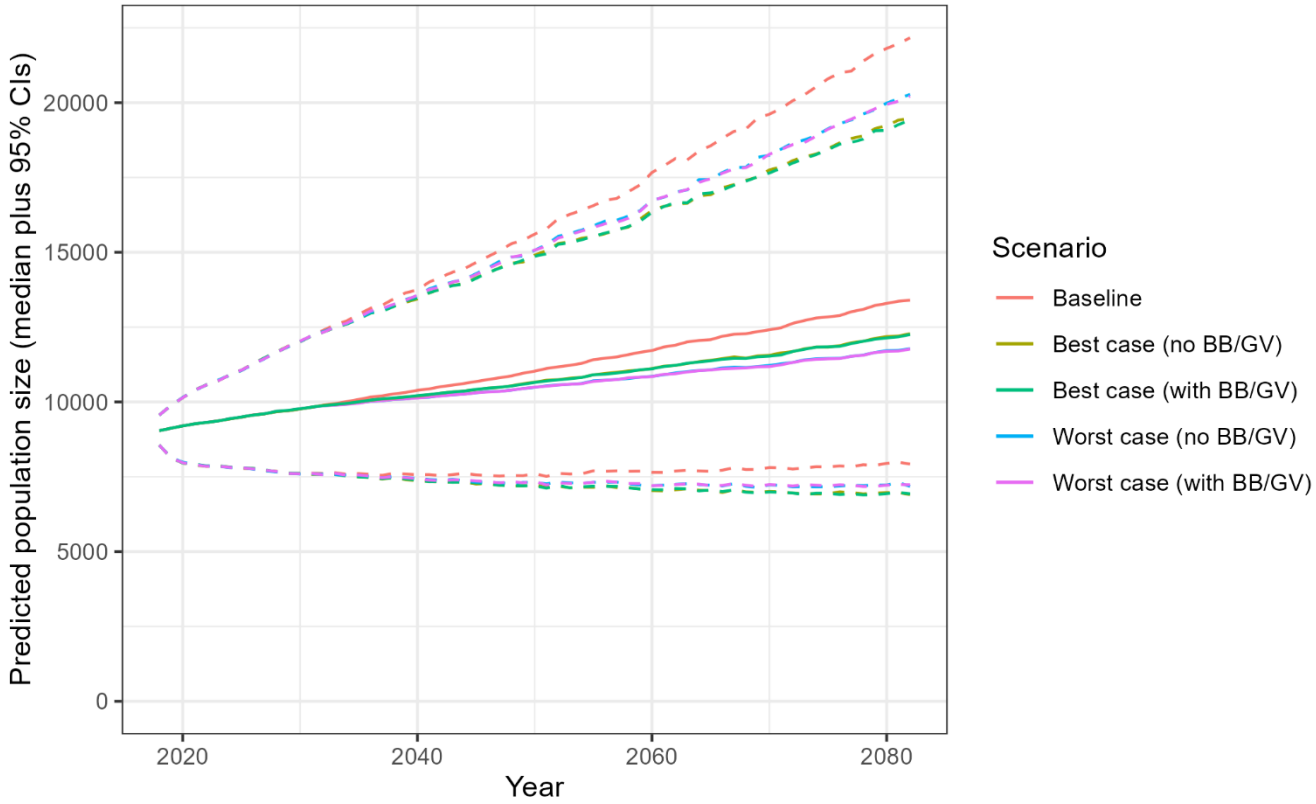

Figure F5.38: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for gannet at the Sule Skerry and Sule Stacks SPA (cumulative scenarios). Population sizes represent breeding pairs.

Source: Recreated from outputs from the NEPVA tool

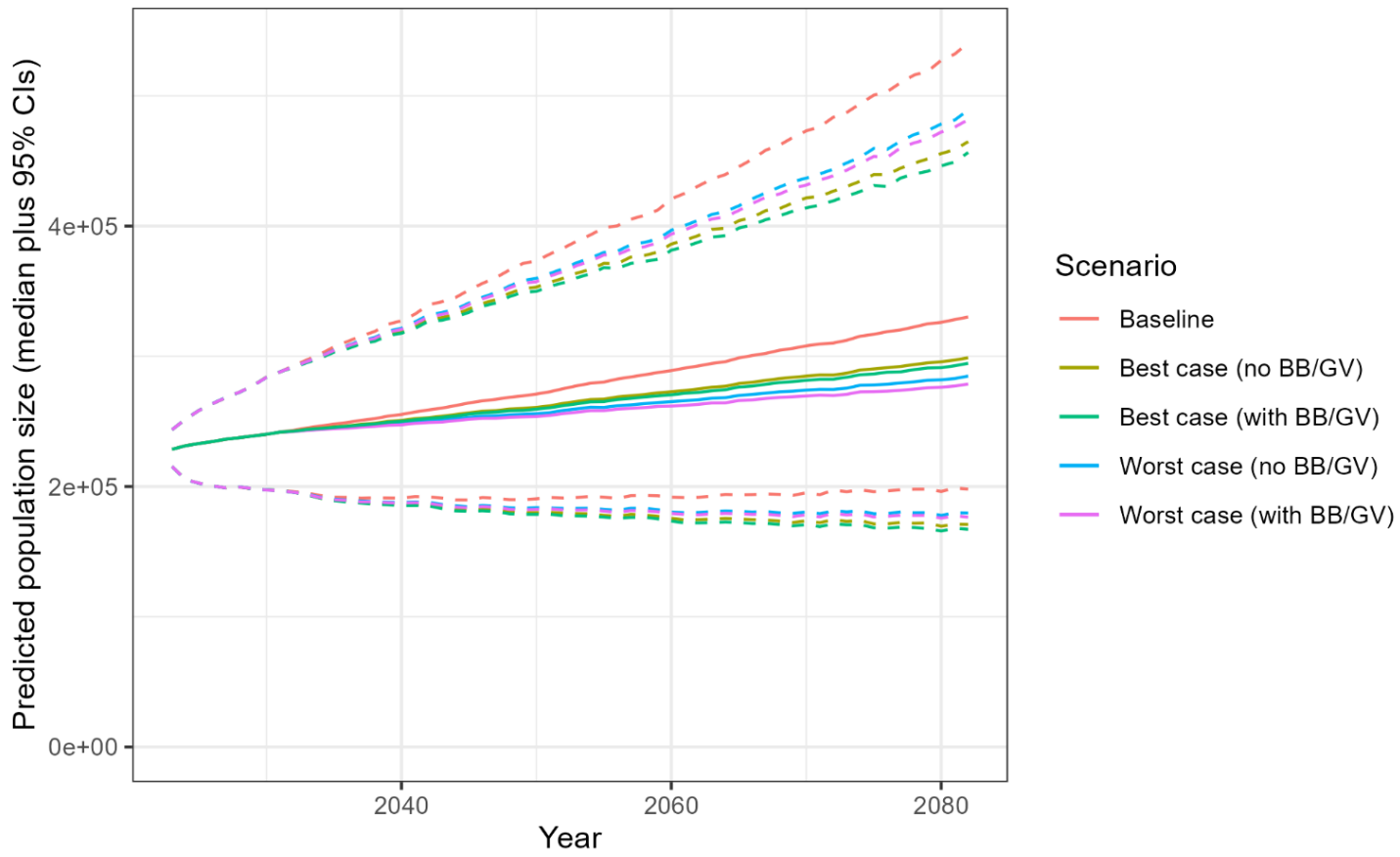

Figure F 39: Median predicted population trajectories (solid line) and 95% confidence intervals (dashed lines) for the regional gannet population (cumulative scenarios). Population sizes represent breeding pairs

G. Impacts attributed to adult birds

Annex G is available as a separate spreadsheet which summarises for each population, the impacts apportioned to breeding adults, once immatures and sabbaticals are removed.

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