MONA OFFSHORE WIND PROJECT

Environmental Statement

Volume 6, Annex 5.6: Offshore ornithology population viability analysis technical report

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Image of an offshore wind farm

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Glossary

Term	Meaning
Breeding Adults	Adults at breeding age proportion of a population.
Counterfactual of Growth Rate	The ratio of impacted to unimpacted annual growth rate.
Counterfactual of Population Size	The ratio of impacted to unimpacted population size.
Cumulative Effects	The combined effect of the Mona Offshore Wind Project in combination with the effects from a number of different projects, on the same single receptor/resource. Cumulative impacts are those that result from changes caused by other past, present or reasonably foreseeable actions together with the Mona Offshore Wind Project
Demographic Parameter	A factor that determines the population size.
Population Viability Analysis	The process of determining the probability that a population will persist over a specified time period.
Productivity	The annual population estimate of number of chicks fledged per pair.
Shiny App	User-friendly graphical user interface accessible via a standard web-browser that uses underlying R code.
Stochasticity	The lack of any predictable order or plan.
Survival Rate	The probability of an individual to survive from one breeding season to the next.

Acronyms

Term	Meaning
BDMPS	Biologically Defined Minimum Population Scale
CEA	Cumulative Effects Assessment
CGR	Counterfactual of Growth Rate
CPS	Counterfactual of Population Size
EIA	Environmental Impact Assessment
PVA	Population Viability Analysis
SD	Standard Deviation
SPA	Special Protection Area

Units

Unit	Description
%	Percentage

1 Offshore ornithology population viability analysis technical report

1.1 Introduction

1.1.1 Background

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

1.1.1.2 One method to estimate the effect that offshore wind projects alone or cumulatively may have on a population is through Population Viability Analysis (PVA). PVA provides a robust framework using demographic parameters to predict changes in the population, using statistical population models to forecast future changes over a set period. Comparisons are made between 'baseline' conditions whereby conditions remain unimpacted and under 'impacted' conditions where an impact is applied to a population by the alteration of demographic parameters. Population metrics that are derived from comparisons of 'baseline' and 'impacted' predictions generated by PVAs can then be used to assess the significance of the anticipated additional mortality associated with planned developments.

1.1.1.3 As part of the Mona Offshore Wind Project alone and cumulative assessments (as detailed in Volume 2, Chapter 5; Offshore ornithology of the Environmental Statement (Document Reference F2.5)), the species taken forward to PVA were:

- Common guillemot *Uria aalge*
- Great black-backed gull *Larus marinus.*

1.1.1.4 PVA was carried out as part of the Mona Offshore Wind Project alone assessment due to Volume 6, Annex 5.5: Offshore ornithology a~~A~~pportioning technical report of the Environmental Statement (Document Reference F6.5.5) indicating that baseline mortality from the operations and maintenance of the Mona Offshore Wind Project would exceed a 1% baseline mortality threshold for common guillemot populations at two Sites of Special Scientific Interest (SSSIs); Pen-y-Gogarth/Great Ormes Head SSSI and Creigiau Rhiwledyn/Little Ormes Head SSSI. All other sites and species evaluated in Volume 6, Annex 5.5: Offshore ornithology ~~A~~apportioning technical report of the Environmental Statement (Document Reference F6.5.5) were below this 1% threshold. Generally, based on findings from population viability analyses for bird species, it would be considered that increases in mortality rates of less than 1% would be undetectable in terms of changes in population size, whereas increases above 1% may produce detectable effects (Natural England, 2022) and hence require further assessment.

1.1.1.5 Additionally, ~~beyond the stand-alone PVA assessment for common guillemot at Pen-y-Gogarth/Great Ormes Head SSSI and Creigiau Rhiwledyn/Little Ormes Head SSSI, additional~~ cumulative PVA assessments for both common guillemot~~s~~ and great black-backed gulls was were conducted. This was necessitated by the anticipated annual cumulative impacts resulting in an increase in baseline mortality, as identified in the Cumulative Effects Assessment (CEA), exceeding the 1% threshold of baseline mortality of each of these species' Biologically Defined Minimum Population Scales (BDMPS) when considering annual impacts. In addition, a cumulative PVA assessment was carried out for gGreat -black-backed gull in the non-breeding season due to impacts also exceeding the 1% threshold. No other PVA assessments in other seasons were required for common guillemot and great-black backed gull due to not exceeding the 1% threshold.

1.1.1.6 The CEA for all other species in all seasons was below 1% and hence no further assessment was required. The CEA PVA assessment aimed to evaluate the cumulative impacts resulting from the Mona Offshore Wind Project, in conjunction with surrounding offshore wind farms within the context of each species'' (common guillemot and great black-backed gull) BDMPS region. Only offshore wind farms with publicly available impact assessment data were included in the assessment.

1.1.2 Aim of report

1.1.2.1 This technical report presents the PVA process conducted for the Mona Offshore Wind Project along and with wind farms in the same BDMPS region.

1.2 Consultation

1.2.1.1 A summary of the key issues raised during consultation activities undertaken to date specific to offshore ornithology is presented in Table 1.1 below, together with how these issues have been considered in the production of this technical report as part of the Environmental Statement.

1.2.1.2 A number of comments were received during the S42 consultation following submission of the PEIR chapter. All the responses provided, and changes suggested by the stakeholders are presented in the consultation report (Document reference E.3) together with changes implemented in the technical reports underpinning the Environmental Statement.

1.2.1.3 A summary of the key responses with changes implemented in the technical report of the Environmental Statement are presented in Table 1.1.

Table 1.1: Summary of key topics and issues raised during consultation activities undertaken for the Mona Offshore Wind Project relevant to offshore ornithology population viability analysis technical report of the Environmental Statement.

Date	Consultee and type of response	Topics and issues raised	Response to issue raised and/or where considered in this report
June 2023	**S42 Consultation** Natural Resources Wales	Whilst Special Protection Areas (SPAs)/Ramsars are assessed within the Habitats Regulation Assessment (HRA) related reports, where there is potential connectivity (for example, within foraging range etc.) and potential impact pathway of seabird features of SSSIs that are not already assessed in the HRA reports as they are also features of SPAs/Ramsars, these SSSIs and features need to be assessed within the Environmental Statement. For example, the Pen y Gogarth/Great Orme's Head SSSI is designated for breeding kittiwake, guillemot and razorbill and the Mona project is located within foraging range of all three of these species. Hence quantitative assessments of displacement for guillemot and razorbill and collision for kittiwake should be undertaken for this site.	Predicted mortalities from collisions and displacement of the Mona Offshore Wind Project to seabird colonies designated as SSSIs, including the Pen y Gogarth/Great Orme's Head SSSI have been presented in Volume 6, Annex 5.5: Offshore ornithology apportioning technical report of the Environmental Statement (Document Reference F6.5.5). Furthermore, Population Viability Analysis (PVA) has been undertaken for common guillemot at the Pen y Gogarth/Great Orme's Head SSSI and presented in section 1.5. This was undertaken as only the guillemot colony impacts went above 1% with the other species well below the 1% threshold and therefore it was not deemed necessary to carry out further investigation of these species and sites.
		Population Viability Analyses (PVAs) have been undertaken where predicted cumulative impacts equate to more than 1% of baseline mortality of the relevant populations, and that these have been undertaken using the Natural England (NE)/Joint Nature Conservation Committee (JNCC) PVA tool. Based on the current figures this has been undertaken for annual cumulative (EIA scale) displacement impacts for guillemot and operational collision impacts for great black-backed gull. Given the lack of evidence for how density dependence acts on the populations for which PVAs have been undertaken, Natural Resources Wales (NRW) (A) agree that these have been run as density independent models.	PVA has been undertaken where predicted cumulative impacts equate to more than 1% of baseline mortality of the relevant populations. The results are presented in section 1.5.
		NRW (A) welcome that the models have been run for 5,000 simulations and that the tool input parameter log files have been included. However, all results of the PVA, including graphs of Counterfactual of Population Size (CPS) and Counterfactual of Growth Rate (CGR) and population size under baseline and impacted conditions should also be presented.	Counterfactual Population Size (CPS), Counterfactual of Growth Rate (CGR) and population size under baseline and impacted condition are presented as well as graphs and output logs.

Date	Consultee and type of response	Topics and issues raised	Response to issue raised and/or where considered in this report
		NRW (A) note that the PVAs have been run excluding a 'burn in' and it has been assumed that any impacts on populations commenced the year following latest population counts, which for all models appears to be 2023. NRW (A) advise that the PVAs are parameterised using a 5-year burn-in period, with the impacts set to commence when the project is anticipated to start operating and to run for the lifetime of the project, and with the starting population being the latest count for the site in question. NRW (A) therefore advise that the models are updated to account for this.	PVAs have been parameterized with a 5-year burn-in period to include age structure from burn-in run period.
		Volume 6, Annex 5.6: Offshore ornithology population viability analysis technical report of the Environmental Statement. We welcome that that the models have been run for 5,000 simulations and that the tool input parameter log files have been included. We recommend providing all results of the PVA, including CPS and CGR and graphs of population size under baseline and impacted conditions.	Counterfactual Population Size (CPS), Counterfactual of Growth Rate (CGR) and population size under baseline and impacted condition are presented as well as the graphic outputs.
		Given the comments made regarding calculation of the breeding Biologically Defined Minimum Population Scale (BDMPS) population (Furness, 2015), apportioning impacts to adults, immatures, and sabbaticals, lack of calculation of annual impacts, and multiple unknown quantitative in-combination impacts from other projects, we cannot agree that a PVA is required for solely common guillemot and great black-backed gull.	Rationale for taking forward species to PVA is presented in this technical report and is based on the assessment presented in the Environmental Statement chapter which accounts for S42 response.
June 2023	**S42 Consultation** Natural England	Natural England advise following our Phase III Best practice guidance which states: 'PVAs should estimate the impacted and unimpacted populations over the lifetime of the project and include a 'burn-in' period (5 years) to allow the model to reach stability prior the projection period beginning'	PVAs have been parameterized with a 5-year burn-in period to include age structure from burn-in run period.
June 2023	**S42 Consultation** IOM Gov Detailed response	The Territorial Sea Committee (TSC) believe that this follows accepted practice with respect to great black-backed gull. There are known problems defining the regional population here but it makes a comparison with both west coast regional populations,	Latest regional productivity rates from the Seabird Monitoring Programme (SMP) database (JNCC, 2023) have been included in section 1.3. It is difficult to apportion to individual colonies during the breeding season in the

Date	Consultee and type of response	Topics and issues raised	Response to issue raised and/or where considered in this report
		as it lies between the two. Of concern here is that the result of the methodology is that there is a slight reduction in the positive growth of the (smaller) southwest population, but the Isle of Man data shows, not a positive growth, but a very severe decline in the breeding population (breeding population reduction 78.5% in 15 years and reduction 70.6% in 30 years) which begs a question as to whether the accepted regional population comparisons provide appropriate data as background, when there are clearly very different effects occurring in areas within that population, and much of it lies far from the study site, whereas the Isle of Man is close. At the expert working group, it was noted that Horswill and Robinson (2015) had been referenced and we ask whether the latest JNCC-held SMP data can be used, which the applicant has stated they will look at (the guidance apparently just recommends a 'custom approach'). Assurances are sought that the Manx population of great black-backed gulls will not be affected significantly, noting the threat that this population is already under, on the Isle of Man.	Cumulative Effects Assessment (CEA) and hence why the BDMPS population (Furness, 2015) was used. Within the Mona Offshore Wind Project alone assessment during the breeding season, great black-backed gull colonies have been considered (including Manx colonies). No Manx colonies went above the 1% threshold.

1.3 Methodology

1.3.1.1 PVA was undertaken using the Seabird PVA Tool developed by Natural England (Searle *et al*. 2019). The Seabird PVA Tool was accessed via the 'Shiny App' interface, which is a user-friendly graphical user interface accessible via a standard web-browser that uses the nepva R package to perform the modelling and analysis. The tool constructs a stochastic Leslie matrix and can assess any type of impact in terms of change to demographic parameters, or as a cull or harvest of a fixed size per year (Searle *et al*. 2019).

1.3.2 Modelling approach

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

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

1.3.2.3 Environmental stochasticity, which accounts for the variation arising from environmental changes affecting individuals in the same group (e.g. between-year differences in weather conditions), was incorporated in the models at the level of productivity and survival rates. For each simulated year, a value for each demographic rate was randomly generated from a probability distribution defined by the mean and standard deviation (SD) estimates of that rate for the population under consideration.

1.3.2.4 Demographic stochasticity, which accounts for individual-level variation affecting transition probabilities between age-classes, was included in the models. For large populations, like the ones considered in this analysis, the effects of environmental stochasticity are deemed more important than those associated with demographic stochasticity (Morris and Doak, 2002). However, including demographic stochasticity will not cause any issues when simulating larger populations (WWT Consulting, 2012) and hence has been included.

1.3.2.5 PVA outputs can either be expressed as the Counterfactual of Population Size (CPS) or the Counterfactual of Growth Rate (CGR) depending on if density dependence is included within the model. As models within this report have been run using density independence, the CGR is considered more robust and informative, while if the PVA is density dependent then the CPS is more robust and informative. Both CPS and CGR are presented in section 1.5.

1.3.3 Simulation parameterisation

1.3.3.1 All PVA modelling in this technical report was undertaken with environmental and demographic stochasticity. To ensure robust results, all simulations were set to run 5,000 times. All models were run for a 35 year time span (the lifetime of the Mona Offshore Wind Project).

1.3.3.2 Modelling has also been undertaken including a five year 'burn in' period within the model. Applying a 'burn in' period allows for a stable age structure to form when starting to run the model. Within the model, impacts were set to commence the year the project was anticipated to start operating (2030) and run for the lifetime of the project (35 years).

1.3.3.3 Although impacts are only reported with respect to the adult numbers, impacts within the simulations were also applied proportionally to immature age-classes (based upon the stable age distribution from eigen-decomposition of the Leslie matrix; Searle *et al.,* 2019).

1.3.3.4 Impacted vs unimpacted comparisons were based on a matched runs approach, whereby stochasticity is applied to the population before impacts are applied (i.e. survival and productivity rates simulated at each time step are the same for the unimpacted and impacted populations, before additional impact mortalities are deducted from simulated survivals for the impacted populations). This approach is used as previous analyses demonstrated that stochastic models using a matched runs approach were likely the most precautionary (Cook and Robinson 2017). Productivity rates were assumed to be unaffected by wind farm effects.

1.3.4 Model parameterisation

Demographic rates

1.3.4.1 The survival rates for common guillemot and great black-backed gull were derived from the national values presented in Horswill and Robinson (2015), with updated productivity values taken from the ~~Joint Nature Conservation Committee (~~JNCC~~)~~ and the British Trust for Ornithology (BTO) (2023).

1.3.4.2 Due to the limited amount of data, Horswill and Robinson (2015) recommended using the survival rates for juvenile and immature birds of other large gull species when conducting population modelling for great black-backed gull. Therefore, the survival rates for great black-backed gull used for the PVA are based on ~~adult and~~ juvenile rates for herring gull as presented in Horswill & Robinson (2015) and Table 1.2.

Table 1.2: Species demographic rates used in population viability analysis (Horswill & Robinson, 2015).

Species	Age first breeding	Final Age	Eggs/pair		Survival rates (per age class)							Productivity
					0-1	1-2	2-3	3-4	4-5	5-6	A	
Guillemot	6	6	1	Mean	0.560	0.792	0.917	0.939	0.939	0.939	0.939	0.583
				SD	0.013	0.034	0.022	0.015	0.015	0.015	0.015	0.079
Great black-backed gull	5	6	1	Mean	0.798	0.93~~834~~	0.93~~0.834~~	0.93~~0.834~~	0.93~~0.834~~	n/a	0.93~~0.834~~	1.061
				SD	0.092	0.0001~~34~~	0.0001~~0.034~~	0.0001~~0.034~~	0.0001~~0.034~~	n/a	0.0001~~0.034~~	0.132

Populations

~~Special Protection Areas~~Sites of Special Scientific Interest

1.3.4.3 Species count data was obtained from the most recent population count data available (JNCC, 2023) for the Pen-y-Gogarth/Great Orme SSSI and Creigiau Rhiwledyn/Little Ormes Head SSSI (Table 1.3).

Table 1.3: Common guillemot designated site populations.

Colony	Adult population	Baseline mortality
Pen-y-Gogarth/Great Orme SSSI	3,578	457.87
Creigiau Rhiwledyn/Little Ormes Head SSSI	1,298	172.63

Biologically Defined Population Scales

1.3.4.4 For the cumulative assessment, impacts are put into the context of the BDMPS for each species (Table 1.4). Population counts were taken from Furness (2015), however for the assessment population were considered to represent the year 2023.

Table 1.4: Biologically Defined Population Scales for use in the assessment (Furness, 2015).

Species	Region	Season	BDMPS	Baseline mortality
Common guillemot	UK Western waters	Annual	1,145,528	152,355
Great black-backed gull	UK Southwest & English Channel	Annual ~~Non-breeding~~	44,753	4,252
		~~Annual~~Non-breeding	17,742	1,685

1.4 Impact scenarios

1.4.1.1 The impact from the Mona Offshore Wind Project (alone and cumulatively with Tier 1 and Tier 2 offshore developments) has been parametrised as a 'relative harvest' (i.e. additional mortality as a result of the impact).

1.4.1.2 Note that for the purposes of the PVA model, specifying a relative harvest means the absolute number of birds that could suffer mortality as a result of the project is proportional to the population size. This is in line with the assessment approach for both collision risk and displacement analysis.

1.4.1.3 All impact scenarios and input parameters for each run and for each species are presented in Appendix A.

1.4.2 Project alone PVA assessment

Common guillemot

1.4.2.1 Impacts assigned to the Pen-y-Gogarth/Great Orme SSSI and Creigiau Rhiwledyn/Little Ormes Head SSSI (Table 1.5) were based on the proportional colony weights estimated in Volume 6, Annex 5.5 Offshore ornithology apportioning technical report of the Environmental Statement (Document Reference F6.5.5).

Table 1.5: Common guillemot relative harvest input for displacement (Project alone assessment).

Colony	Proportional weight	Adult mortalities	Increase in baseline mortality
Pen-y-Gogarth / Great Orme SSS	0.156	3.3 (2.0 to 45.9)	1.50% (0.93% to 21.05%)
Creigiau Rhiwledyn / Little Ormes Head SSSI	0.055	1.2 (0.7 to 16.3)	1.46% (0.91% to 20.57%)

1.4.3 Cumulative PVA assessment

Common guillemot

1.4.3.1 The displacement values used in the PVA assessment for common guillemot are based on the CEA presented in Volume 2, Chapter 5: Offshore ornithology of the Environmental Statement (Document Reference F2.5).

1.4.3.2 The displacement impacts assessed for the CEA followed a range-based approach, considering displacement values of 30 to 70% and a 1 to 10% mortality rate as advised via the Offshore Ornithology Expert Working Group, with meetings held in February 2022 and July 2022. The cumulative displacement values are presented in Table 1.6.

Table 1.6: Cumulative impacts, increase in baseline mortality and decrease in survival rate of ~~C~~common guillemot annually ~~increase in baseline mortality percentage~~ for nine impact scenarios~~a range of differing scenarios for the UK Western waters BDMPS~~.

Scenario	Cumulative predicted ~~adult~~ mortalities	Increase in baseline mortality	Decrease in survival rate
~~1.~~30% displacement, 1% mortality	280~~7~~	0.184~~22~~%	0.000244429
~~2.~~50% displacement, 1% mortality	466~~78~~	0.306~~35~~%	0.000406799
~~3.~~70% displacement, 1% mortality	653~~69~~	0.429~~7~~%	0.000570043
~~7.~~30% displacement, 5% mortality	1,399~~433~~	0.918~~8~~%	0.001221271

Scenario	Cumulative predicted ~~adult~~ mortalities	Increase in baseline mortality	Decrease in survival rate
~~8.~~ 50% displacement, 5% mortality	2,332~~89~~	1.531~~60~~%	0.002035742
~~9.~~ 70% displacement, 5% mortality	3,265~~344~~	2.143~~23~~%	0.002850214
~~10.~~ 30% displacement, 10% mortality	2,798~~867~~	1.837~~92~~%	0.002442542
~~11.~~ 50% displacement, 10% mortality	4,664~~778~~	3.061~~17~~%	0.004071485
~~12.~~ 70% displacement, 10% mortality	6,529~~689~~	4.286~~43~~%	0.005699555

Great black-backed gull

1.4.3.3 The collision risk values used in the PVA assessment for great black-backed gull are based on the annual cumulative total and non-breeding cumulative total, both of which are presented in Volume 2, Chapter 5: Offshore ornithology of the Environmental Statement (Document Reference F2.5).

1.4.3.4 The approach taken to assessing cumulative collision risk is a quantitative one, drawing upon the published information produced by the other projects considered in the cumulative effects assessment. The cumulative values using a range of avoidance rates (with newer applications using species-specific avoidance rates) are presented in Table 1.8.

1.4.3.5 Additionally, a cumulative assessment for great black-backed gull using JNCC (2023) species-specific avoidance rates was undertaken to convey a more realistic scenario (Table 1.8).

Table 1.7: Cumulative impacts, increase in baseline mortality and decrease in survival rate of ~~Annual~~ great black-backed gull annually for two impact scenarios. ~~PVA results using Natural England advised grouped avoidance rates (0.9939) and species -specific avoidance rates (0.9991~~)

Scenario	Cumulative predicted mortality	Increase in baseline mortality	Decrease in survival rate
~~UK South-west & English Channel BDMPS~~			
Species-group avoidance rate (0.9939)~~Annual~~	1~~04.60~~20.84	2.842~~46~~%	0.002700154
Species-specific avoidance rate (0.9991)~~Annual~~	17.83~~6.51~~	0.419~~39~~%	0.000398409

Table 1.8: Cumulative impact, increase in baseline mortality and decrease in survival rate of ~~Non-breeding~~ great black-backed gull during the non-breeding season for two impact scenarios. ~~PVA results using Natural England advised grouped avoidance rates (0.9939) and species -specific avoidance rates (0.9991)~~

Scenario	Cumulative predicted mortality	Increase in baseline mortality	Decrease in survival rate
UK South-west & English Channel BDMPS			
Species-group avoidance rate (0.9939)Non-breeding season	66.0072.72	4.3143.89%	0.004098749
Species-specific avoidance rate (0.9991)Non-breeding season	11.6710.73	0.67369%	0.00060478

1.5 PVA outputs

1.5.1 Mona Offshore Wind Project alone

Common guillemot

Pen-y-Gogarth/Great Orme SSSI

1.5.1.1 The results of the PVA runs for impacts from the Mona Offshore Wind Project alone to the common guillemot population at Pen-y-Gogarth/Great Orme SSSI at the start of operation (2030) and for the duration of the project (35 years) are presented in Table 1.9 below. The baseline ‘unimpacted’ scenario (i.e assuming no additional mortality other than baseline mortality exists) is also shown for comparison purposes. Graphs relating to population size, Counterfactual of Population Size (CPS) and Counterfactual of Growth Rate (GCR) for each impact scenario has also been presented (Figure 1.1 to Figure 1.3) at the request of NRW during statutory consultation.

Table 1.9: Growth rates of simulated populations under different impact scenarios for the duration of the Mona Offshore Wind Project (2030 to 2065) at Pen-y-Gogarth/Great Orme SSSI. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Year	Impact scenario	Simulated Population size	Percentage Median population change	Median Growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Median counterfactual of growth rate	Median counterfactual of population size
2030	baseline	4,081	+ 14.06%	1.020	0.976	1.061	-	-
2030	30% displacement, 1% mortality	4,079	+ 14.00%	1.020	0.976	1.060	0.999	0.999
2030	50% displacement, 1% mortality	4,077	+ 13.95%	1.020	0.976	1.061	0.999	0.999
2030	70% displacement, 10% mortality	4,025	+ 12.49%	1.007	0.962	1.048	0.986	0.987
2065	baseline	8,158	+ 128.00%	1.020	1.015	1.025	-	-
2065	30% displacement, 1% mortality	7,981	+ 123.04%	1.019	1.014	1.024	0.999	0.979
2065	50% displacement, 1% mortality	7,857	+ 119.59%	1.019	1.014	1.024	0.999	0.964
2065	70% displacement, 10% mortality	4,870	+ 36.10%	1.005	1.000	1.011	0.986	0.596

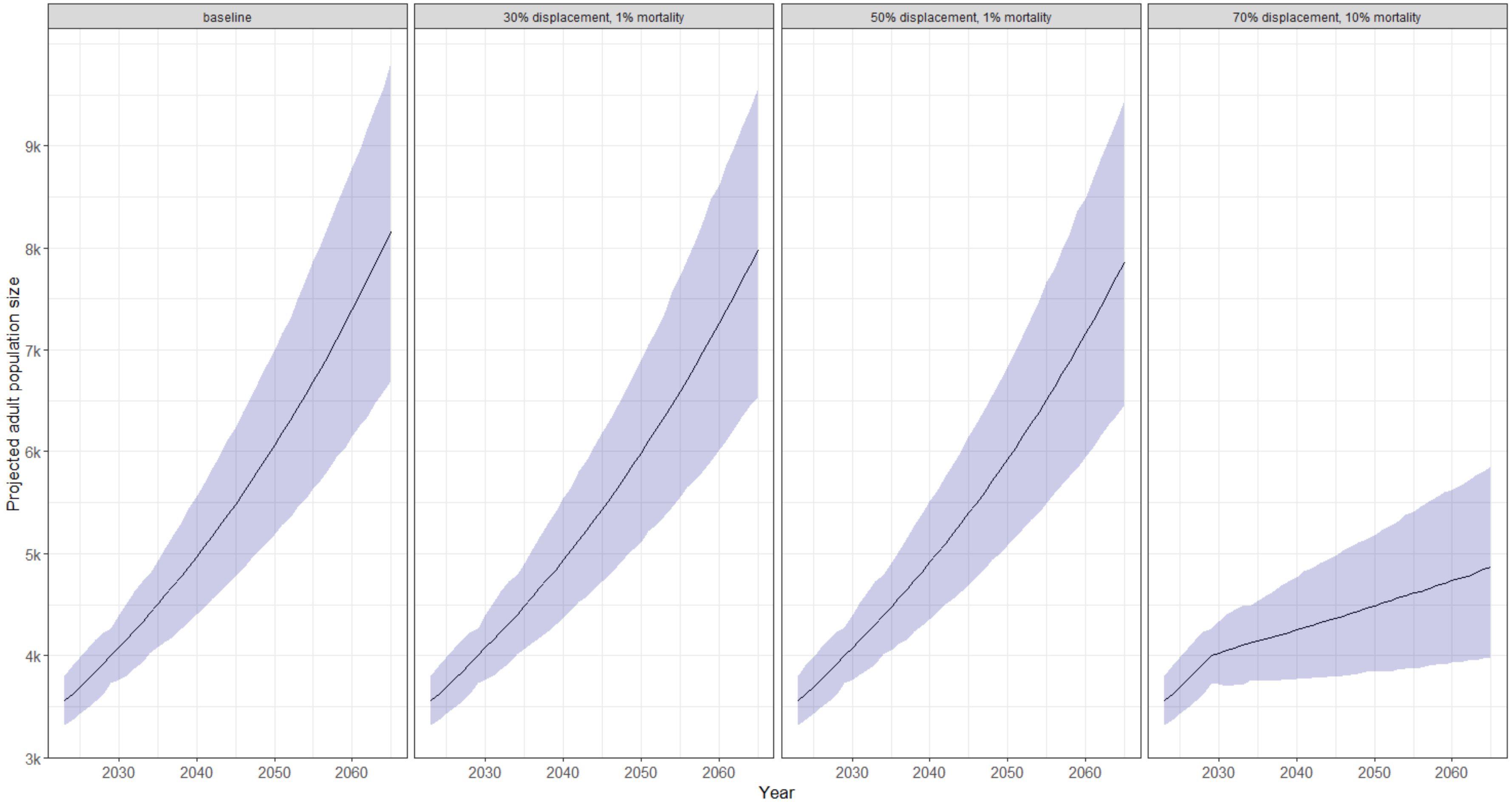


Figure 1.1: Projections of population sizes over a 35-year time-frame at Pen-y-Gogarth/Great Orme SSSI. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at baseline (i.e. unimpacted)).

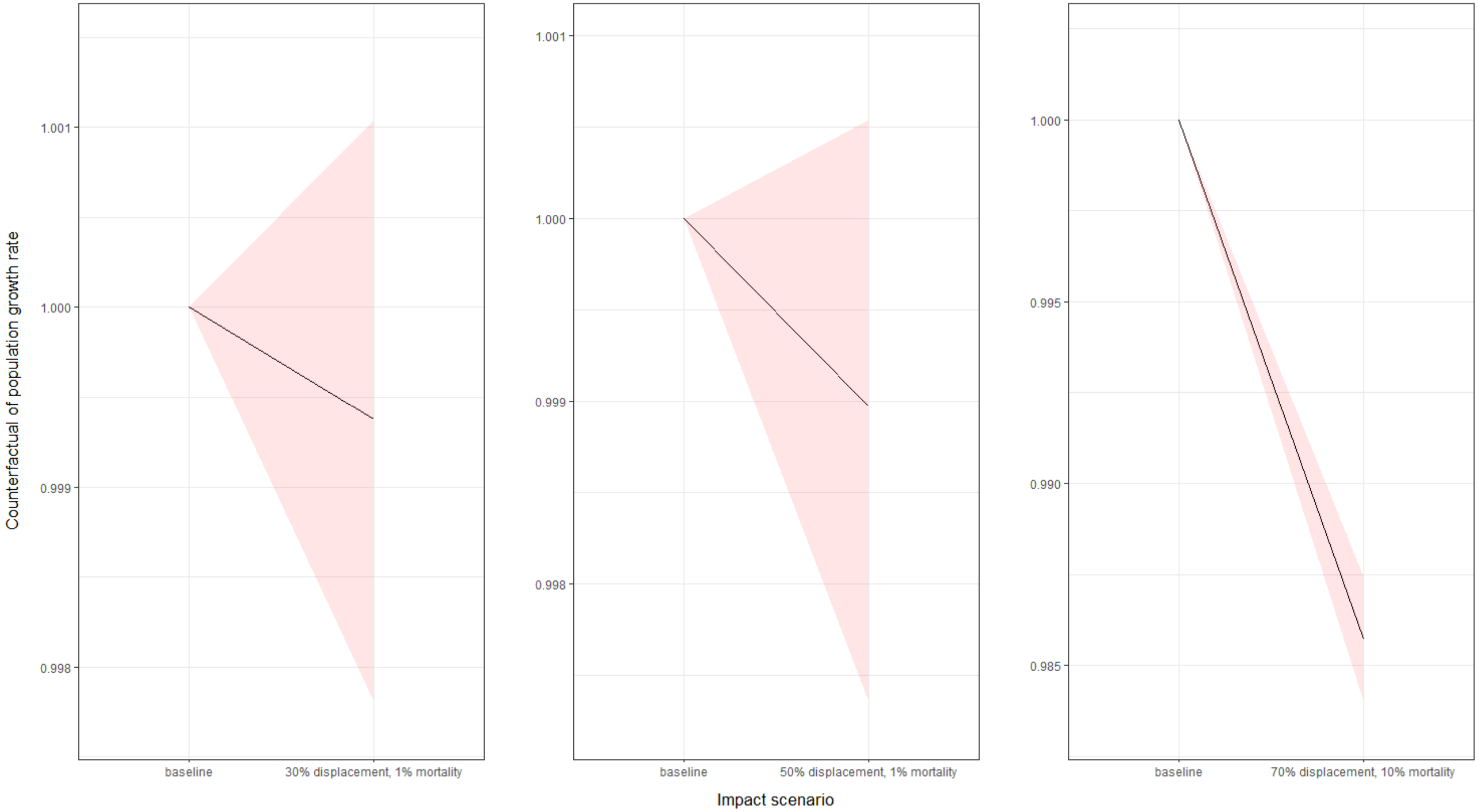


Figure 1.2: Ratio of impacted growth rates after 35 years at Pen-y-Gogarth/Great Orme SSSI under a range of impact scenarios

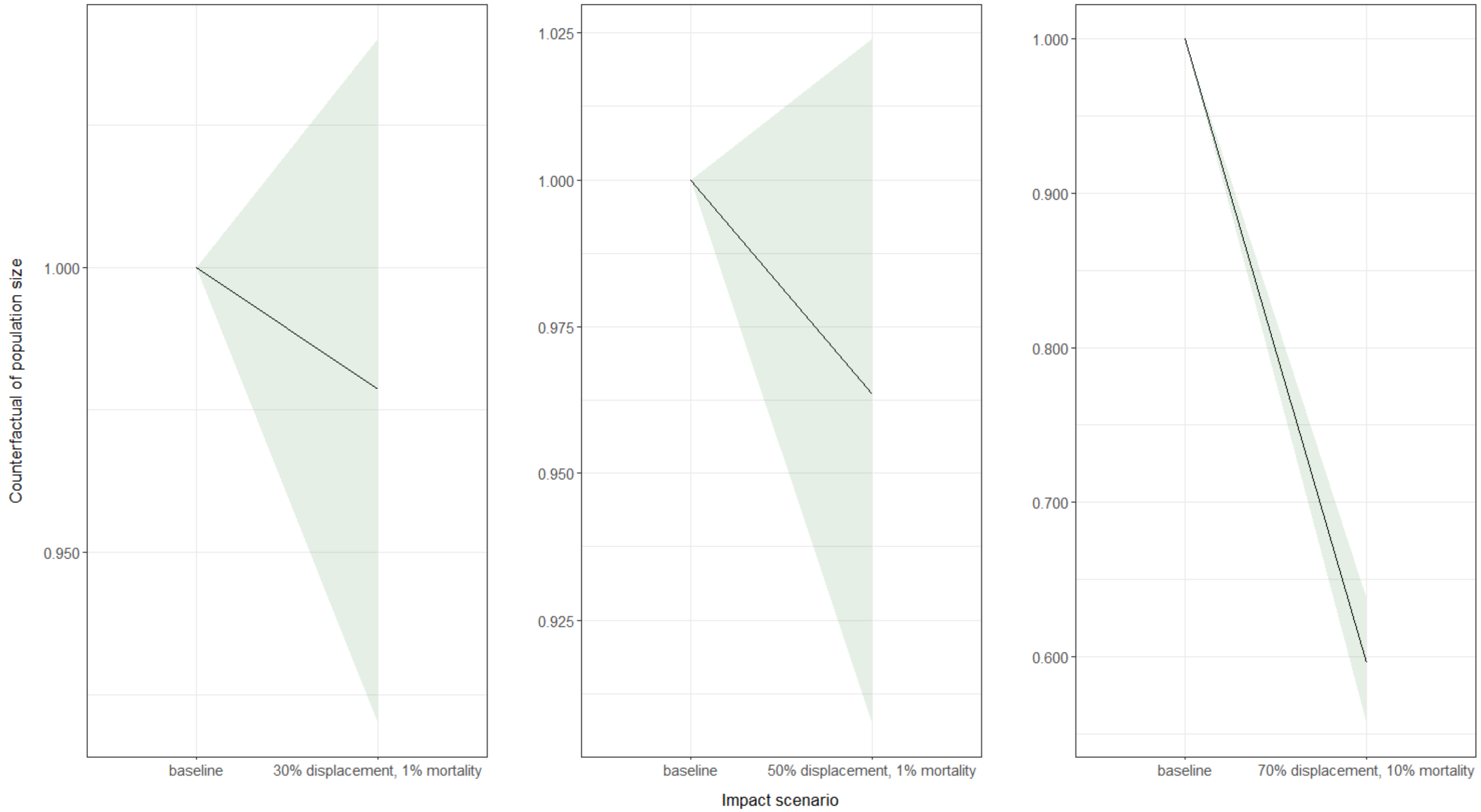


Figure 1.3: The ratio of the median impacted population sizes at Pen-y-Gogarth/Great Orme SSSI from the simulations after 35 years under a range of impact scenarios.

Creigiau Rhiwledyn/Little Ormes Head SSSI

1.5.1.2 The results of the PVA runs for impacts from the Mona Offshore Wind Project alone to the common guillemot population at Creigiau Rhiwledyn/Little Ormes Head SSSI at the start of operation (2030) and for the duration of the project (35 years) are presented in Table 1.10 below. The baseline ‘unimpacted’ scenario (i.e assuming no additional mortality other than baseline mortality exists) is also shown for comparison purposes. Graphs relating to population size, CPS and GCR for each impact scenario has also been presented (Figure 1.4 to Figure 1.6) at the request of Natural Resources Wales (NRW) during statutory consultation in June 2023.

Table 1.10: Growth rates of simulated populations under different impact scenarios for the duration of the Mona Offshore Wind Project (2030 to 2065) at Creigiau Rhiwledyn/Little Ormes Head SSSI. Reference points are 2.5%, 50% (median) and 97.5% of the distribution of simulated growth rates.

Year	Impact scenario	Simulated Population size	Percentage Median population change	Median Growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Median counterfactual of growth rate	Median counterfactual of population size
2030	baseline	1,480	+14.02%	1.020	0.975	1.064	-	-
2030	30% displacement, 1% mortality	1,480	+14.02%	1.020	0.973	1.063	0.999	0.999
2030	50% displacement, 1% mortality	1,479	+13.94%	1.020	0.972	1.063	0.999	0.999
2030	70% displacement, 10% mortality	1,461	+12.56%	1.007	0.961	1.051	0.987	0.987
2065	baseline	2,957	+127.81%	1.020	1.015	1.025	-	-
2065	30% displacement, 1% mortality	2,898	+123.27%	1.019	1.014	1.025	0.999	0.979
2065	50% displacement, 1% mortality	2,849	+119.49%	1.019	1.013	1.024	0.999	0.963
2065	70% displacement, 10% mortality	1,780	+37.13%	1.006	1.000	1.011	0.986	0.602

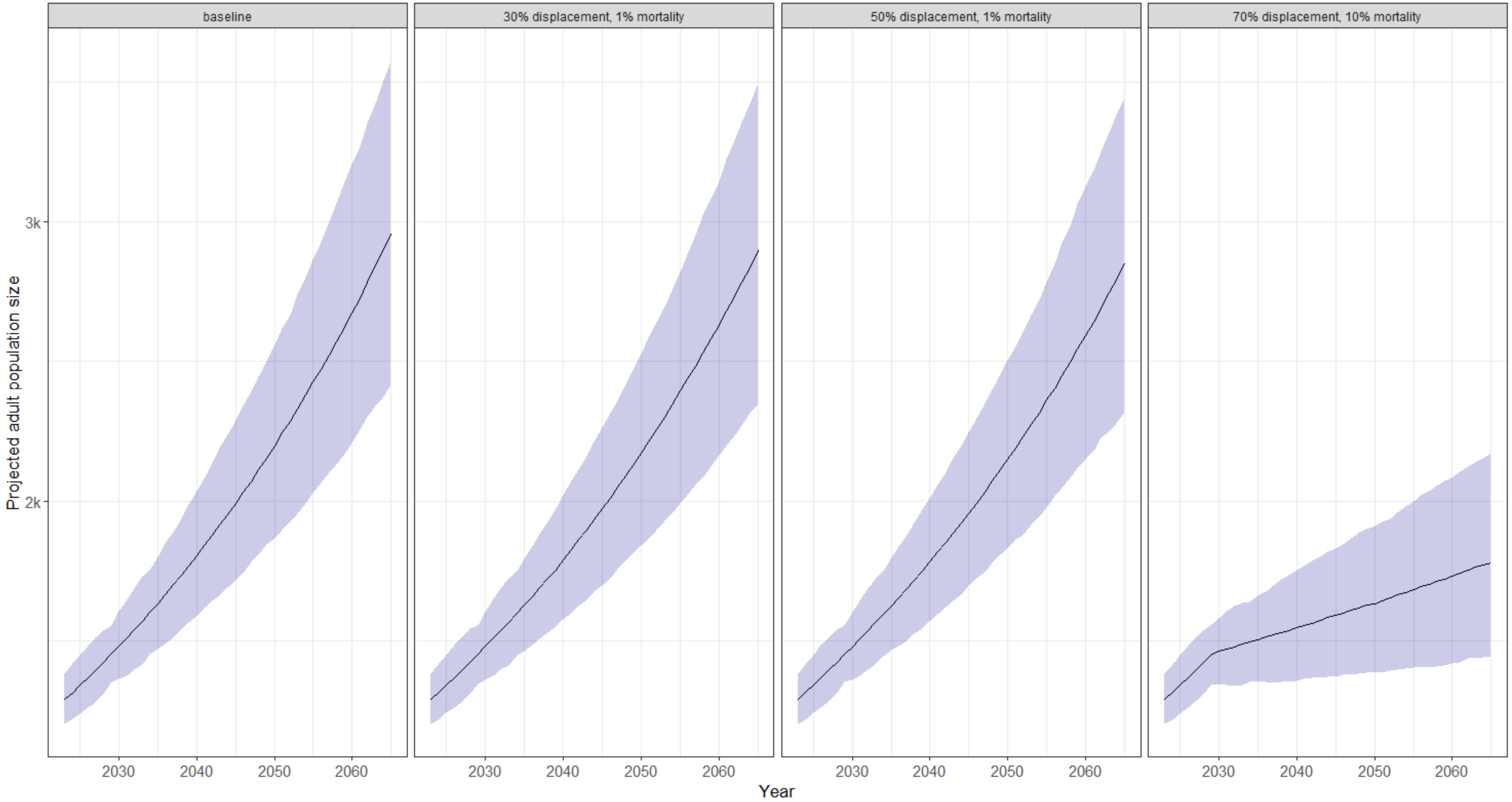


Figure 1.4: Projections of population sizes over a 35-year time-frame at Creigiau Rhiwledyn/Little Ormes Head SSSI. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at baseline (i.e. unimpacted)).

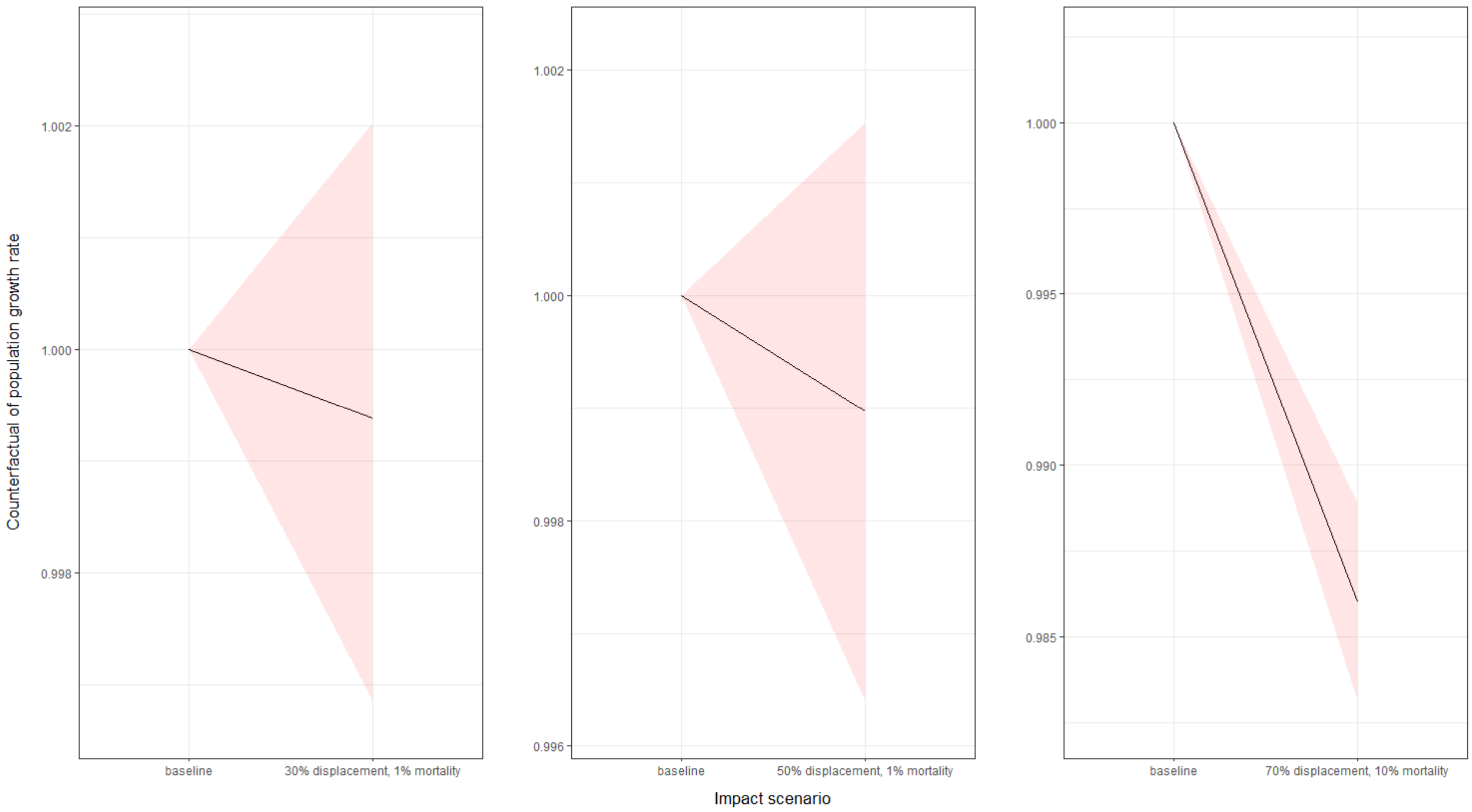


Figure 1.5: Ratio of impacted growth rates after 35 years at Creigiau Rhiwledyn/Little Ormes Head SSSI under a range of impact scenarios

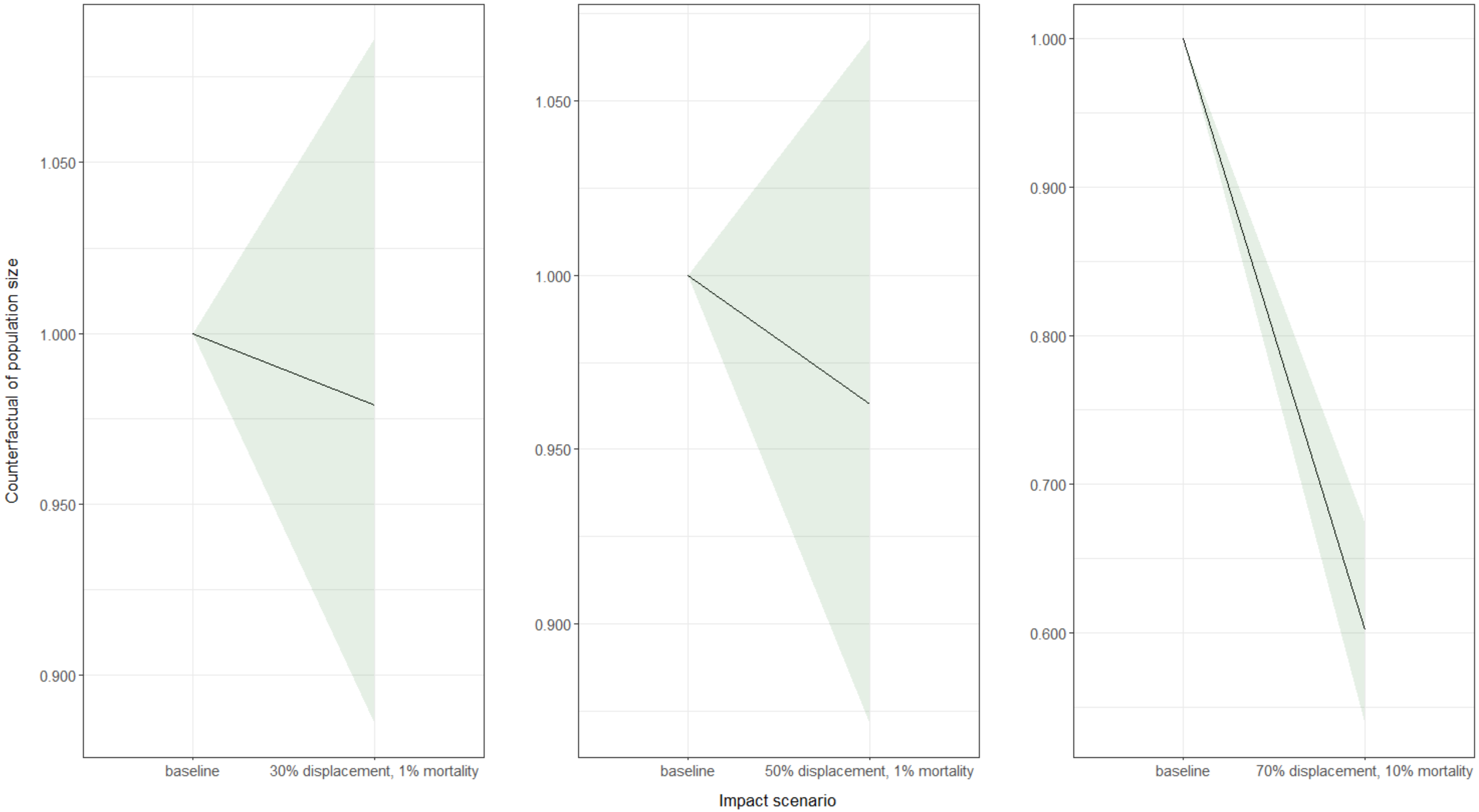


Figure 1.6: The ratio of the median impacted population sizes at Creigiau Rhiwledyn/Little Ormes Head SSSI from the simulations after 35 years under a range of impact scenarios.

1.5.2 Cumulative

1.5.2.1 For common guillemot, a range of displacement and mortality rates have been modelled due to uncertainty surrounding the true level of impact. A total of nine different impact scenarios were modelled (Table 1.6) against the annual common guillemot population within the UK Western Waters region.

1.5.2.2 For great black-backed gull, a total of four separate scenarios were modelled due to using both Natural England grouped avoidance rates and JNCC species- specific avoidance rates within the CRM. Impacts were assessed against the annual great black-backed gull population and the non-breeding population within the UK South West and English Channel region.

Common guillemot

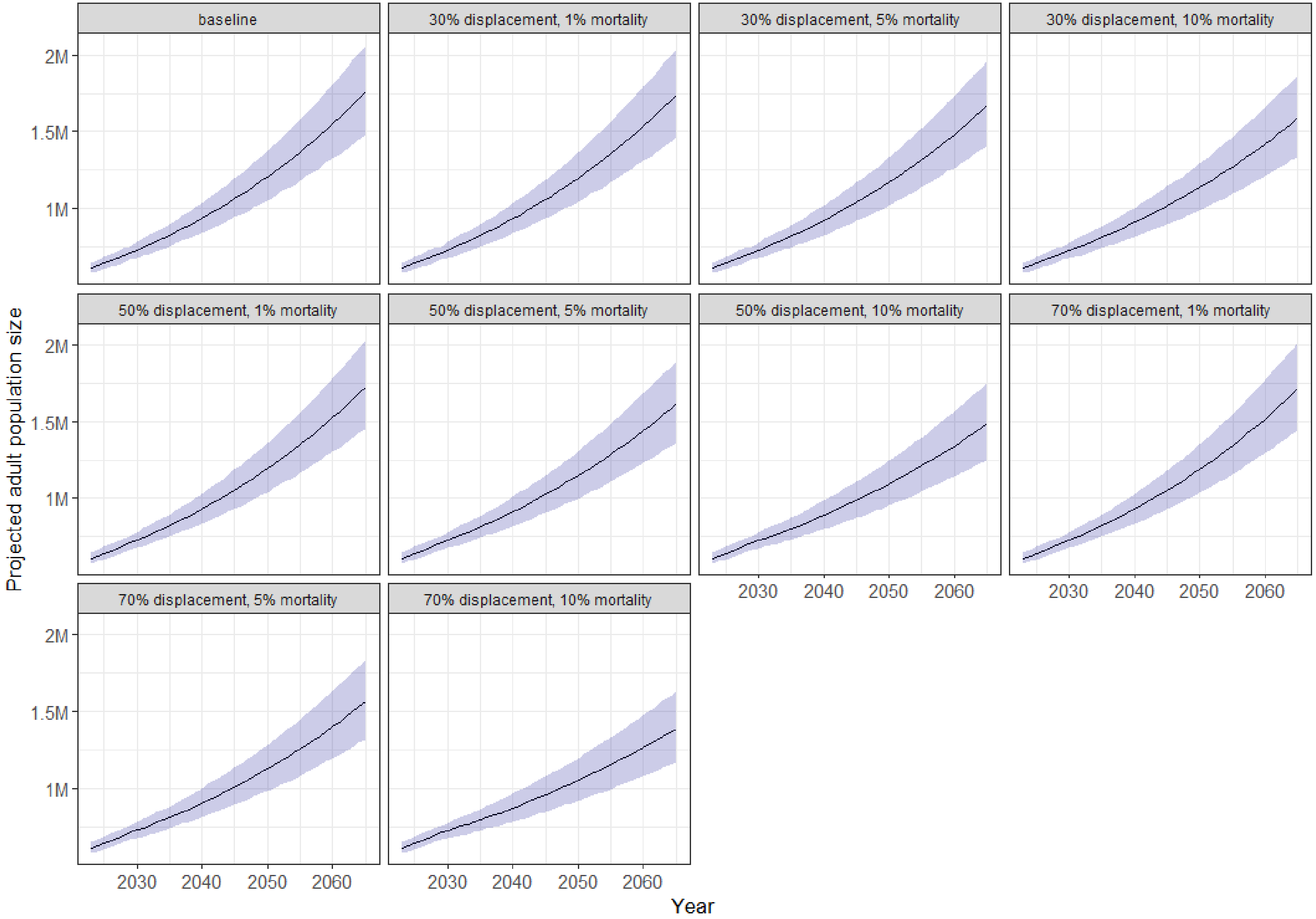
Annual impact

1.5.2.3 The results of the PVA runs for impacts from the Mona Offshore Wind Project cumulatively with other offshore wind farms to the annual common guillemot UK Wester waters BDMPS at the start of operation (2030) and for the duration of the project (35 years) are presented in Table 1.11 below. The baseline ‘unimpacted’ scenario (i.e assuming no additional mortality other than baseline mortality exists) is also shown for comparison purposes. Graphs relating to population size, CPS and GCR for each impact scenario has also been presented (Figure 1.7 to Figure 1.9) at the request of NRW during statutory consultation.

Table 1.11: Common guillemot PVA results for the UK Western waters BDMPS.

Year	Impact scenario	Simulated ~~adult~~ population size	Percentage population change since 2023	Median growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Median counterfactual of population size	Median counterfactual of growth rate
2030	baseline	1,365,125~~728,185~~	+19.17%~~10.61%~~	1.025~~1.027~~	0.974~~0.986~~	1.078~~1.061~~	-	-
2030	30% displacement, 1% mortality	1,364,756~~727,932~~	+19.14%~~10.57%~~	1.025~~1.026~~	0.974~~0.986~~	1.078~~1.061~~	1.000~~1.000~~	1.000~~1.000~~
2030	50% displacement, 1% mortality	1,364,506~~727,818~~	+19.12%~~10.55%~~	1.024~~1.026~~	0.974~~0.986~~	1.078~~1.061~~	1.000~~0.999~~	1.000~~1.000~~
2030	70% displacement, 1% mortality	1,364,263~~727,691~~	+19.09%~~10.53%~~	1.024~~1.026~~	0.974~~0.985~~	1.078~~1.061~~	0.999~~0.999~~	0.999~~0.999~~
2030	30% displacement, 5% mortality	1,363,221~~727,179~~	+19.00%~~10.46%~~	1.023~~1.025~~	0.973~~0.985~~	1.077~~1.060~~	0.999~~0.999~~	0.999~~0.999~~
2030	50% displacement, 5% mortality	1,361,965~~726,539~~	+18.89%~~10.36%~~	1.022~~1.024~~	0.972~~0.984~~	1.076~~1.059~~	0.998~~0.998~~	0.998~~0.998~~
2030	70% displacement, 5% mortality	1,360,694~~725,890~~	+18.78%~~10.26%~~	1.021~~1.023~~	0.971~~0.983~~	1.075~~1.058~~	0.997~~0.997~~	0.997~~0.997~~
2030	30% displacement, 10% mortality	1,361,339~~726,212~~	+18.84%~~10.31%~~	1.022~~1.024~~	0.972~~0.983~~	1.075~~1.059~~	0.997~~0.997~~	0.997~~0.997~~
2030	50% displacement, 10% mortality	1,358,802~~724,918~~	+18.62%~~10.11%~~	1.020~~1.022~~	0.970~~0.981~~	1.073~~1.057~~	0.995~~0.995~~	0.995~~0.996~~
2030	70% displacement, 10% mortality	1,356,261~~723,625~~	+18.40%~~9.92%~~	1.018~~1.020~~	0.968~~0.980~~	1.072~~1.055~~	0.993~~0.994~~	0.994~~0.994~~
2065	baseline	3,299,067~~1,719,410~~	+188.00%~~+167.90%~~	1.025~~1.025~~	1.021~~1.021~~	1.030~~1.030~~	-~~-~~	-~~-~~
2065	30% displacement, 1% mortality	3,266,768~~1,673,915~~	+185.18%~~+164.70%~~	1.025~~1.024~~	1.020~~1.021~~	1.030~~1.030~~	0.990~~0.988~~	1.000~~1.000~~
2065	50% displacement, 1% mortality	3,245,339~~1,618,777~~	+183.31%~~+162.93%~~	1.025~~1.023~~	1.020~~1.020~~	1.030~~1.030~~	0.984~~0.981~~	1.000~~0.999~~

Year	Impact scenario	Simulated ~~adult~~ population size	Percentage population change since 2023	Median growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Median counterfactual of population size	Median counterfactual of growth rate
2065	70% displacement, 1% mortality	3,224,109~~1,565,278~~	+181.45%~~+161.17%~~	1.025~~1.022~~	1.020~~1.020~~	1.030~~1.029~~	0.977~~0.975~~	0.999~~0.999~~
2065	30% displacement, 5% mortality	3,140,407~~1,591,804~~	+174.14%~~+154.26%~~	1.024~~1.023~~	1.019~~1.019~~	1.029~~1.029~~	0.952~~0.949~~	0.999~~0.999~~
2065	50% displacement, 5% mortality	3,038,527~~1,488,348~~	+165.25%~~+145.89%~~	1.023~~1.021~~	1.018~~1.018~~	1.028~~1.028~~	0.921~~0.918~~	0.998~~0.998~~
2065	70% displacement, 5% mortality	2,940,085~~1,391,333~~	+156.66%~~+137.76%~~	1.022~~1.019~~	1.017~~1.018~~	1.027~~1.027~~	0.891~~0.887~~	0.997~~0.997~~
2065	30% displacement, 10% mortality	2,988,923~~728,185~~	+160.92%~~+141.79%~~	1.023~~1.027~~	1.018~~1.018~~	1.027~~1.027~~	0.906~~0.903~~	0.997~~0.997~~
2065	50% displacement, 10% mortality	2,798,126~~727,932~~	+144.27%~~+126.08%~~	1.021~~1.026~~	1.016~~1.016~~	1.025~~1.025~~	0.848~~0.844~~	0.995~~0.995~~
2065	70% displacement, 10% mortality	2,619,179~~727,818~~	+128.64%~~+111.34%~~	1.019~~1.026~~	1.014~~1.014~~	1.024~~1.023~~	0.794~~0.789~~	0.994~~0.993~~


baseline
30% displacement, 1% mortality
30% displacement, 5% mortality
30% displacement, 10% mortality
50% displacement, 1% mortality
50% displacement, 5% mortality
50% displacement, 10% mortality
70% displacement, 1% mortality
70% displacement, 5% mortality
70% displacement, 10% mortality
Projected adult population size
2M
1.5M
1M
2030
2040
2050
2060
Year

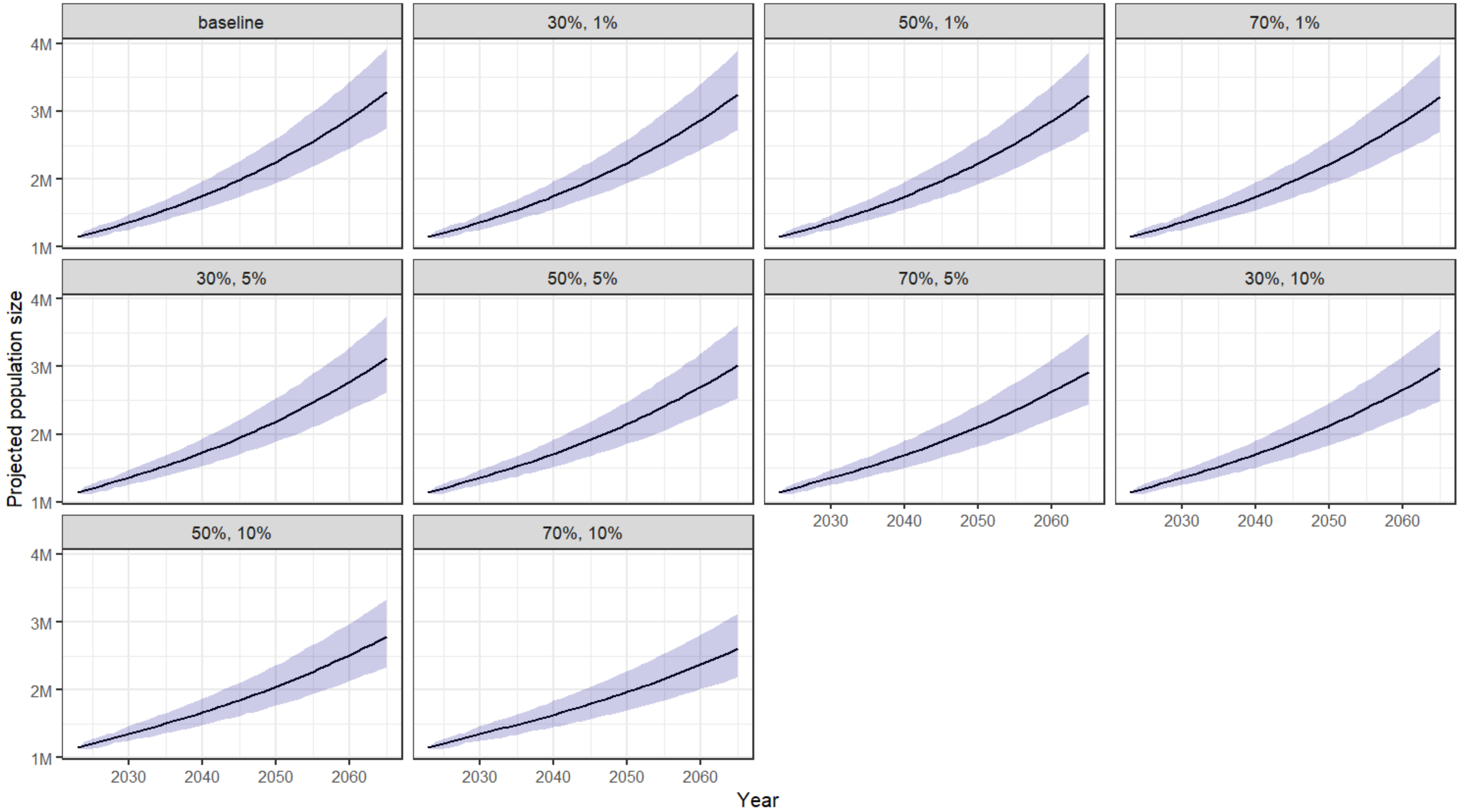
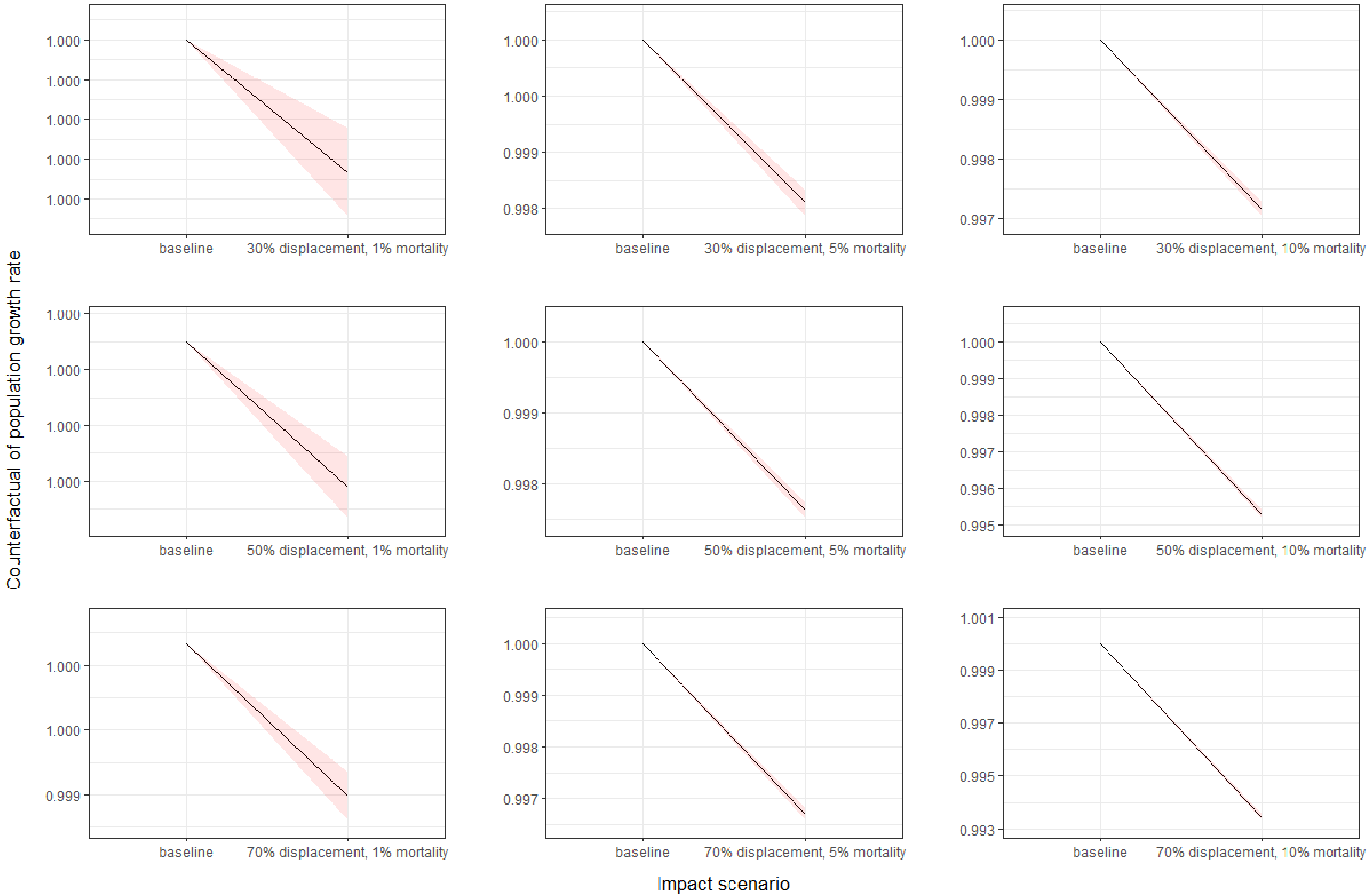
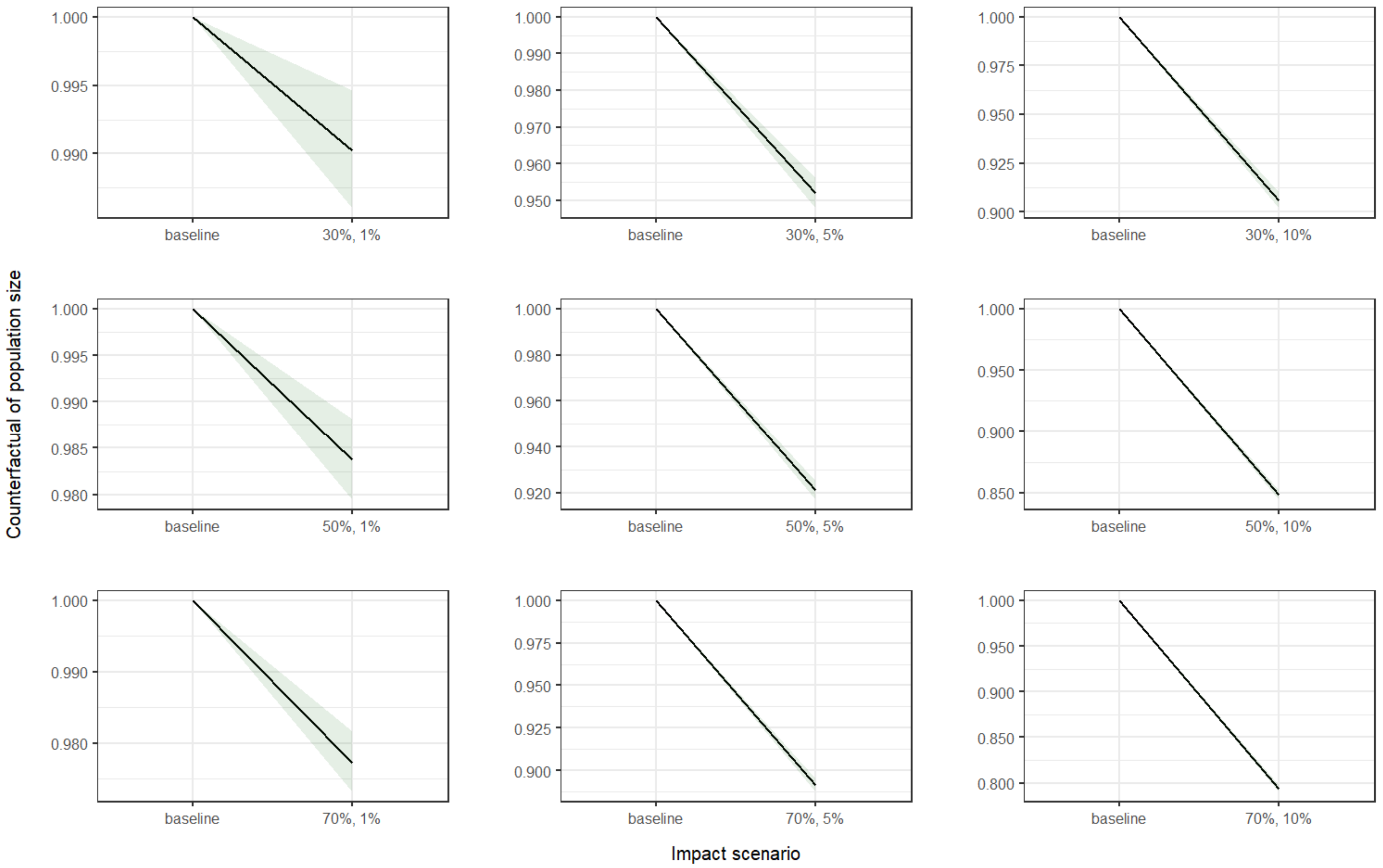


Figure 1.7: Projections of population sizes over a 35-year time-frame for the UK Western waters BDMPS. Each plot represents a different impact scenario in terms of additional ~~adult~~ mortalities (starting at baseline (i.e. unimpacted))~~.~~

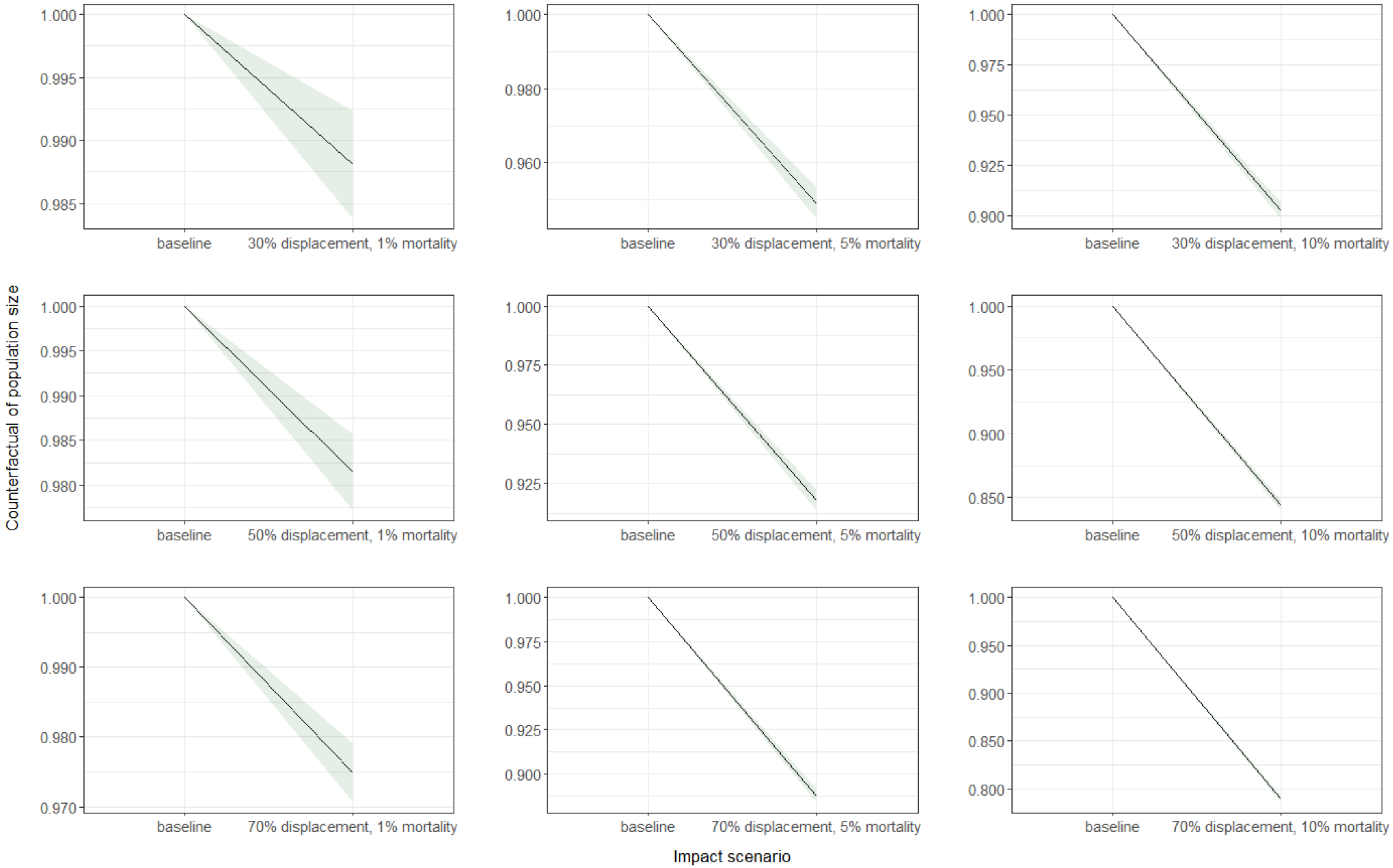

Counterfactual of population growth rate
1.000
1.000
1.000
1.000
1.000
baseline
30% displacement, 1% mortality
1.000
1.000
0.999
0.998
baseline
30% displacement, 5% mortality
1.000
0.999
0.998
0.997
baseline
30% displacement, 10% mortality
1.000
1.000
1.000
1.000
baseline
50% displacement, 1% mortality
1.000
0.999
0.998
baseline
50% displacement, 5% mortality
1.000
0.999
0.998
0.997
0.996
0.995
baseline
50% displacement, 10% mortality
1.000
1.000
0.999
baseline
70% displacement, 1% mortality
1.000
0.999
0.998
0.997
baseline
70% displacement, 5% mortality
1.001
0.999
0.997
0.995
0.993
baseline
70% displacement, 10% mortality
Impact scenario


1.000
1.000
1.000
1.000
1.000
0.999

Figure 1.8: Ratio of impacted growth rates after 35 years for the UK Western waters BDMPS under a range of impact scenarios after 35 years.



Counterfactual of population size
Impact scenario
baseline
30%, 1%
30%, 5%
30%, 10%
50%, 1%
50%, 5%
50%, 10%
70%, 1%
70%, 5%
70%, 10%



Counterfactual of population size
Impact scenario
1.000
0.995
0.990
0.985
baseline
30% displacement, 1% mortality
1.000
0.980
0.960
baseline
30% displacement, 5% mortality
1.000
0.975
0.950
0.925
0.900
baseline
30% displacement, 10% mortality
1.000
0.995
0.990
0.985
0.980
baseline
50% displacement, 1% mortality
1.000
0.975
0.950
0.925
baseline
50% displacement, 5% mortality
1.000
0.950
0.900
0.850
baseline
50% displacement, 10% mortality
1.000
0.990
0.980
0.970
baseline
70% displacement, 1% mortality
1.000
0.975
0.950
0.925
0.900
baseline
70% displacement, 5% mortality
1.000
0.950
0.900
0.850
0.800
baseline
70% displacement, 10% mortality

Figure 1.9: The ratio of the median impacted population sizes for the UK Western waters BDMPS under a range of impact scenarios after 35 years.

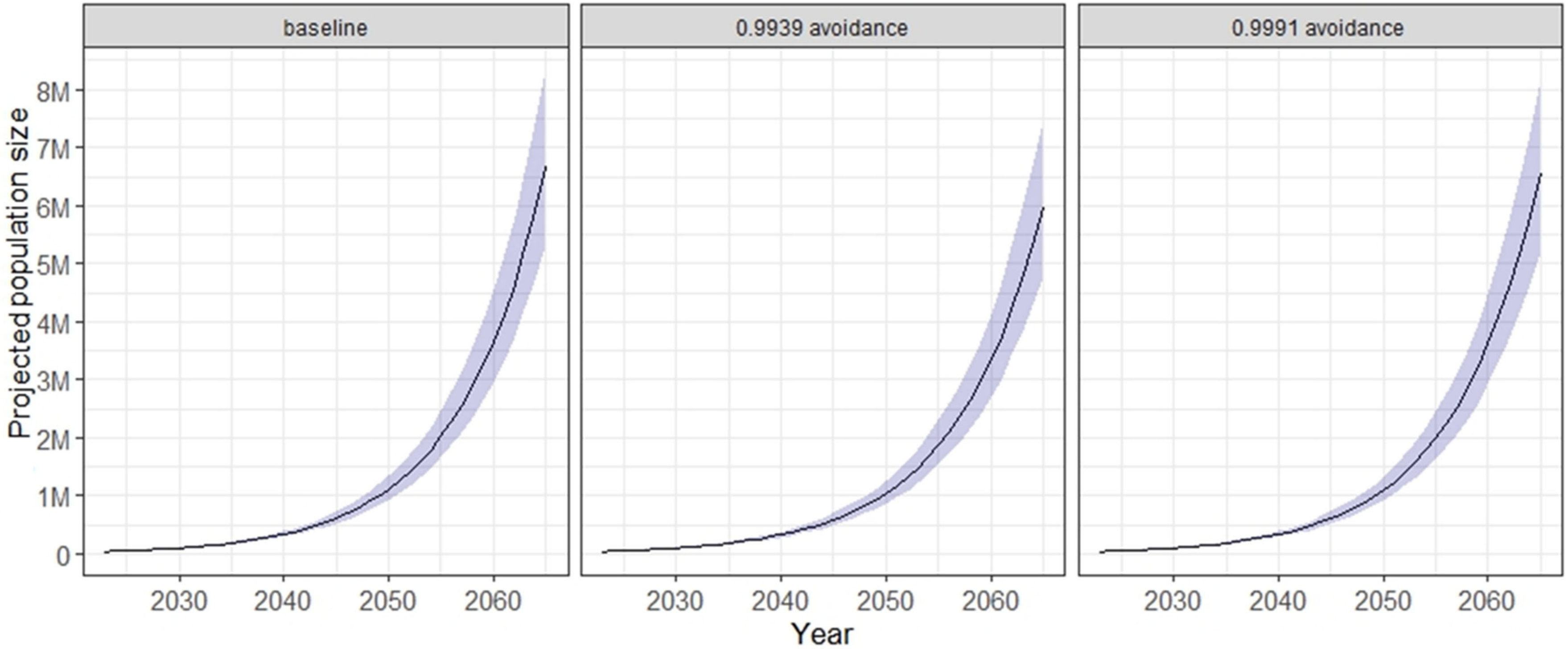
Great black-backed gull

Annual impacts

1.5.2.4 The results of the PVA runs for impacts from the Mona Offshore Wind Project cumulatively with other offshore wind farms to the great black-backed gull South-west and English Channel BDMPS at the start of operation (2030) and for the duration of the project (35 years) are presented in Table 1.12 using the ~~Natural England advised~~species--grouped avoidance rates and using the ~~JNCC~~ species-specific avoidance rate~~s~~. The baseline 'unimpacted' scenario (i.e assuming no additional mortality other than baseline mortality exists) is also shown for comparison purposes. Graphs relating to population size, CPS and GCR for each impact scenario has also been presented (Figure 1.10 to Figure 1.12) at the request of NRW during statutory consultation.

Table 1.12: Annual g~~G~~reat black-backed gull PVA results for the South-West and English Channel BDMPS using ~~Natural England advised~~species-group avoidance rate~~s~~ (0.9939) and species-specific avoidance rate~~s~~ (0.9991).

Year	Impact scenario	Simulated ~~adult~~ population size	Percentage population change since 2023	Median growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Median counterfactual of population size	Median counterfactual of growth rate
2030	Baseline	103,227 ~~38,432~~	+130.66%~~+94.08%~~	1.126	1.058	1.197~~1.206~~	~~-~~-	-
2030	0.9939 avoidance	102,917 ~~38,340~~	+129.97%~~+93.61%~~	1.123	1.055	1.194~~1.204~~	0.997~~8~~	0.997~~8~~
2030	0.9991 avoidance	103,171 ~~38,418~~	+130.53%~~+94.01%~~	1.126	1.058	1.197~~1.206~~	0.999~~1.000~~	1.000
2065	Baseline	6,691,897 ~~2,500,706~~	+14,852.96%~~+12,528.55%~~	1.126~~7~~	1.120	1.133~~1.133~~	-	-
2065	0.9939 avoidance	6,015,662 ~~2,281,227~~	+13,341.92%~~+11,420.18%~~	1.123~~4~~	1.116~~7~~	1.130~~1.130~~	0.899~~912~~	0.997
2065	0.9991 avoidance	6,587,191 ~~2,464,356~~	+14,618.99%~~+12,344.99%~~	1.126	1.119~~20~~	1.133~~1.132~~	0.984~~5~~	1.000


baseline
0.9939 avoidance
0.9991 avoidance
Projected population size
8M
7M
6M
5M
4M
3M
2M
1M
0
2030
2040
2050
2060
Year

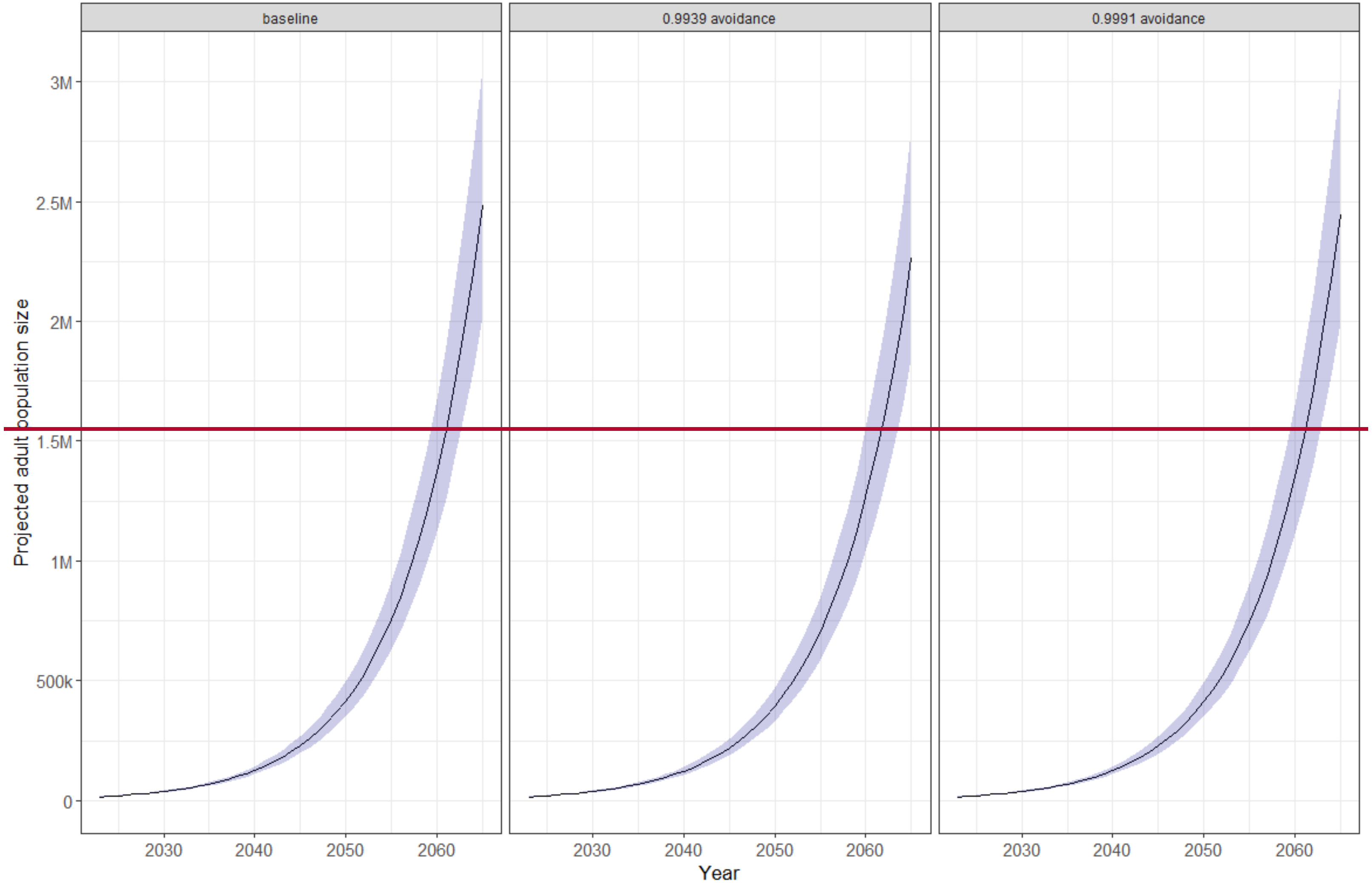
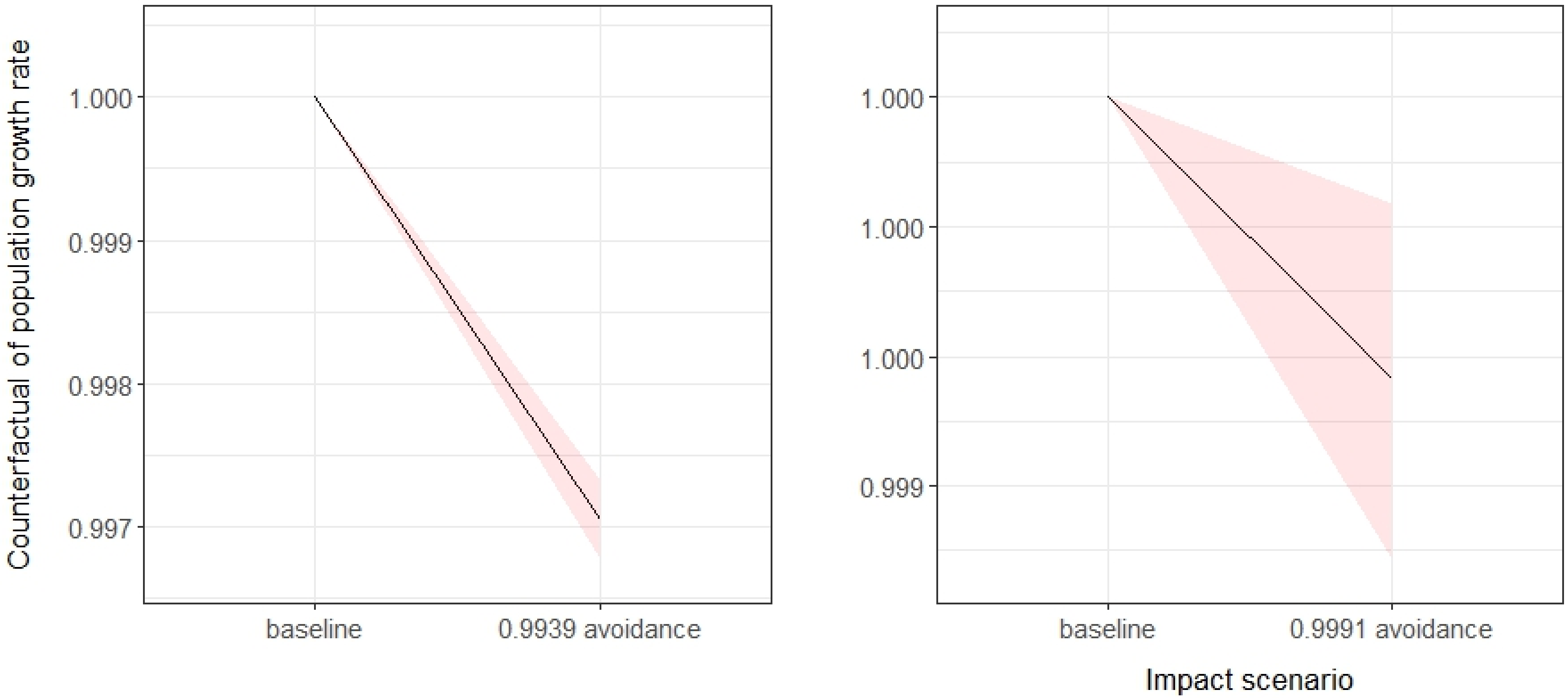


Figure 1.10: Projections of annual population sizes over a 35-year time-frame for the South-West and English Channel BDMPS using ~~grouped~~ species-group avoidance rate~~s~~ (0.9939) and species-specific avoidance rate~~s~~ (0.9939) avoidance rates. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at baseline (i.e. unimpacted)).


Counterfactual of population growth rate
1.000
0.999
0.998
0.997
baseline
0.9939 avoidance
1.000
1.000
1.000
0.999
baseline
0.9991 avoidance
Impact scenario

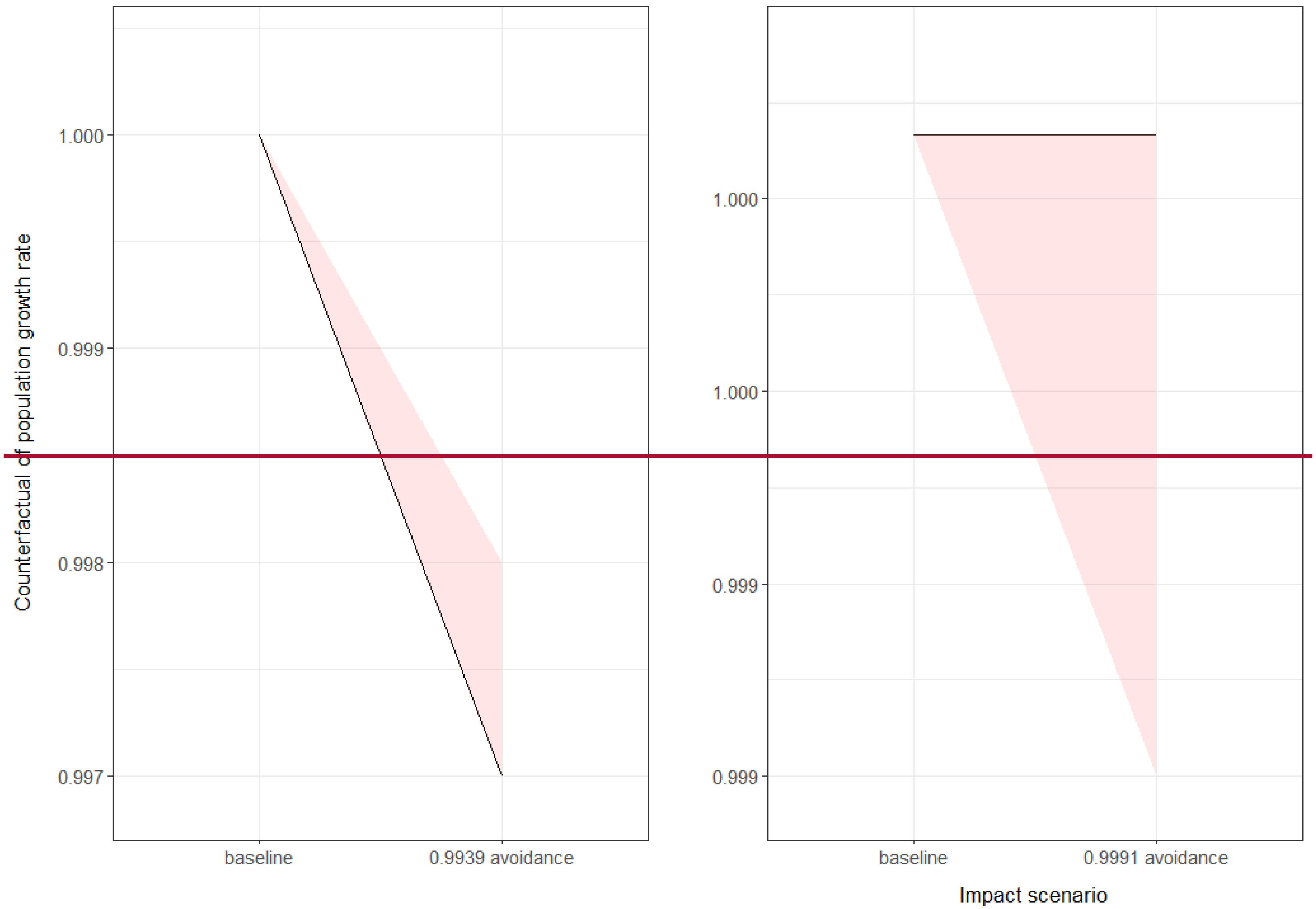
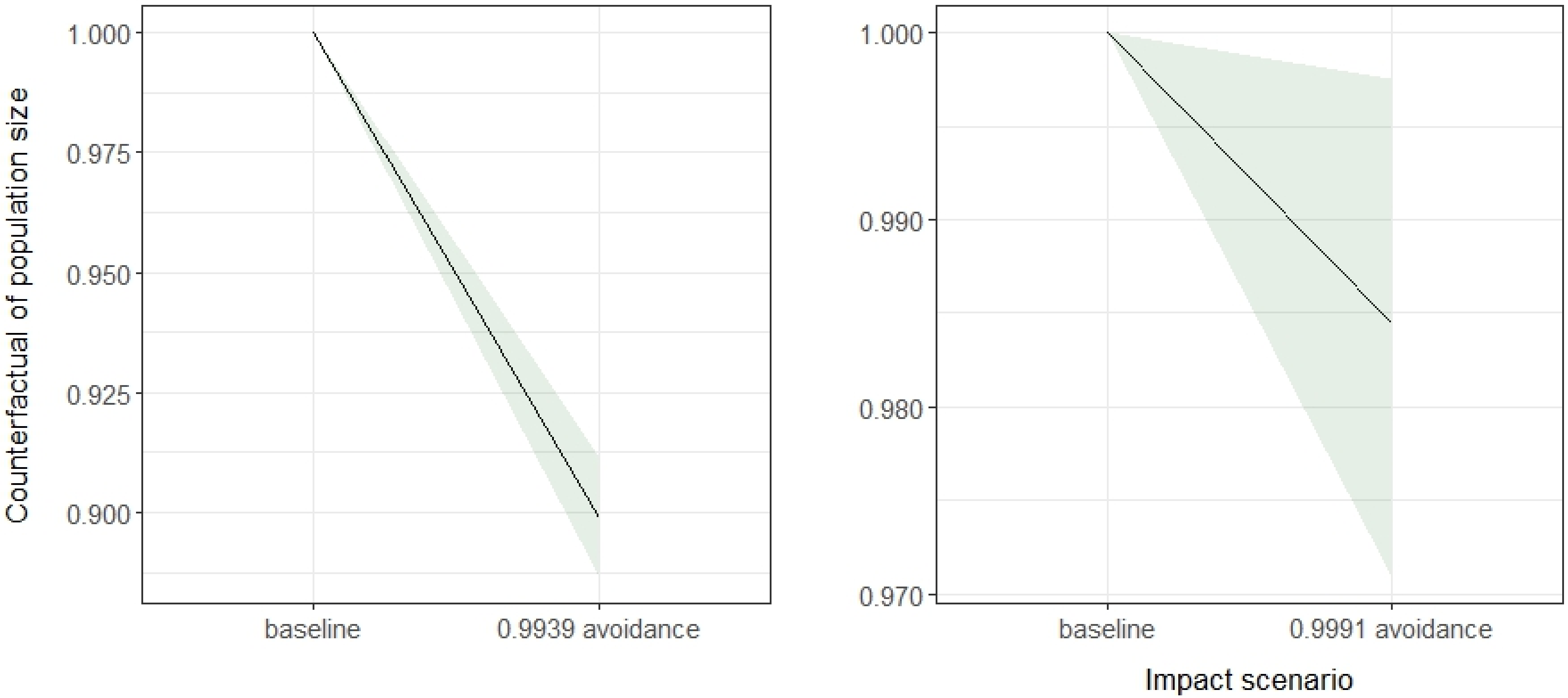


Figure 1.11: Ratio of annual impacted growth rates after 35 years for the South-West and English Channel BDMPS using ~~grouped~~ species-group avoidance rate~~s~~ (0.9939) and species-specific avoidance rate~~s~~ (0.9991).



Counterfactual of population size
1.000
0.975
0.950
0.925
0.900
baseline
0.9939 avoidance
1.000
0.990
0.980
0.970
baseline
0.9991 avoidance
Impact scenario

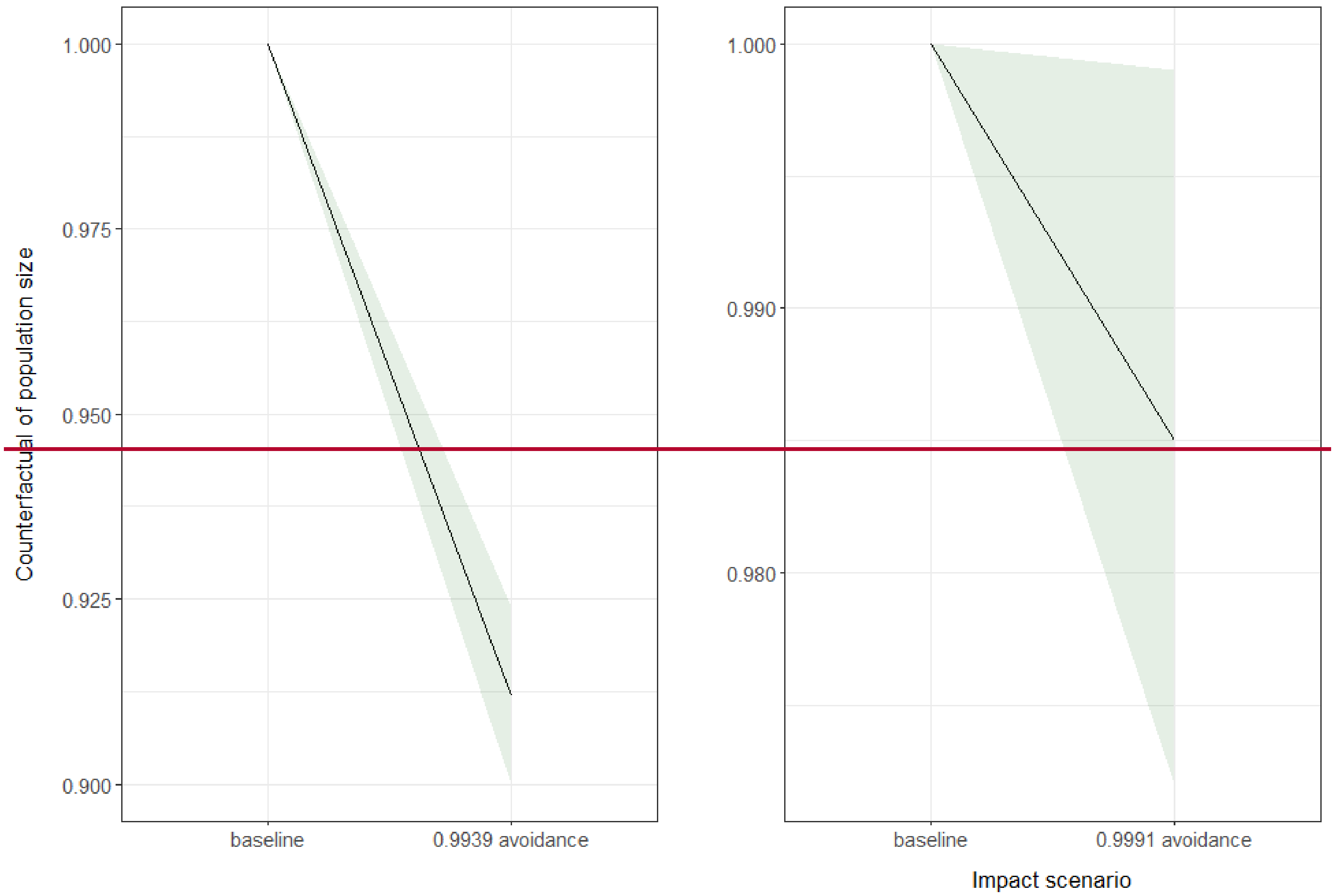


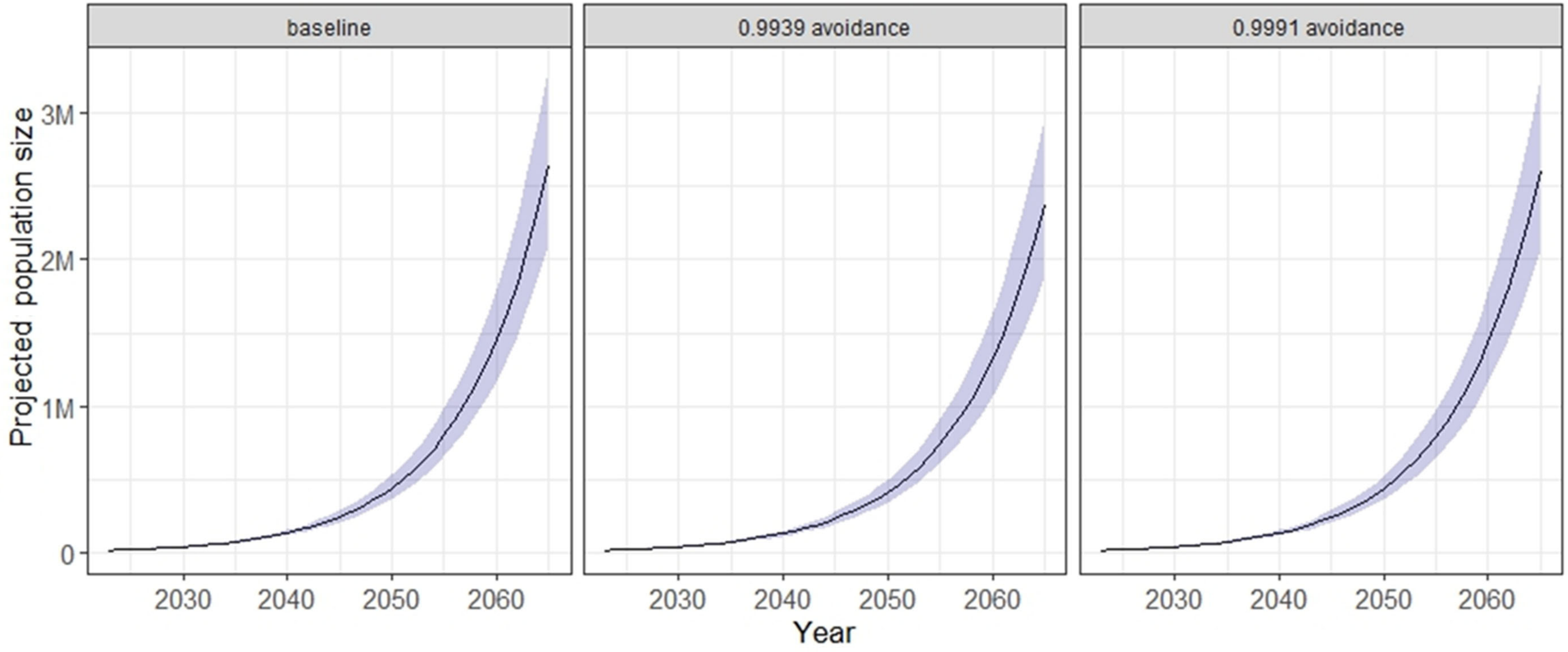
Figure 1.12: The ratio of the median impacted annual population sizes for the South-West and English Channel BDMPS using ~~grouped~~ species-group avoidance rate~~s~~ (0.9939) and species-specific avoidance rate~~s~~ (0.9991) from the simulations after 35 years.

Non-breeding season impacts

1.5.2.5 The results of the PVA runs for impacts from the Mona Offshore Wind Project cumulatively with other offshore wind farms to the great black-backed gull South-west and English Channel BDMPS in the non-breeding season at the start of operation (2030) and for the duration of the project (35 years) are presented in Table 1.12 using the ~~Natural England advised grouped~~species-group avoidance rates (0.9939) and using the ~~JNCC~~ species-specific avoidance rates (0.9991). The baseline 'unimpacted' scenario (i.e assuming no additional mortality other than baseline mortality exists) is also shown for comparison purposes. Graphs relating to population size, CPS and GCR for each impact scenario has also been presented (Figure 1.13 to Figure 1.15) at the request of NRW during statutory consultation.

Table 1.13: Non-breeding season gGreat black-backed gull PVA results for the South-West and English Channel BDMPS using Natural England advisedspecies-group avoidance rates (0.9939) and species-specific avoidance rates (0.9991).

Year	Impact scenario	Simulated adult population size	Percentage population change since 2023	Median growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Median counterfactual of population size	Median counterfactual of growth rate
2030	Baseline	40,915 15,234	+130.61%+170.98%	1.126	1.058	1.1971.206	-	-
2030	0.9939 avoidance	40,796 15,177	+129.94%+169.95%	1.1232	1.054	1.1941.201	0.9976	0.9976
2030	0.9991 avoidance	40,903 15,224	+130.54%+170.79%	1.125	1.057	1.1971.205	1.00000.999	1.00000.999
2065	Baseline	2,652,788 991,195	+14,852.02%+17,530.65%	1.1267	1.120	1.1331.133	-	-
2065	0.9939 avoidance	2,384,365 857,145	+13,339.10%+15,146.27%	1.1232	1.116	1.1301.128	0.89965	0.9976
2065	0.9991 avoidance	2,611,556 965,809	+14,619.63%+17,079.10%	1.126	1.119	1.1331.132	0.98575	1.00000.999


baseline
0.9939 avoidance
0.9991 avoidance
Projected population size
3M
2M
1M
0
2030
2040
2050
2060
Year

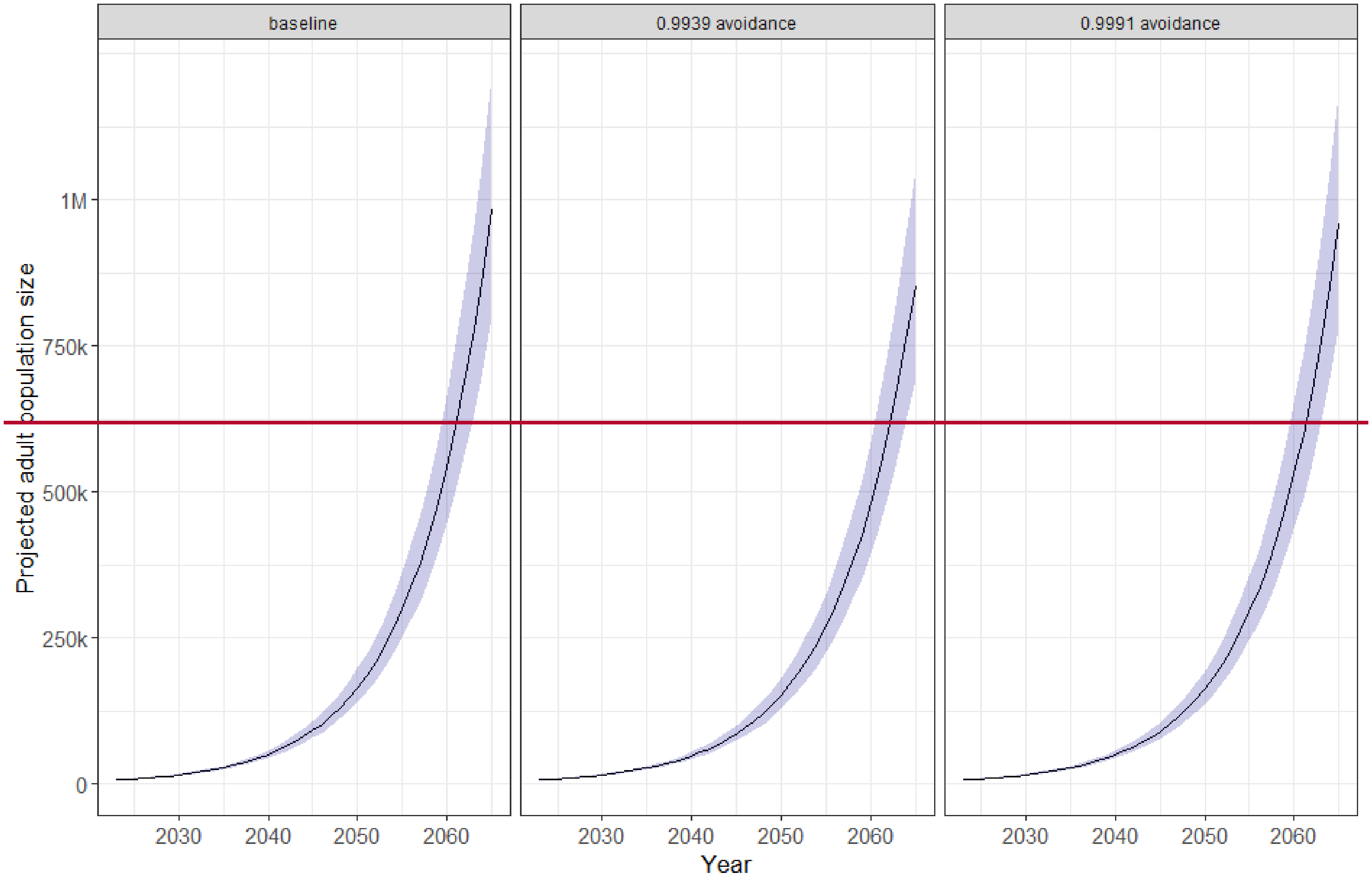
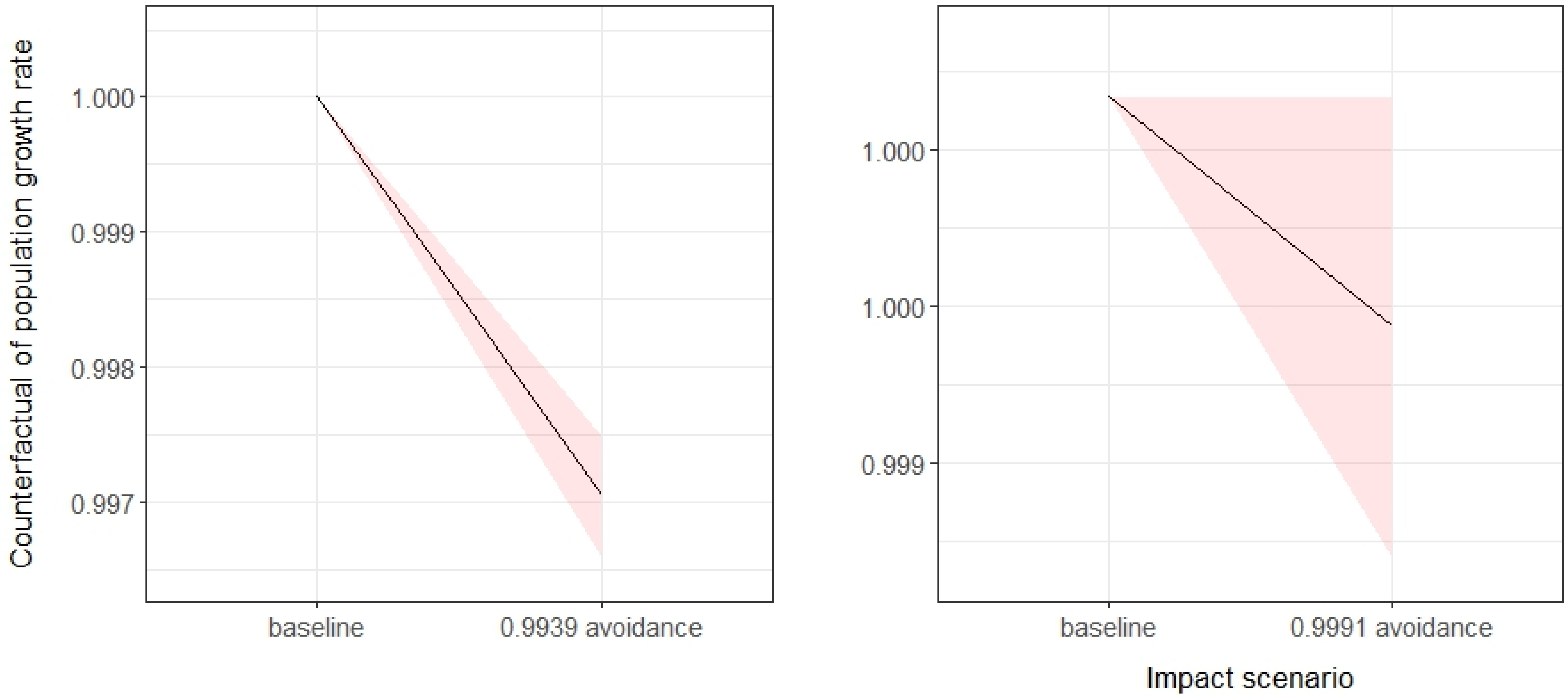


Figure 1.13: Projections of population sizes over a 35-year time-frame for the South-West and English Channel BDMPS using JNCC avoidance rates. Each plot represents a different impact scenario in terms of additional adult mortalities (starting at baseline (i.e. unimpacted)).


Counterfactual of population growth rate
1.000
0.999
0.998
0.997
baseline
0.9939 avoidance
1.000
1.000
0.999
baseline
0.9991 avoidance
Impact scenario

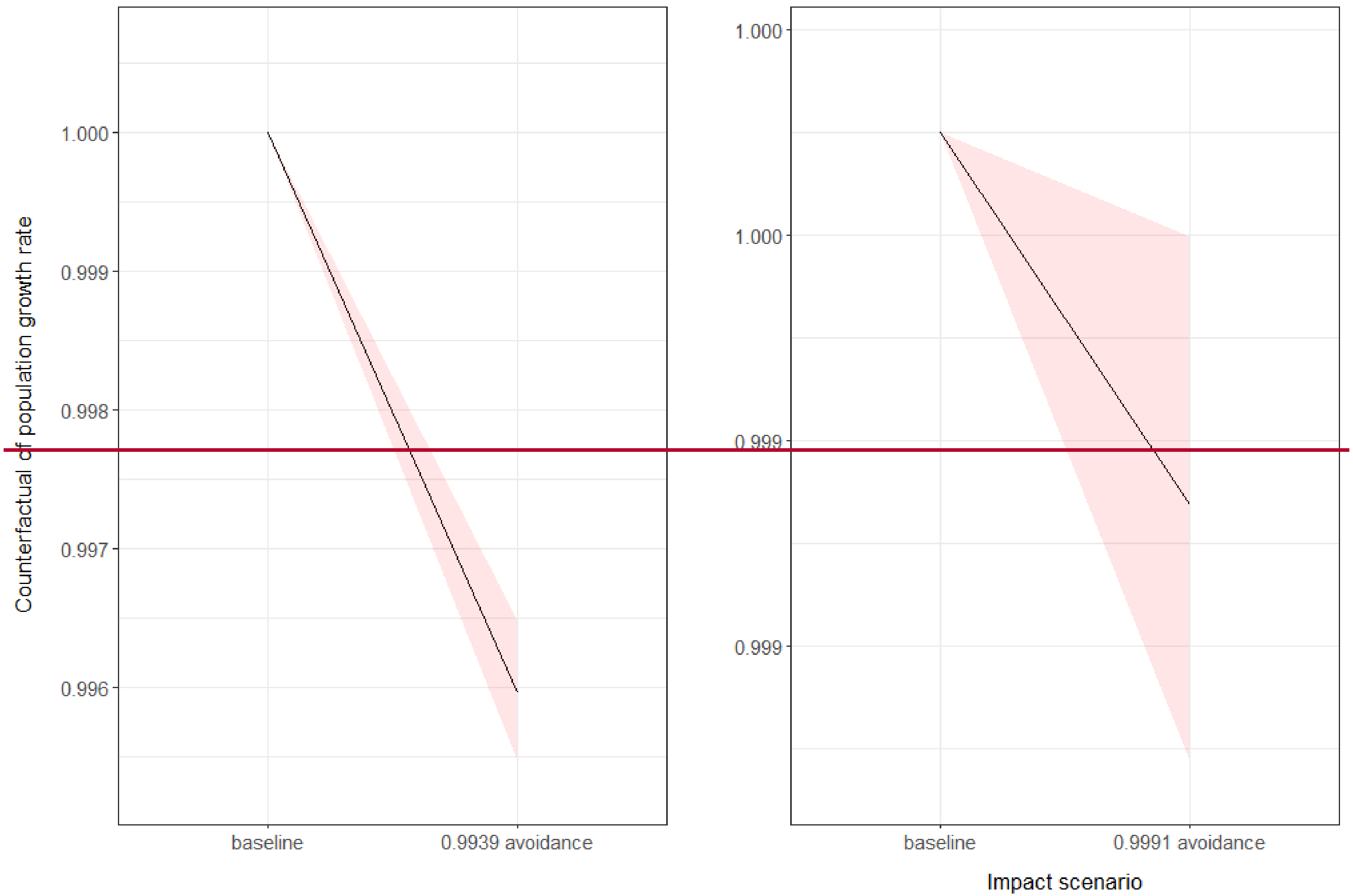
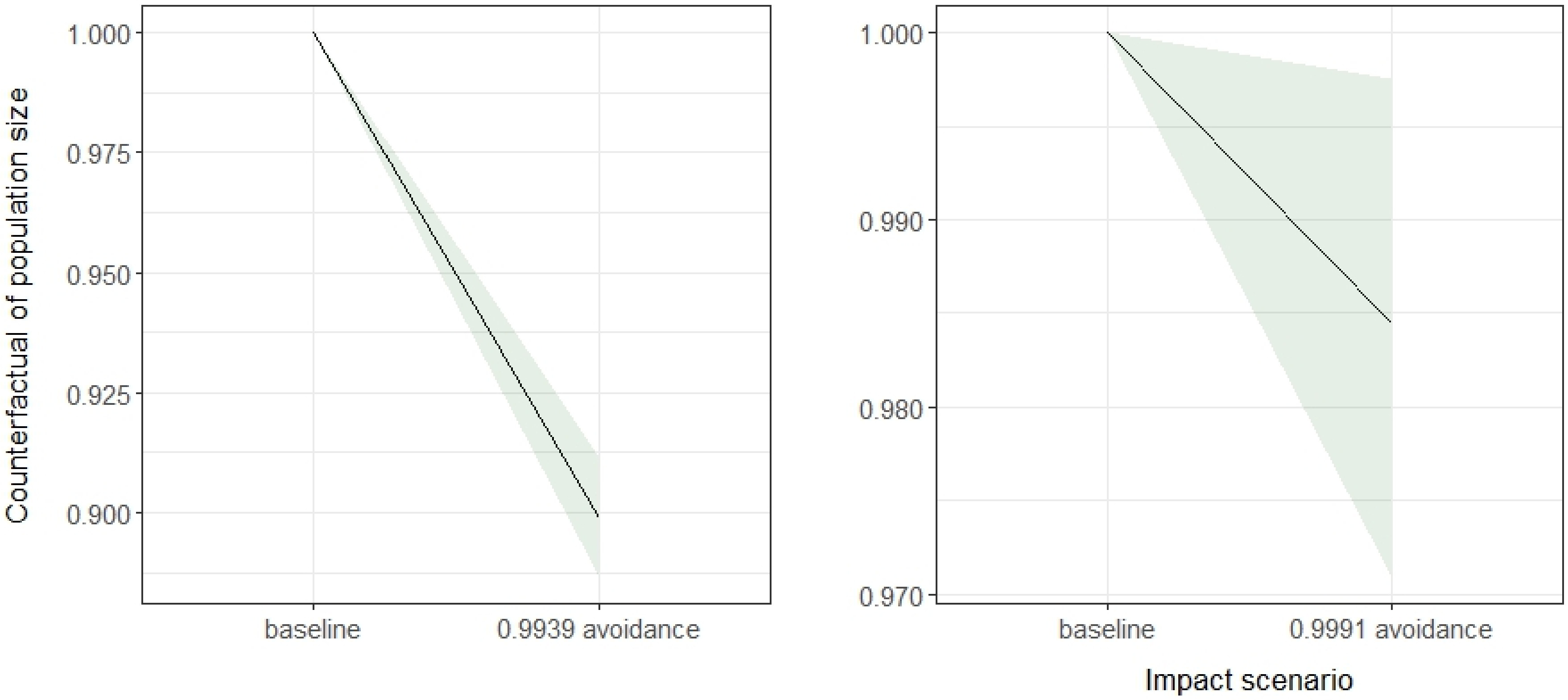


Figure 1.14: Ratio of annual impacted growth rates after 35 years for the South-West and English Channel BDMPS using grouped avoidance rates (0.9939) and species-specific avoidance rates (0.9991).


Counterfactual of population size
1.000
0.975
0.950
0.925
0.900
baseline
0.9939 avoidance
1.000
0.990
0.980
0.970
baseline
0.9991 avoidance
Impact scenario

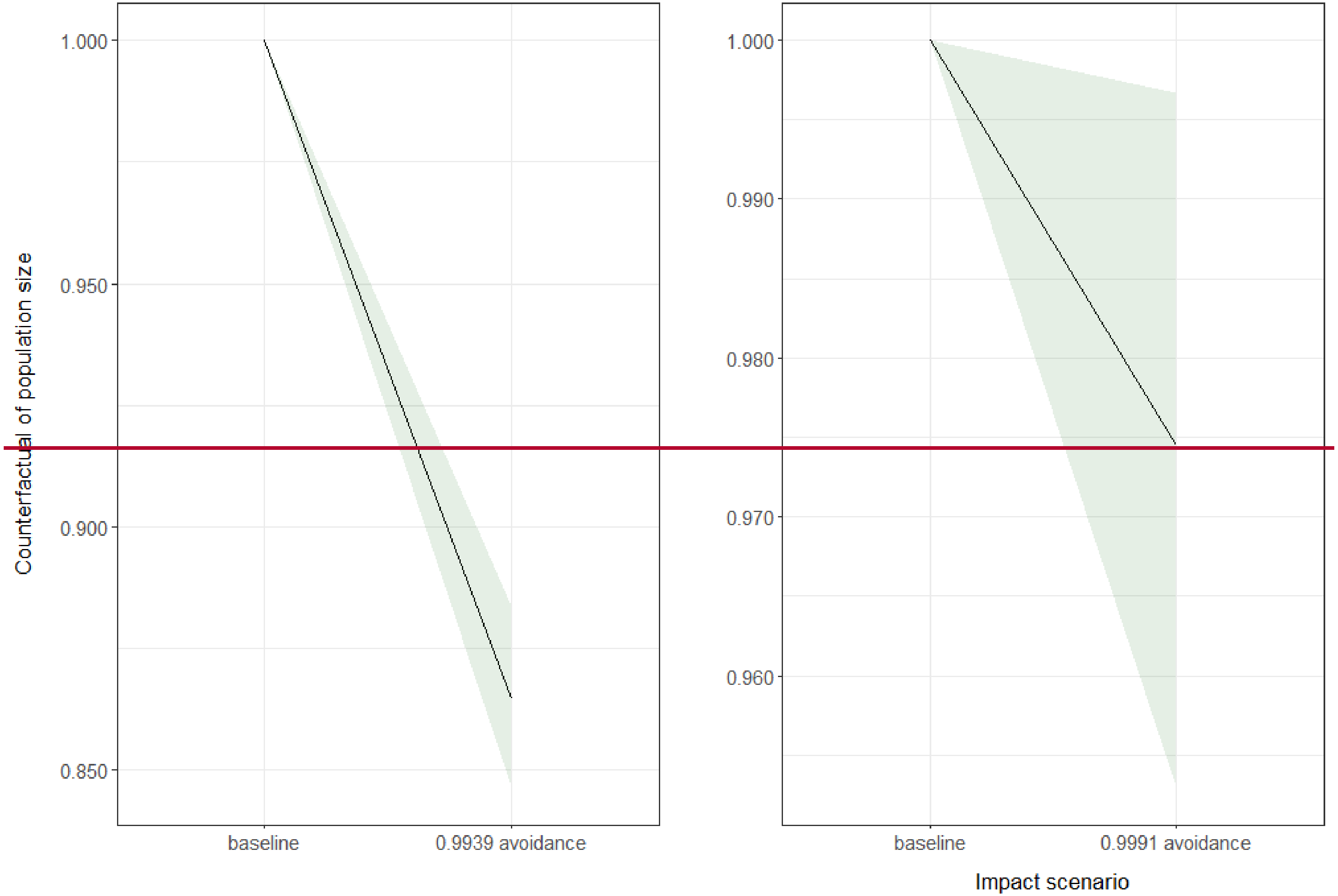


Figure 1.15: The ratio of the median impacted annual population sizes for the South-West and English Channel BDMPS using grouped avoidance rates (0.9939) and species-specific avoidance rates (0.9991) from the simulations after 35 years.

1.6 References

Searle, K., Mobbs, D., Daunt, F., & Butler, A. (2019) A Population Viability Analysis Modelling Tool for Seabird Species. Centre for Ecology & Hydrology report for Natural England. Natural England Commissioned Report NECR274.

JNCC(2023) Seabird Monitoring Program

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

Mobbs, D., Searle, K., Daunt, F. & Butler, A. (2020) A Population Viability Analysis Modelling Tool for Seabird Species: Guide for using the PVA tool (v2.0) user interface.

Morris, W.F. and Doak, D.F. (2002) Quantitative conservation biology: theory and practice of population viability analysis. Sinauer, MA.

Natural England. (2022) Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards. Phase III: Expectations for data analysis and presentation at examination for offshore wind applications. Report to Department for Environment Food and Rural Affairs.

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

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

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

Appendix A: Seabird PVA Parameter Log

A.1 Common guillemot

A.1.1 Great Ormes Head Model

The log file was created on: 2023-11-27 09:46:11 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

```
##                Package          Version
## popbio         "popbio"         "2.4.4"
## shiny          "shiny"          "1.1.0"
## shinyjs        "shinyjs"        "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"   "0.4.5"
## DT             "DT"             "0.5"
## plotly         "plotly"         "4.8.0"
## rmarkdown      "rmarkdown"      "1.10"
## dplyr          "dplyr"          "0.7.6"
## tidyr          "tidyr"          "0.8.1"
```

Basic information

This run had reference name “GU_GOH”.
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 15.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Common Guillemot.
Region type to use for breeding success data: Reg.Seas.
Available colony-specific survival rate: Skomer (1985-2011). Sector to use within breeding success region: Irish Sea.
Age at first breeding: 6.
Is there an upper constraint on productivity in the model?: Yes, constrained to 1 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 3578 in 2023

Productivity rate per pair: mean: 0.532 , sd: 0.089

Adult survival rate: mean: 0.939 , sd: 0.015

Immatures survival rates:

Age class 0 to 1 - mean: 0.56 , sd: 0.013 , DD: NA

Age class 1 to 2 - mean: 0.792 , sd: 0.034 , DD: NA

Age class 2 to 3 - mean: 0.917 , sd: 0.022 , DD: NA

Age class 3 to 4 - mean: 0.939 , sd: 0.015 , DD: NA

Age class 4 to 5 - mean: 0.939 , sd: 0.015 , DD: NA

Age class 5 to 6 - mean: 0.939 , sd: 0.015 , DD: NA

Impacts

Number of impact scenarios: 3.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

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

Years in which impacts are assumed to begin and end: 2030 to 2065

Impact on Demographic Rates

Scenario A - Name: 50% displacement, 1% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000559 , se: NA

Scenario B - Name: 30% displacement, 1% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000922 , se: NA

Scenario C - Name: 70% displacement, 10% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.012828 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2065
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

A.1.2 Little Ormes Head Model

The log file was created on: 2023-11-27 10:11:06 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

```
##                Package        Version
## popbio         "popbio"       "2.4.4"
## shiny          "shiny"        "1.1.0"
## shinyjs        "shinyjs"      "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"  "0.4.5"
## DT             "DT"           "0.5"
## plotly         "plotly"       "4.8.0"
## rmarkdown      "rmarkdown"    "1.10"
## dplyr          "dplyr"        "0.7.6"
## tidyr          "tidyr"        "0.8.1"
```

Basic information

This run had reference name “GU_LOH”.
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 15.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Common Guillemot.
Region type to use for breeding success data: Reg.Seas.
Available colony-specific survival rate: Skomer (1985-2011). Sector to use within breeding success region: Irish Sea.
Age at first breeding: 6.
Is there an upper constraint on productivity in the model?: Yes, constrained to 1 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1298 in 2023

Productivity rate per pair: mean: 0.532 , sd: 0.089

Adult survival rate: mean: 0.939 , sd: 0.015

Immatures survival rates:

Age class 0 to 1 - mean: 0.56 , sd: 0.013 , DD: NA

Age class 1 to 2 - mean: 0.792 , sd: 0.034 , DD: NA

Age class 2 to 3 - mean: 0.917 , sd: 0.022 , DD: NA

Age class 3 to 4 - mean: 0.939 , sd: 0.015 , DD: NA

Age class 4 to 5 - mean: 0.939 , sd: 0.015 , DD: NA

Age class 5 to 6 - mean: 0.939 , sd: 0.015 , DD: NA

Impacts

Number of impact scenarios: 3.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

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

Years in which impacts are assumed to begin and end: 2030 to 2065

Impact on Demographic Rates

Scenario A - Name: 50% displacement, 1% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000539291 , se: NA

Scenario B - Name: 30% displacement, 1% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000924499 , se: NA

Scenario C - Name: 70% displacement, 10% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.01255778 , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2065
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

A.1.3 Cumulative

The log file was created on: 2024~~3~~-08~~11~~-14~~24~~ 20~~18~~:20~~58~~:50~~31~~ using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

```
##                Package         Version
## popbio         "popbio"        "2.4.4"
## shiny          "shiny"         "1.1.0"
## shinyjs        "shinyjs"       "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"  "0.4.5"
## DT             "DT"            "0.5"
## plotly         "plotly"        "4.8.0"
## rmarkdown      "rmarkdown"     "1.10"
## dplyr          "dplyr"         "0.7.6"
## tidyr          "tidyr"         "0.8.1"
```

Basic information

This run had reference name “GU_CEA”.
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 12345.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Common Guillemot.
Region type to use for breeding success data: Reg.Seas.
Available colony-specific survival rate: Skomer (1985-2011). Sector to use within breeding success region: Irish Sea.
Age at first breeding: 6.
Is there an upper constraint on productivity in the model?: Yes, constrained to 1 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1145528 in ~~2015~~2023

Productivity rate per pair: mean: 0.583 , sd: 0.079

Adult survival rate: mean: 0.939 , sd: 0.015

Immatures survival rates:

Age class 0 to 1 - mean: 0.56 , sd: 0.013 , DD: NA

Age class 1 to 2 - mean: 0.792 , sd: 0.034 , DD: NA

Age class 2 to 3 - mean: 0.917 , sd: 0.022 , DD: NA

Age class 3 to 4 - mean: 0.939 , sd: 0.015 , DD: NA

Age class 4 to 5 - mean: 0.939 , sd: 0.015 , DD: NA

Age class 5 to 6 - mean: 0.939 , sd: 0.015 , DD: NA

Impacts

Number of impact scenarios: 9.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

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

Years in which impacts are assumed to begin and end: 2030 to 2065

Impact on Demographic Rates

Scenario A – Name: 30% displacement, 1% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000244429~~000297382~~ , se: NA

Scenario B - Name: 50% displacement, 1% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000406799~~00046421~~ , se: NA

Scenario C - Name: 70% displacement, 1% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000570043~~000631037~~ , se: NA

Scenario D - Name: 30% displacement, 5% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001221271~~001298349~~ , se: NA

Scenario E - Name: 50% displacement, 5% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002035742~~002132488~~ , se: NA

Scenario F - Name: 70% displacement, 5% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002850214~~002966628~~ , se: NA

Scenario G - Name: 30% displacement, 10% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002442542~~002549558~~ , se: NA

Scenario H - Name: 50% displacement, 10% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004071485~~004217837~~ , se: NA

Scenario I - Name: 70% displacement, 10% mortality

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005699555~~005886115~~ , se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2065
How should outputs be produced, in terms of ages?: ~~breeding.adults~~whole.population
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

A.2 Great black-backed gull

A.2.1 Annual PVA model for the South-West and English Channel BDMPS

The log file was created on: 2024-08-14 21:22:30 ~~2023-11-24 20:14:51~~ using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

```
##                Package          Version
## popbio         "popbio"         "2.4.4"
## shiny          "shiny"          "1.1.0"
## shinyjs        "shinyjs"        "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets   "shinyWidgets"   "0.4.5"
## DT             "DT"             "0.5"
## plotly         "plotly"         "4.8.0"
## rmarkdown      "rmarkdown"      "1.10"
## dplyr          "dplyr"          "0.7.6"
## tidyr          "tidyr"          "0.8.1"
```

Basic information

This run had reference name "GBBG_CEA_Annual".
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000
Random seed: 12345.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Great Black-Backed Gull.
Region type to use for breeding success data: Reg.Seas.
Available colony-specific survival rate: National. Sector to use within breeding success region: Irish Sea.
Age at first breeding: 5.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 44753 in 2023

Productivity rate per pair: mean: 1.061 , sd: 0.132

Adult survival rate: mean: 0.93 , sd: 0.0001

Immatures survival rates:

Age class 0 to 1 – mean: 0.798 , sd: 0.092 , DD: NA

Age class 1 to 2 – mean: 0.93 , sd: 0.0001 , DD: NA

Age class 2 to 3 – mean: 0.93 , sd: 0.0001, DD: NA

Age class 3 to 4 – mean: 0.93 , sd: 0.0001 , DD: NA

Age class 4 to 5 – mean: 0.93 , sd: 0.0001 , DD: NA

Impact scenario inputs

Number of impact scenarios: 2.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

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

Years in which impacts are assumed to begin and end: 2030 to 2065

Impact on Demographic Rates

Scenario A – Name: 0.9939 avoidance

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002700154~~02337363~~, se: NA

Scenario B – Name: 0.9991 avoidance

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: ~~0.~~0.000398409~~000368941~~, se: NA

Output:

First year to include in outputs: 2023
Final year to include in outputs: 2065
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

A.2.2 Non-breeding season PVA model for the South-West and English Channel BDMPS

The log file was created on: 2024-08-14 21:32:30 ~~2023-11-24 20:56:04~~ using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

```
##                 Package         Version
## popbio          "popbio"        "2.4.4"
## shiny           "shiny"         "1.1.0"
## shinyjs         "shinyjs"       "1.0"
## shinydashboard "shinydashboard" "0.7.1"
## shinyWidgets    "shinyWidgets"  "0.4.5"
## DT              "DT"            "0.5"
## plotly          "plotly"        "4.8.0"
## rmarkdown       "rmarkdown"     "1.10"
## dplyr           "dplyr"         "0.7.6"
## tidyr           "tidyr"         "0.8.1"
```

Basic information

This run had reference name “GBBG_CEA_Nonbreed”.
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000
Random seed: 12345.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Great Black-Backed Gull.
Region type to use for breeding success data: Reg.Seas.
Available colony-specific survival rate: National. Sector to use within breeding success region: Irish Sea.
Age at first breeding: 5.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: all.individuals
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 17742 in 2023

Productivity rate per pair: mean: 1.061 , sd: 0.132

Adult survival rate: mean: 0.93 , sd: 0.0001

Immatures survival rates:

Age class 0 to 1 - mean: 0.798 , sd: 0.092 , DD: NA

Age class 1 to 2 - mean: 0.93 , sd: 0.0001 , DD: NA

Age class 2 to 3 - mean: 0.93 , sd: 0.0001 , DD: NA

Age class 3 to 4 - mean: 0.93 , sd: 0.0001 , DD: NA

Age class 4 to 5 - mean: 0.93 , sd: 0.0001 , DD: NA

Impact scenario inputs

Number of impact scenarios: 2.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

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

Years in which impacts are assumed to begin and end: 2030 to 2065

Impact scenario outputs

Scenario A - Name: 0.9939 avoidance

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.004098749~~003699527~~ , se: NA

Scenario B - Name: 0.9991 avoidance

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.00060478~~000657719~~ , se: NA

Output:

First year to include in outputs: 2015
Final year to include in outputs: 2065
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA