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Appendix 11.5: Offshore Ornithology EIA Population Viability Analysis Technical Report

Array EIA Report

2024

Revision	Comments	Author	Checker	Approver
FINAL	Final	NIRAS/RPS	RPS	RPS

Approval for Issue		
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1. INTRODUCTION

1.1. BACKGROUND

1. Seabirds can be impacted by offshore wind developments in a number of ways, including collision with wind turbine blades resulting in mortality, and 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 allows for evaluating the potential impacts of offshore wind farms on different population scales.

2. In the case of breeding seabirds, NatureScot (2023c) considers barrier effects alongside displacement as 'distributional responses'. This is because distinguishing between barrier effects and displacement effects can be challenging for breeding seabirds foraging in the region. Therefore, for the purpose of the PVA assessment, the term 'displacement' is used throughout this report to encompass both habitat displacement effects and barrier effects.

3. One method to estimate the potential 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 ‘scenario’ 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 scenarios’ predictions generated by PVAs can then be used to assess the significance of the anticipated additional mortality associated with planned developments. Assessing the acceptability of the impact involves evaluating biological responses alongside statutory, policy, and other relevant considerations. There is no universally defined threshold for what constitutes an 'acceptable' level of impact; rather, determinations will be population-specific and guided by a comprehensive analysis of these factors.

4. PVA was carried out as part of the Ossian Array (hereafter referred to as “the Array”) cumulative assessment due to volume 3, chapter 11 indicating that baseline mortality due to the cumulative impact during the operation and maintenance phase was exceeding a 1% baseline mortality threshold for multiple seabird populations. Generally, based on findings from PVA 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. No PVA was required for the Array alone assessment due to impacts not exceeding the 1% threshold.

5. Cumulative PVAs were modelled for the following impacts, bird species and populations:

- displacement (with Berwick Bank (BB) Offshore Wind Farm impacts included):
  - kittiwake *Rissa tridactyla* (breeding season, annual);
  - guillemot *Uria aalge* (breeding season, non-breeding season, annual);
  - puffin *Fratercula arctica* (breeding season); and
  - razorbill *Alca torda* (breeding season, non-breeding season, annual).
- displacement (with Berwick Bank Offshore Wind Farm impacts excluded):
  - kittiwake (annual);
  - guillemot (breeding season, non-breeding, annual);
  - puffin (breeding season); and
  - razorbill (breeding, non-breeding, annual).
- collision (with Berwick Bank Offshore Wind Farm impacts included):
  - kittiwake (pre-breeding, breeding, annual);
  - herring gull *Larus argentatus* (breeding); and
  - gannet *Morus bassanus* (annual).
- collision (with Berwick Bank Offshore Wind Farm impacts excluded):
  - kittiwake (breeding, annual); and
  - gannet (annual).
- combined displacement and collision (with Berwick Bank Offshore Wind Farm impacts included):
  - kittiwake (pre-breeding, breeding, post-breeding, annual); and
  - gannet (breeding, post-breeding, annual).
- combined displacement and collision (with Berwick Bank Offshore Wind Farm impacts excluded):
  - kittiwake (pre-breeding, breeding, annual); and
  - gannet (post-breeding, annual).

1.2. AIM OF THE REPORT

6. This technical report presents the PVA process conducted for the EIA for the Array along with other offshore wind farms in the surrounding area. Projects that overlapped with a species' mean-maximum foraging range plus one standard deviation during the breeding season, and situated within the Biologically Defined Minimum Population Scale (BDMPS) region for that species during the non-breeding and migration periods, were included in the cumulative assessment. Specific details regarding these plans and projects can be found in volume 3, chapter 11, selected based on Woodward *et al.* (2019) foraging range data for each species. Guidance for guillemot and razorbill from NatureScot (2023a) was incorporated for designated sites and establishing a regional breeding population; i.e. for all designated sites south of the Pentland Firth, mean max plus one standard deviation foraging ranges were determined discounting Fair Isle values as presented in Woodward *et al.* (2019). BDMPS regions used were those as defined in Furness (2015).

7. For the EIA, PVAs were conducted on combined populations comprising colonies from designated sites and populations from BDMPS regions, as outlined in Furness (2015). This process involved collating designated sites and their respective populations to create an overarching population representative of the regional breeding populations. For PVAs specific to individual designated site populations, refer to the Array Report to Inform Appropriate Assessment (RIAA) Appendix 3B (Ossian OWFL, 2024).

2. METHOLOGY

8. PVA was undertaken using the Seabird PVA Tool developed by Natural England (Searle *et. al*., 2019). This software has a user-friendly interface and another series of code tools for direct use. Both are written within the computer software ‘R’ (R is a free software environment for statistical computing and graphics) and are intended to give the same fundamental calculations. The underlying R-code within the nepva R package which underpins the nepva tool was used directly to perform the modelling and analysis for this technical report. The R-code uses nepva version 2 tools as a basis (Mobbs *et al.*, 2020) (tool v 2.0, nepva R package: v 4.17), as found within the associated Natural England GitHub repository (Natural England, 2020). All analysis was conducted using R version 4.3.2 for Windows (R Core Team, 2023).

9. The code 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). PVAs were run for a 25, 35 and 50 year timespan, for species and populations where a potentially significant effect was identified (either when applying the Applicant’s Approach, the NatureScot lower range and/or the

NatureScot upper range). All runs were set with inputs to replicating those set out in the nepva online tool as detailed below.

2.1. MODELLING APPROACH

10. All PVA models were undertaken using the 'nepva.fullrun' function within the nepva R package, which is used to simulate population trajectories based on the specified demographic parameters, initial population sizes and impact scenarios the user inputs into the model.

11. The tool includes an option to run the model 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). For the PVA runs undertaken within this technical report all models were therefore run using density independence.

12. 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.

13. 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 (Wildfowl and Wetlands Trust (WWT) Consulting, 2012) and hence has been included.

14. PVA outputs can either be expressed as the Counterfactual of Population Size (CPS) or the Counterfactual of the Population Growth Rate (CPGR) depending on whether density dependence is included within the model. As models within this technical report have been run using density independence, the CPGR is considered more robust and informative than the CPS. While both CPS and CPGR are provided as requested by NatureScot (2023b), the interpretation of the density independent PVA outputs focusses on the CPGR.

15. Additionally, the quantile from the unimpacted population that matched the 50% quantile for the impacted population (U=50%I) and the quantile from the impacted population that matched the 50% quantile for the unimpacted population (I=50%U) has been presented. These quantiles provide a baseline against which the impacted population can be evaluated, aiding in assessing the magnitude of impact and potential consequences.

2.2. SIMULATION PARAMETERS

16. 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 (5,000 runs is regarded as the standard approach and has been utilised in several offshore wind applications such as Hornsea Four Offshore Wind Farm, Awel Y Mor Offshore Wind Farm, Mona and Morgan Offshore Wind Farms, Berwick Bank Offshore Wind Farm and Green Volt Offshore Wind Farm). All models were run for a 50 year time span (to include the lifetime of the Array and beyond). Results are presented for a 35 year time span (the expected lifetime of the Array) alongside a 25 year and 50 year span (as recommended in NatureScot guidance (NatureScot, 2023b)).

17. 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 from the year the Array is anticipated to start operating (2039) and run for 50 years.

18. 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).

19. For the purpose of the Array EIA Report, the assessment has considered the impact on all birds and has not been corrected for sabbaticals. Further consideration on the relevance of sabbatical birds to estimating impacts on designated breeding populations is given in the Array RIAA (Ossian OWFL, 2024).

20. 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 has been used as previous analyses demonstrated that stochastic models using a matched runs approach were likely to be the most precautionary (Cook and Robinson, 2017). Productivity rates used within the analysis were therefore unaffected by impacts from the offshore wind farm.

2.3. MODEL PARAMETERISATION

2.3.1. DEMOGRAPHIC RATES

21. The survival rates for the species considered 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) (JNCC, 2023) (Table 2.1). These values matched with those set out within the most recent version of the nepva tool.

22. Survival rates vary depending on age class, with 0 to 1 used to represent birds below the age of one, age class 1 to 2 used to represent birds aged one, age class 2 to 3 representing two year olds and so on. Adults are grouped together as survival rates are consistent between adult aged birds regardless of actual age (e.g. seven year olds have the same survival rate as eight year olds and so on) (Table 2.1).

Table 2.1: Demographic Rates for Key Species. Derived from Horswill and Robinson (2015)

Species	Age at First Breeding	Eggs per Pair	Parameter	Age Class (Years)							Productivity (Chicks per Pair)
				Juvenile	0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	Adult	
Guillemot	6	1	Survival	N/A	0.56	0.792	0.917	0.939	0.939	0.939	0.583
			Proportion in population	N/A	0.153	0.084	0.065	0.058	0.053	0.587	
Razorbill	5	1	Survival	N/A	0.63	0.63	0.895	0.895	N/A	0.895	0.532
			Proportion in population	N/A	0.155	0.099	0.064	0.059	N/A	0.623	
Puffin	5	1	Survival	N/A	0.709	0.709	0.709	0.76	0.805	0.906	0.555
			Proportion in population	N/A	0.155	0.113	0.082	0.06	0.046	0.544	
Gannet	5	1	Survival	N/A	0.424	0.829	0.891	0.895	0.895	0.919	0.766
			Proportion in population	N/A	0.201	0.084	0.069	0.061	0.054	0.531	
Kittiwake	4	2	Survival	N/A	0.79	0.854	0.854	0.854	N/A	0.854	0.619
			Proportion in population	N/A	0.16	0.126	0.107	0.09	N/A	0.517	
Herring gull	5	3	Survival	N/A	0.798	0.834	0.834	0.834	0.834	0.834	0.498
			Proportion in population	N/A	0.132	0.11	0.096	0.084	0.073	0.505	

2.4. POPULATIONS

23. During the breeding season, the population derived from the Array alone assessment was utilised within the PVA modelling. Populations were derived using each species' foraging range as detailed within volume 3, appendix 11.1. Breeding populations used within the PVAs are shown in Table 2.2. Baseline mortality was estimated using the respective demographic rates for each species, as detailed in Table 2.1.

24. During the non-breeding season, impacts are put into the context of the BDMPS for each species (Table 2.2). Baseline mortality was estimated using the respective demographic rates for each species, as detailed in Table 2.1.

25. For the annual assessment, the population is defined as the largest of the individual seasonal regional populations, as further detailed within volume 3, appendix 11.1.

Table 2.2: Biologically Defined Population Scales for Use in the Assessment (Furness, 2015)

Species	Season	Region	BDMPS (no. of birds)	Baseline Mortality (no. of birds)
Guillemot	Breeding	Foraging Range	916,667	121,733
	Non-breeding	United Kingdom (UK) North Sea and Channel Waters	1,617,306	214,778
	Annual	UK North Sea and Channel Waters	1,617,306	214,778
Razorbill	Breeding	Foraging Range	54,552	9,399
	Non-breeding	UK North Sea and Channel Waters	218,622	37,669
	Annual	UK North Sea and Channel Waters	591,874	101,980
Puffin	Breeding	Foraging Range	279,803	49,357
Gannet	Breeding	Foraging Range	763,577	147,141
	Post-breeding	UK North Sea and Channel Waters	456,298	87,929
	Annual	Foraging Range	763,577	147,141
Kittiwake	Pre-breeding	UK North Sea Waters	627,816	98,065
	Breeding	Foraging Range	261,047	40,776
	Post-breeding	UK North Sea Waters	829,937	129,636
	Annual	UK North Sea Waters	829,937	129,636
Herring gull	Breeding	Foraging Range	13,836	2,363

2.4.1. IMPACT SCENARIOS

26. The impact from the Array cumulatively with surrounding offshore wind farms has been parametrised as a 'relative harvest' (i.e. the increase in baseline mortality rate as a result of the impact).

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

28. Each simulation run within the PVA model was paired with an impact scenario that included additional population-level mortality due to wind turbine collision or displacement effects. This additional mortality was calculated as a proportion of the starting population and applied to the adult age class only. This way, the number of additional deaths scaled proportionately with changes to the simulated number of breeding adults in the population.

29. For all six species and the relevant seasons, a range of impact levels has been modelled based on the cumulative impact values provided in volume 3, chapter 11. It is worth noting that only the impact scenarios that surpassed the 1% threshold have been taken forward to PVA modelling. Impact scenarios and input parameters for each run and for each species are presented in section 3.

3. INPUT PARAMETERS

3.1. CUMULATIVE

3.1.1. GUILLEMOT

30. The displacement values used in the PVA assessment for guillemot (Table 3.1) are based on the Cumulative Effects Assessment (CEA) presented in volume 3, chapter 11.

Table 3.1: Guillemot Relative Harvest PVA Input from Displacement

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	60% displacement, 3% mortality	2,406	0.002625
		60% displacement, 5% mortality	4,010	0.004375
	Non-breeding	60% displacement, 1% mortality	2,395	0.001481
		60% displacement, 3% mortality	7,184	0.004442
	Annual	60% displacement, 1% mortality	4,801	0.002969
		60% displacement, 3% mortality	11,194	0.006921
Applicant's Approach	Annual	50% displacement, 1% mortality	2,664	0.001647
Without Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	60% displacement, 5% mortality	1,786	0.001948
	Non-breeding	60% displacement, 3% mortality	6,389	0.003950
	Annual	60% displacement, 1% mortality	3,201	0.001979
		60% displacement, 3% mortality	8,175	0.005055

3.1.2. RAZORBILL

31. The displacement values used in the PVA assessment for razorbill (Table 3.2) are based on the CEA presented in volume 3, chapter 11.

Table 3.2: Razorbill Relative Harvest PVA Input from Displacement

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	60% displacement, 3% mortality	336	0.006159
		60% displacement, 5% mortality	560	0.010265
	Non-breeding	60% displacement, 3% mortality	623	0.002850
	Annual	60% displacement, 1% mortality	1,213	0.005548
		60% displacement, 3% mortality	3,192	0.005393
Without Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	60% displacement, 3% mortality	263	0.004821
		60% displacement, 5% mortality	439	0.008047
	Non-breeding	60% displacement, 3% mortality	597	0.002731
	Annual	60% displacement, 1% mortality	1,034	0.001747
		60% displacement, 3% mortality	2,752	0.004650

3.1.3. PUFFIN

32. The displacement values used in the PVA assessment for puffin (Table 3.3) are based on the CEA presented in volume 3, chapter 11.

Table 3.3: Puffin Relative Harvest PVA Input from Displacement

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
	Breeding	60% displacement, 5% mortality	774	0.002766
Without Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	60% displacement, 5% mortality	638	0.002280

3.1.4. GANNET

33. The collision and combined displacement and collision values used in the PVA assessment for gannet (Table 3.4 and Table 3.5) are based on the CEA presented in volume 3, chapter 11.

Table 3.4: Gannet Relative Harvest PVA Input from Collision

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Post-breeding	0.993 avoidance rate	1,052.48	0.002307
	Annual	0.993 avoidance rate	1,966.19	0.002575
Without Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Annual	0.993 avoidance rate	1,774.78	0.002324

Table 3.5: Gannet Relative Harvest PVA Input from Combined Displacement and Collision

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	0.993 avoidance rate, 70% displacement, 3% mortality	1,662	0.002177
	Post breeding	0.993 avoidance rate, 70% displacement, 3% mortality	1,218	0.001595
	Annual	0.993 avoidance rate, 70% displacement, 1% mortality	2,394	0.005247

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
		0.993 avoidance rate, 70% displacement, 3% mortality	3,249	0.004255
Applicant's Approach	Annual	0.993 avoidance rate, 70% displacement, 1% mortality	2,394	0.003135
Without Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Post-breeding	0.993 avoidance rate, 70% displacement, 3% mortality	1,169	0.002562
	Annual	0.993 avoidance rate, 70% displacement, 1% mortality	2,157	0.002825
		0.993 avoidance rate, 70% displacement, 3% mortality	2,922	0.003827
Applicant's Approach	Annual	0.993 avoidance rate, 70% displacement, 1% mortality	2,157	0.002825

3.1.5. KITTIWAKE

34. The displacement and collision (Table 3.6 and Table 3.7) and the combined displacement and collision values (Table 3.8) used in the PVA assessment for kittiwake are based on the CEA presented in volume 3, chapter 11.

Table 3.6: Kittiwake Relative Harvest PVA Input from Displacement

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	30% displacement, 3% mortality	566	0.002168
	Annual	30% displacement, 3% mortality	1,923	0.002317
Without Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Annual	30% displacement, 3% mortality	1,508	0.001817

Table 3.7: Kittiwake Relative Harvest PVA Input from Collision

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Pre-breeding	0.993 avoidance rate	1,020.62	0.001626
	Breeding	0.993 avoidance rate	1,514.44	0.005801
	Annual	0.993 avoidance rate	3,572.30	0.004304
Without Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	0.993 avoidance rate	897.44	0.003438
	Annual	0.993 avoidance rate	2,586.30	0.003116

Table 3.8: Kittiwake Relative Harvest PVA Input from Combined Displacement and Collision

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Pre-Breeding	0.993 avoidance rate, 30% displacement, 1% mortality	1,225	0.001951
		0.993 avoidance rate, 30% displacement, 3% mortality	1,634	0.002603
	Breeding	0.993 avoidance rate, 30% displacement, 1% mortality	1,703	0.006524
		0.993 avoidance rate, 30% displacement, 3% mortality	2,080	0.007968
	Post-breeding	0.993 avoidance rate, 30% displacement, 3% mortality	1,781	0.002146
	Annual	0.993 avoidance rate, 30% displacement, 1% mortality	4,213	0.005076
		0.993 avoidance rate, 30% displacement, 3% mortality	5,495	0.006621
Applicant's Approach	Pre-breeding	0.993 avoidance rate, 30% displacement, 1% mortality	1,225	0.001951
	Breeding	0.993 avoidance rate, 30% displacement, 1% mortality	1,703	0.006524
	Annual	0.993 avoidance rate, 30% displacement, 1% mortality	4,213	0.005076

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
Without Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Pre-breeding	0.993 avoidance rate, 30% displacement, 1% mortality	1,005	0.001601
		0.993 avoidance rate, 30% displacement, 3% mortality	1,331	0.002120
	Breeding	0.993 avoidance rate, 30% displacement, 1% mortality	1,023	0.003919
		0.993 avoidance rate, 30% displacement, 3% mortality	1,273	0.004877
	Post-breeding	0.993 avoidance rate, 30% displacement, 3% mortality	1,490	0.001795
	Annual	0.993 avoidance rate, 30% displacement, 1% mortality	3,089	0.003722
		0.993 avoidance rate, 30% displacement, 3% mortality	4,094	0.004933
Applicant's Approach	Pre-breeding	0.993 avoidance rate, 30% displacement, 1% mortality	1.005	0.000002
	Breeding	0.993 avoidance rate, 30% displacement, 1% mortality	1,023	0.001233
	Annual	0.993 avoidance rate, 30% displacement, 1% mortality	3,089	0.003722

3.1.6. HERRING GULL

35. The collision values used in the PVA assessment for herring gull (Table 3.9) are based on the CEA presented in volume 3, chapter 11).

Table 3.9: Herring Gull Relative Harvest PVA Input for the UK Western Waters BDMPS

Approach	Season	Impact Rates	Predicted Mortality (Original impact) (no. of birds)	Predicted Impact on Adult Survival Rate (no. of absolute mortalities)
With Berwick Bank Offshore Wind Farm Impacts				
NatureScot Approach	Breeding	0.994 avoidance rate	64.4	0.00466

4. CUMULATIVE PVA ASSESSMENT OUTPUTS

36. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms on each species outlined in section 3.1 at the start of the operation and maintenance phase (2039) and for a 25 year timespan (section 4.1), the expected lifespan of the Array (35 years; section 4.2) and a 50 year timespan (section 4.3) are presented below. The baseline 'unimpacted' scenarios (i.e. assuming no additional mortality other than baseline mortality exists) is also shown for comparison purposes. Graphs relating to population size, CPS and CPGR for each impact scenario for the lifetime of the Array are also presented.

4.1. RESULTS: AFTER 25 YEARS

4.1.1. GUILLEMOT

37. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the guillemot UK BDMPS at the start of the operation and maintenance phase (2039) and for a 25 year timespan are presented in Table 4.1. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.1: Guillemot 25 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	2,406	0.9915	0.9670	0.4185	3.30%	58.15%	0	100
	NatureScot Approach - 60% displacement, 5% mortality	4,010	0.9690	0.9451	0.2302	5.49%	76.98%	0	100
Non-breeding	Baseline	0	1.0254	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	2,395	1.0223	0.9972	0.9300	0.28%	7.00%	35.40	65.28

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	NatureScot Approach - 60% displacement, 3% mortality	7,184	1.0173	0.9916	0.8037	0.84%	19.63%	13.12	87.68
Annual	Baseline	0	1.0254	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	4,801	1.0194	0.9944	0.8643	0.56%	13.57%	22.96	77.72
	NatureScot Approach - 60% displacement, 3% mortality	11,194	1.0118	0.9870	0.7110	1.30%	28.90%	3.68	96.32
	Applicant's Approach - 50% displacement, 1% mortality	2,664	1.0220	0.9969	0.9224	0.31%	7.76%	34.04	66.28
Without Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 5% mortality	1,786	1.0001	0.9755	0.5251	2.45%	47.49%	0	100
Non-breeding	Baseline	0	1.0254	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	6,839	1.0170	0.9920	0.8123	0.80%	18.77%	14.12	86.32
Annual	Baseline	0	1.0254	1.000	1.000	N/A	N/A		
	NatureScot Approach - 60% displacement, 1% mortality	3,201	1.0213	0.9963	0.9075	0.37%	9.25%	31.28	69.64
	NatureScot Approach - 60% displacement, 3% mortality	8,175	1.0154	0.9905	0.7798	0.95%	22.02%	10.08	90.48

4.1.2. RAZORBILL

38. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the razorbill UK BDMPS at the start of the operation and maintenance phase (2039) and for a 25 year timespan are presented in Table 4.2. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.2: Razorbill 25 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9770	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	336	0.9522	0.9747	0.5136	2.53%	48.64%	4.4	96.84
	NatureScot Approach - 60% displacement, 5% mortality	560	0.9357	0.9579	0.3265	4.21%	67.35%	0.28	99.96
Non-breeding	Baseline	0	0.9774	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	623	0.9700	0.9931	0.8358	0.69%	16.42%	32.88	66.80
Annual	Baseline	0	0.9775	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	1,213	0.9721	0.9953	0.8848	0.47%	11.52%	38.24	62.04
	NatureScot Approach - 60% displacement, 3% mortality	3,192	0.9646	0.9876	0.7231	1.24%	27.69%	20.64	79.04
Without Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9770	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	263	0.9575	0.9802	0.5945	1.98%	40.55%	9.2	92.56

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	NatureScot Approach - 60% displacement, 5% mortality	439	0.9446	0.9670	0.4173	3.30%	58.27%	1.4	99.32
Non-breeding	Baseline	0	0.9774	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	597	0.9702	0.9934	0.8419	0.66%	15.81%	33.72	66.28
Annual	Baseline	0	0.9775	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	1,034	0.9728	0.9960	0.9009	0.40%	9.91%	40.36	60.20
	NatureScot Approach - 60% displacement, 3% mortality	2,752	0.9662	0.9893	0.7565	1.07%	24.35%	24.56	75.56

4.1.3. PUFFIN

39. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the puffin UK BDMPS at the start of the operation and maintenance phase (2039) and for a 25 year timespan are presented in Table 4.3. The baseline 'unimpacted' is also shown for comparison purposes.

Table 4.3: Puffin 25 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9801	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 5% mortality	774	0.9743	0.9941	0.8570	0.59%	14.30%	35.96	63.04
Without Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9801	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 5% mortality	638	0.9754	0.9951	0.8805	0.49%	11.95%	38	60.48

4.1.4. GANNET

40. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the gannet UK BDMPS at the start of the operation and maintenance phase (2039) and for a 25 year timespan are presented in Table 4.4. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.4: Gannet 25 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,662	1.0072	0.9954	0.8863	0.46%	11.37%	28.28	71.44
Post-breeding	Baseline	0	1.0124	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,052.48	1.0067	0.9949	0.8753	0.51%	12.47%	29.84	72.16
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,218	1.0059	0.9941	0.8571	0.59%	14.29%	27.00	74.96
Annual	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,966.19	1.0064	0.9945	0.8669	0.55%	13.31%	24.84	74.96
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,394	1.0052	0.9933	0.8403	0.67%	15.97%	20.52	79.40
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	3,249	1.0027	0.9909	0.7894	0.91%	21.06%	13.72	87.32
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,394	1.0051	0.9933	0.8402	0.67%	15.98%	20.56	79.40
Without Berwick Bank Offshore Wind Farm Impacts									
Post-breeding	Baseline	0	1.0124	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,169	1.0061	0.9943	0.8623	0.57%	13.77%	27.60	73.96
Annual	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,774.78	1.0069	0.9951	0.8791	0.49%	12.09%	26.88	73.04
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,157	1.0058	0.9940	0.8549	0.60%	14.51%	22.92	77.00
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	2,992	1.0035	0.9917	0.8043	0.83%	19.57%	15.20	85.00
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,157	1.0058	0.9940	0.8549	0.60%	14.51%	23.04	76.96

4.1.5. KITTIWAKE

41. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the kittiwake UK BDMPS at the start of the operation and maintenance phase (2039) and for a 25 year timespan are presented in Table 4.5. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.5: Kittiwake 25 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Pre-breeding	Baseline	0	0.9953	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance	1,020.62	0.9917	0.9968	0.9198	0.32%	8.02%	44.56	55.68
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,225	0.9911	0.9961	0.9046	0.39%	9.54%	43.48	56.72
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,634	0.9898	0.9949	0.8745	0.51%	12.55%	41.48	59.20
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,225	0.9911	0.9961	0.9043	0.39%	9.57%	43.72	56.68
Breeding	Baseline	0	0.9949	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,514.44	0.9824	0.9871	0.7133	1.29%	28.67%	27.00	74.24
	NatureScot Approach – 30% displacement, 3% mortality	566	0.9905	0.9952	0.8820	0.48%	11.80%	40.52	58.72
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 1% mortality	1,703	0.9808	0.9855	0.6838	1.45%	31.62%	24.40	76.40
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 3% mortality	2,080	0.9776	0.9823	0.6282	1.77%	37.18%	19.92	80.52
	Applicant's Approach – 0.993 avoidance rate, 30% displacement, 1%	1,703	0.9808	0.9855	0.6841	1.45%	31.59%	24.40	76.40
Post-breeding	Baseline	0	0.9951	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 3% mortality	1,781	0.9907	0.9956	0.8920	0.44%	10.80%	42.8	57.36
Annual	Baseline	0	0.9953	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate	3,572.30	0.9862	0.9912	0.7947	0.88%	20.53%	35.56	65.08
	NatureScot Approach - 30% displacement, 3% mortality	1,923	0.9902	0.9953	0.8841	0.47%	11.59%	42.24	58.40
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	4,213	0.9847	0.9896	0.7627	1.04%	23.73%	32.88	67.44

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	5,495	0.9815	0.9865	0.7015	1.35%	29.85%	27.92	71.72
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	4,213	0.9846	0.9896	0.7628	1.04%	23.72%	32.92	67.52
Without Berwick Bank Offshore Wind Farm Impacts									
Pre-breeding	Baseline	0	0.9953	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,005	0.9918	0.9968	0.9210	0.32%	7.90%	44.60	55.76
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,331	0.9907	0.9958	0.8967	0.42%	10.33%	43.16	57.20
	Applicants Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,005	0.9918	0.9968	0.9210	0.32%	7.90%	44.84	55.64
Breeding	Baseline	0	0.9949	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate	897.44	0.9876	0.9924	0.8193	0.76%	18.07%	35.52	64.20
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,023	0.9865	0.9913	0.7965	0.87%	20.35%	33.60	66.36
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,273	0.9845	0.9892	0.7532	1.08%	24.68%	30.24	70.84
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,023	0.9866	0.9913	0.7965	0.87%	20.35%	33.52	66.16
Post-breeding	Baseline	0	0.9951	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,490	0.9913	0.9963	0.9089	0.37%	9.11%	43.88	56.44
Annual	Baseline	0	0.9949	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	2,586.30	0.9886	0.9936	0.8469	0.64%	15.31%	39.68	60.68
	NatureScot Approach- 30% displacement, 3% mortality	1,508	0.9912	0.9963	0.9078	0.37%	9.22%	43.92	56.52
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 1% mortality	3,089	0.9873	0.9924	0.8200	0.76%	18.00%	37.28	62.88

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 3% mortality	4,094	0.9849	0.9899	0.7683	1.01%	23.17%	33.52	67.00
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 30% displacement, 1% mortality	3,089	0.9873	0.9924	0.8200	0.76%	18.00%	37.28	62.88

4.1.6. HERRING GULL

42. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the herring gull UK BDMPS at the start of the operation and maintenance phase (2039) and for a 25 year timespan are presented in Table 4.6. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.6: Herring Gull 25 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 25 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9501	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.994 avoidance rate	64.4	0.9445	0.9943	0.86206	0.57%	13.79%	37.2	63.88

4.2. RESULTS: AFTER 35 YEARS

4.2.1. GUILLEMOT

43. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the guillemot UK BDMPS at the start of the operation and maintenance phase (2039) and for the expected lifespan of the Array (35 years) are presented in Table 4.7. The baseline 'unimpacted' scenario is also shown for comparison purposes.

44. As part of NatureScot guidance (2023b), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such the population size graphs are shown in Figure 4.1 for the breeding season, Figure 4.4 for the non-breeding season and Figure 4.7 for the annual projection. CPGR graphs are shown in Figure 4.2 for the breeding season, Figure 4.5 for the non-breeding season and Figure 4.8 annually. Figure 4.3, Figure 4.6 and Figure 4.9 show the CPS values for the breeding, non-breeding season and for also for annually.

45. Note that due to window width, impact scenarios had to be abbreviated to ensure the graphs could be clearly read. As such the following impact scenarios have been abbreviated in the figure headings:

- breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Statutory Nature Conservation Body (SNCB) Low with BB; and
  - NatureScot Approach – 60% displacement, 5% mortality with Berwick Bank Offshore Wind Farm = SNCB High with BB.
- non-breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = SNCB Low with BB; and
  - NatureScot Approach – 60% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = SNCB High with BB.
- annual with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = SNCB Low with BB;
  - NatureScot Approach – 60% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = SNCB High with BB; and
  - Applicant's Approach - 50% displacement, 1% mortality with Berwick Bank = Applicant with BB.
- breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach - 60% displacement, 5% mortality without Berwick Bank Offshore Wind Farm = SNCB High without BB.
- non-breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 3% mortality without Berwick Bank = SNCB High without BB.
- annual without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = SNCB Low without BB; and
  - NatureScot Approach – 60% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = SNCB High without BB.

Table 4.7: Guillemot 35 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	2,406	0.9915	0.9670	0.2986	3.30%	70.14%	0	100
	NatureScot Approach - 60% displacement, 5% mortality	4,010	0.9689	0.9450	0.1303	5.50%	86.97%	0	100
Non-breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	2,395	1.0224	0.9972	0.9042	0.28%	9.58%	32.92	69.40
	NatureScot Approach - 60% displacement, 3% mortality	7,184	1.0167	0.9916	0.7385	0.84%	26.15%	8.32	92.68
Annual	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	4,801	1.0195	0.9944	0.8169	0.56%	18.31%	17.72	83.92
	NatureScot Approach - 60% displacement, 3% mortality	11,194	1.0119	0.9869	0.6229	1.31%	37.71%	1.52	98.92
	Applicant's Approach - 50% displacement, 1% mortality	2,664	1.0221	0.9969	0.8940	0.31%	10.60%	31.04	71.24
Without Berwick Bank **Offshore Wind Farm Impacts**									
Breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 5% mortality	1,786	1.0001	0.9755	0.4092	2.45%	59.08%	0	100
Non-breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	6,389	1.0171	0.9920	0.7494	0.80%	25.06%	9.00	92.00
Annual	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	3,201	1.0214	0.9963	0.8740	0.37%	12.60%	27.56	74.76
	NatureScot Approach - 60% displacement, 3% mortality	8,175	1.0155	0.9905	0.7081	0.95%	29.19%	5.04	95.28

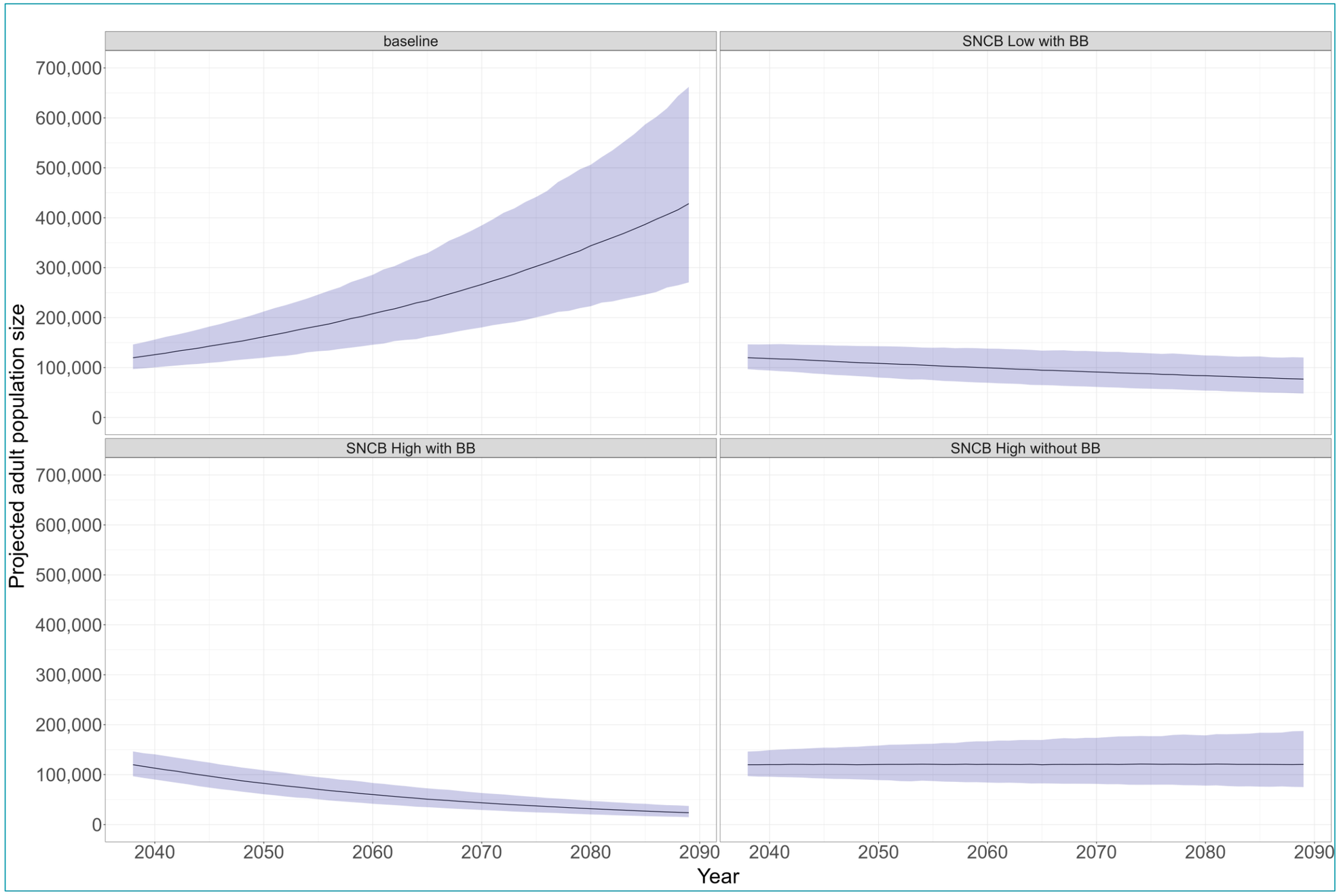

Figure 4.1 **Guillemot Population Projection over 35 years during the Breeding Season under a Range of Impact Scenarios**

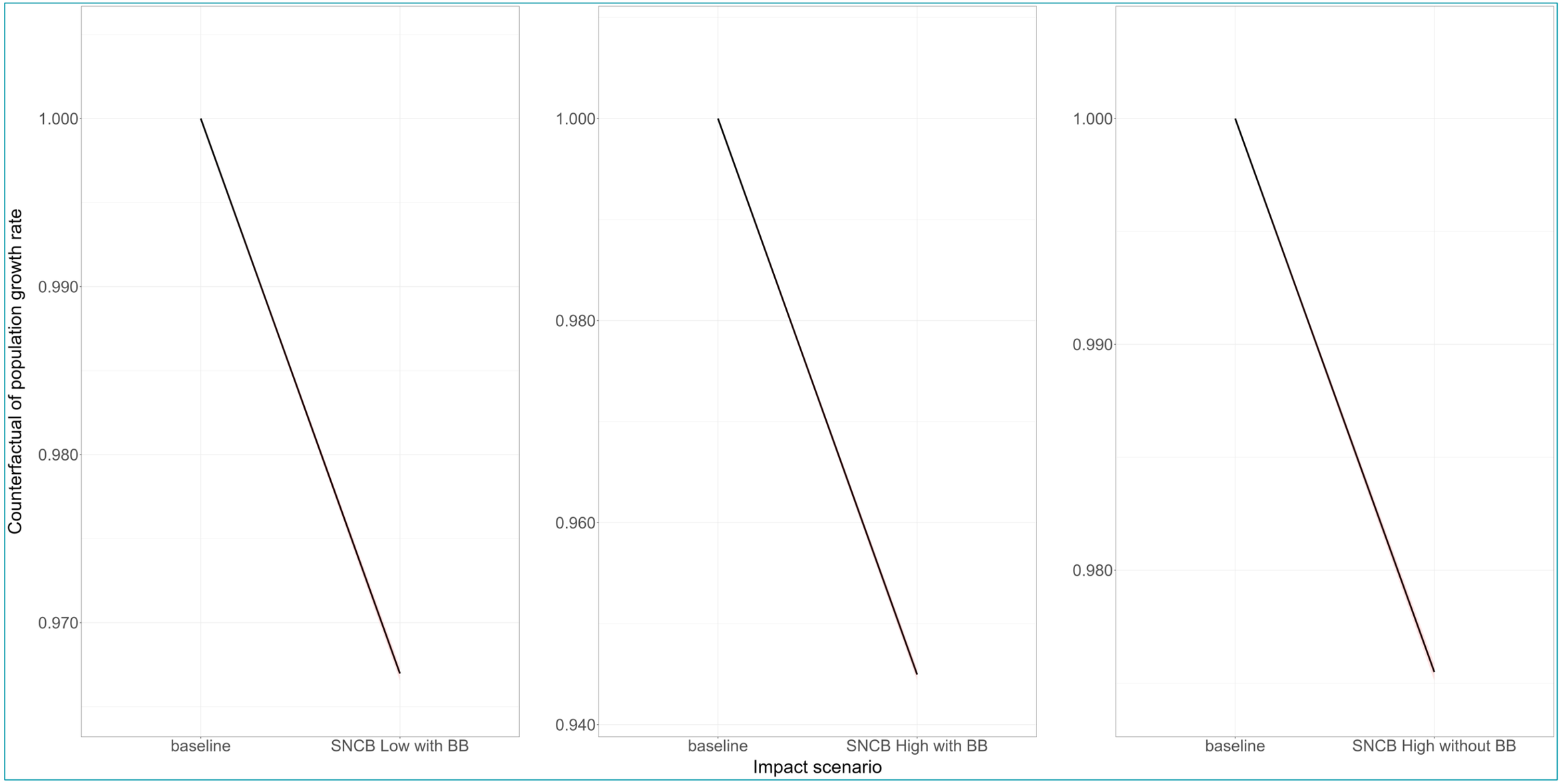

Figure 4.2 **Ratio of Impacted Growth Rates after 35 Years for the Guillemot Population during the Breeding Season under a Range of Impact Scenarios**

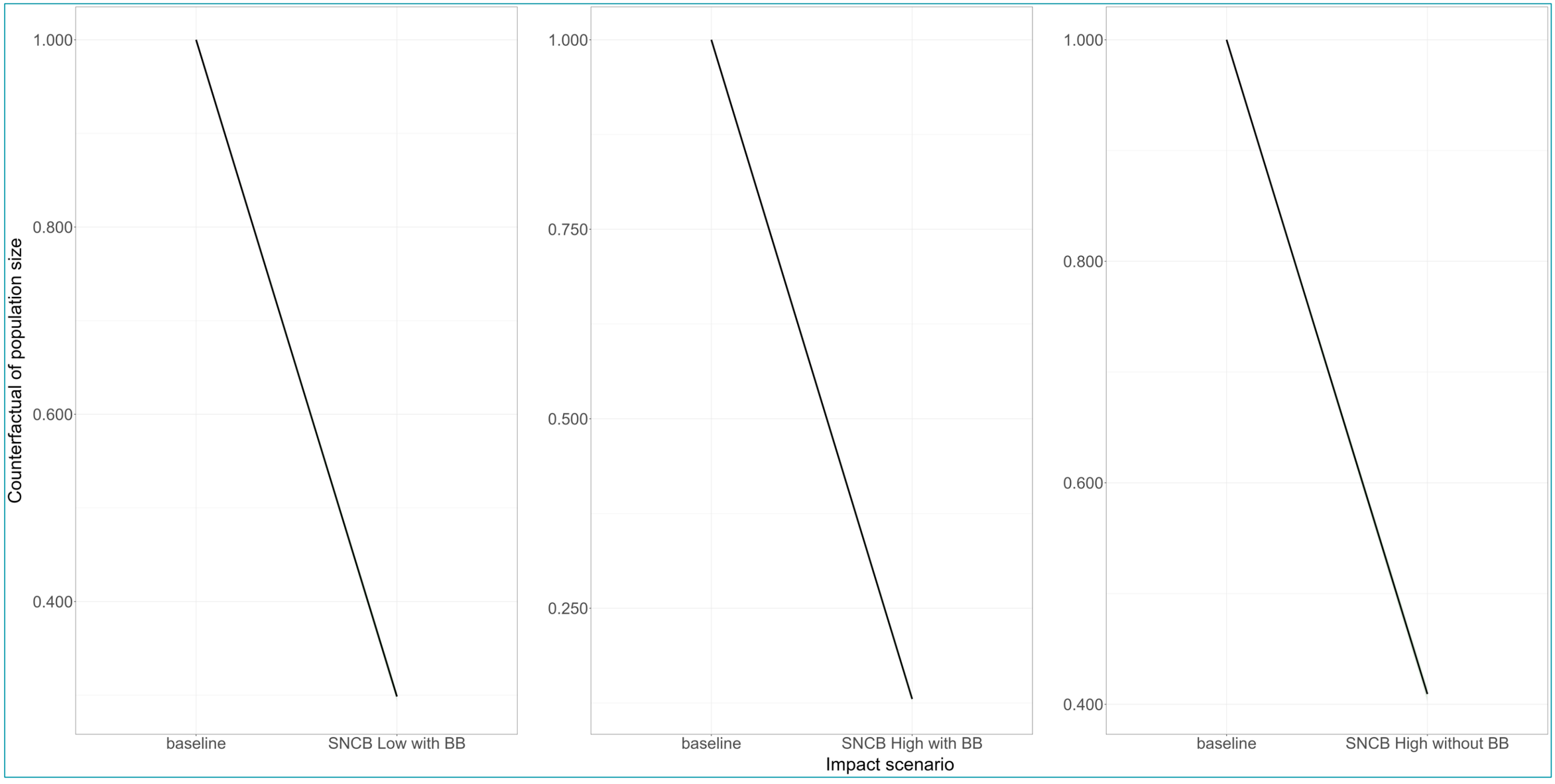

Figure 4.3 The Ratio of the Median Impacted Population Sizes for the Guillemot Population during the Breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

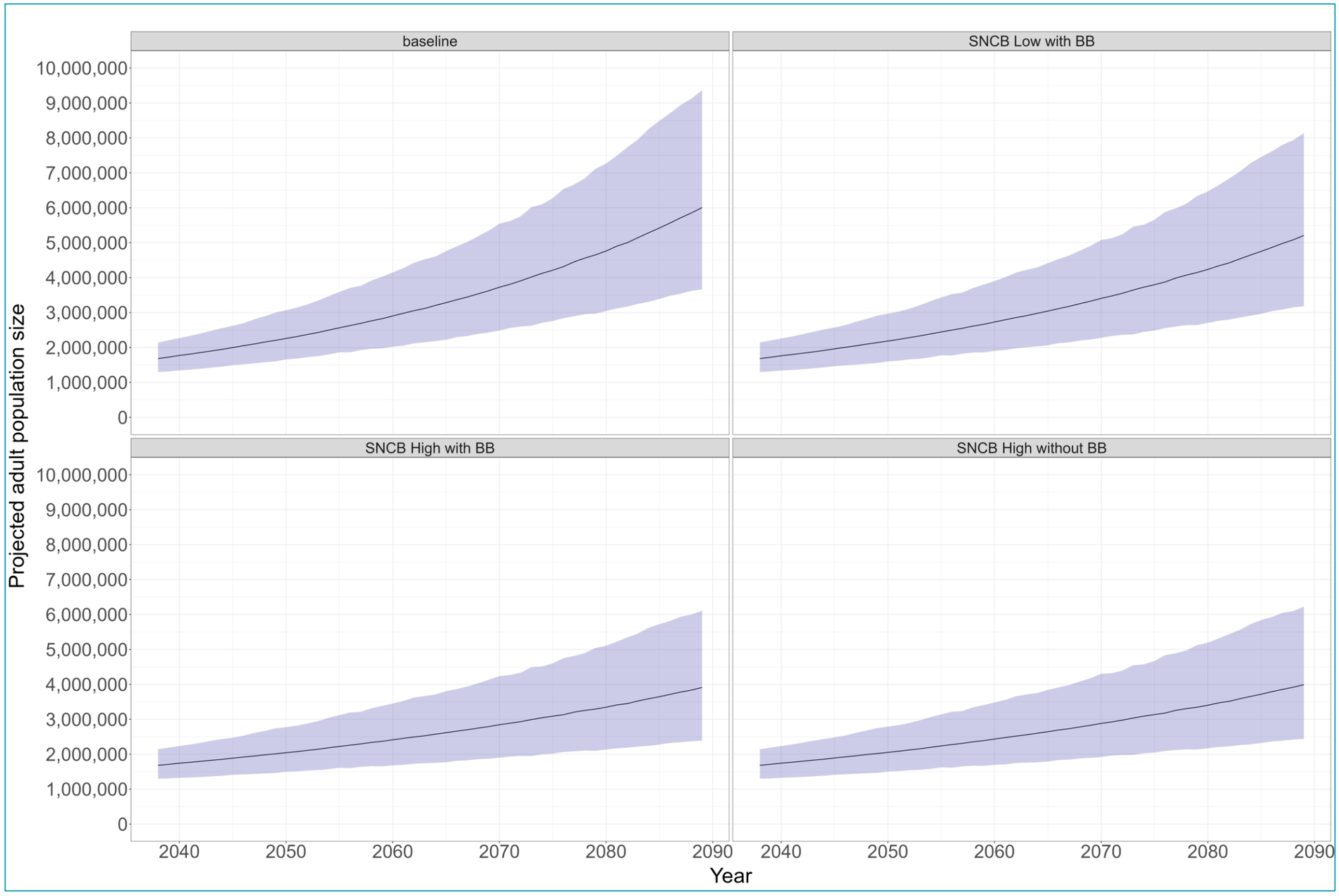

Figure 4.4 **Guillemot Population Projection over 35 years during the Non-breeding Season under a Range of Impact Scenarios**

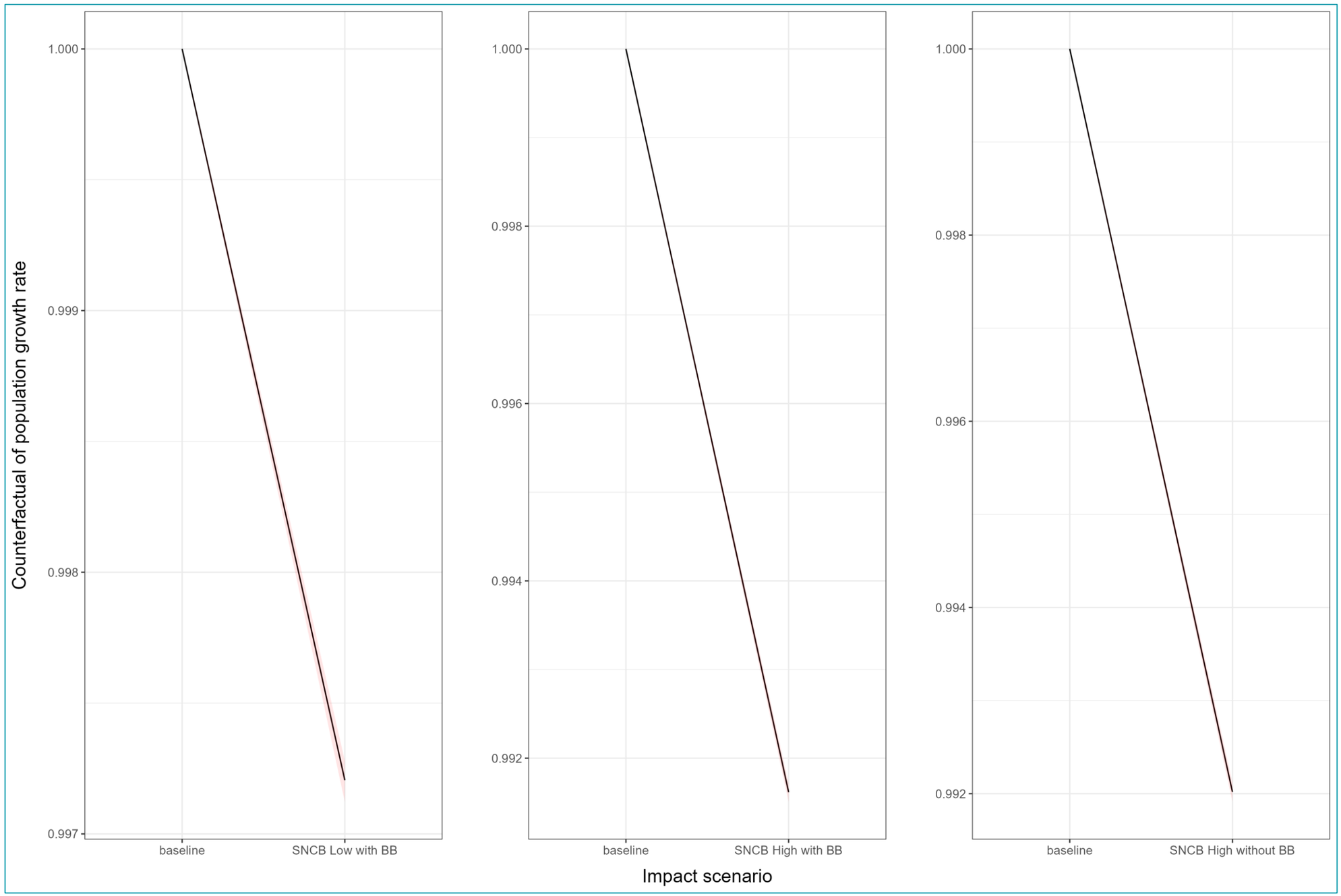

Figure 4.5 Ratio of Impacted Growth Rates after 35 Years for the Guillemot Population during the Non-breeding Season under a Range of Impact Scenarios

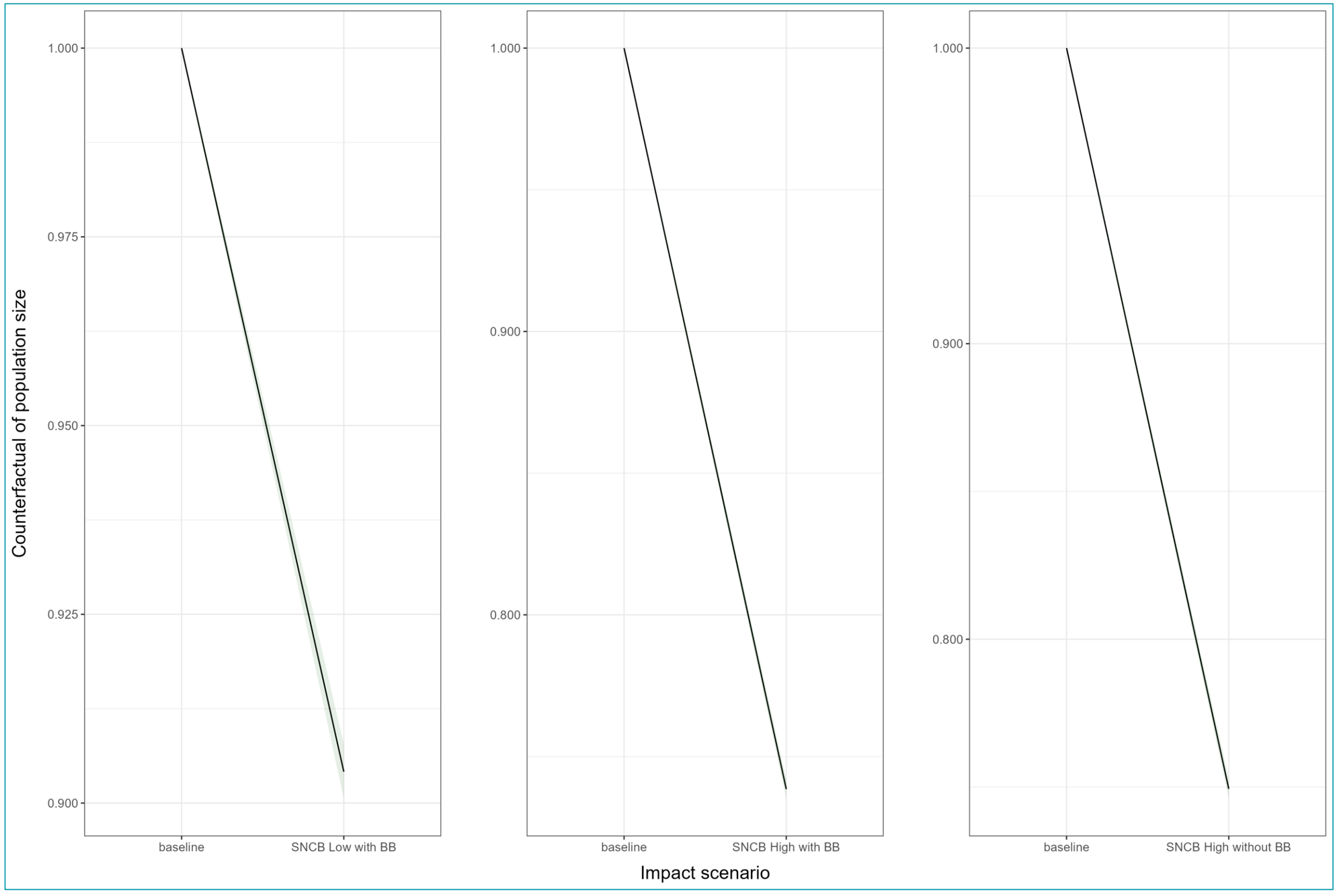

Figure 4.6 The Ratio of the Median Impacted Population Sizes for the Guillemot Population during the Non-breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

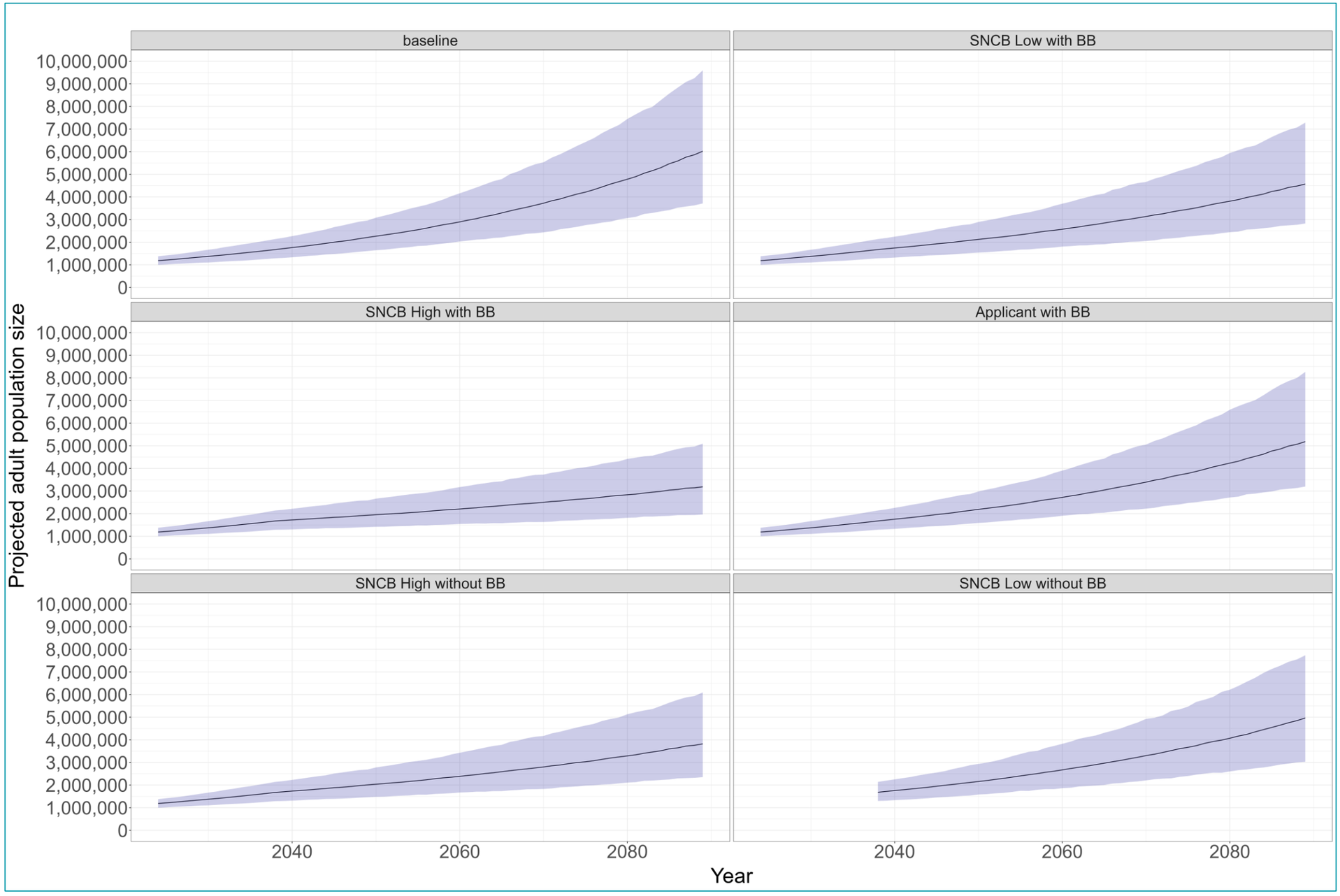

Figure 4.7 Annual Guillemot Population Projection over 35 years under a Range of Impact Scenarios

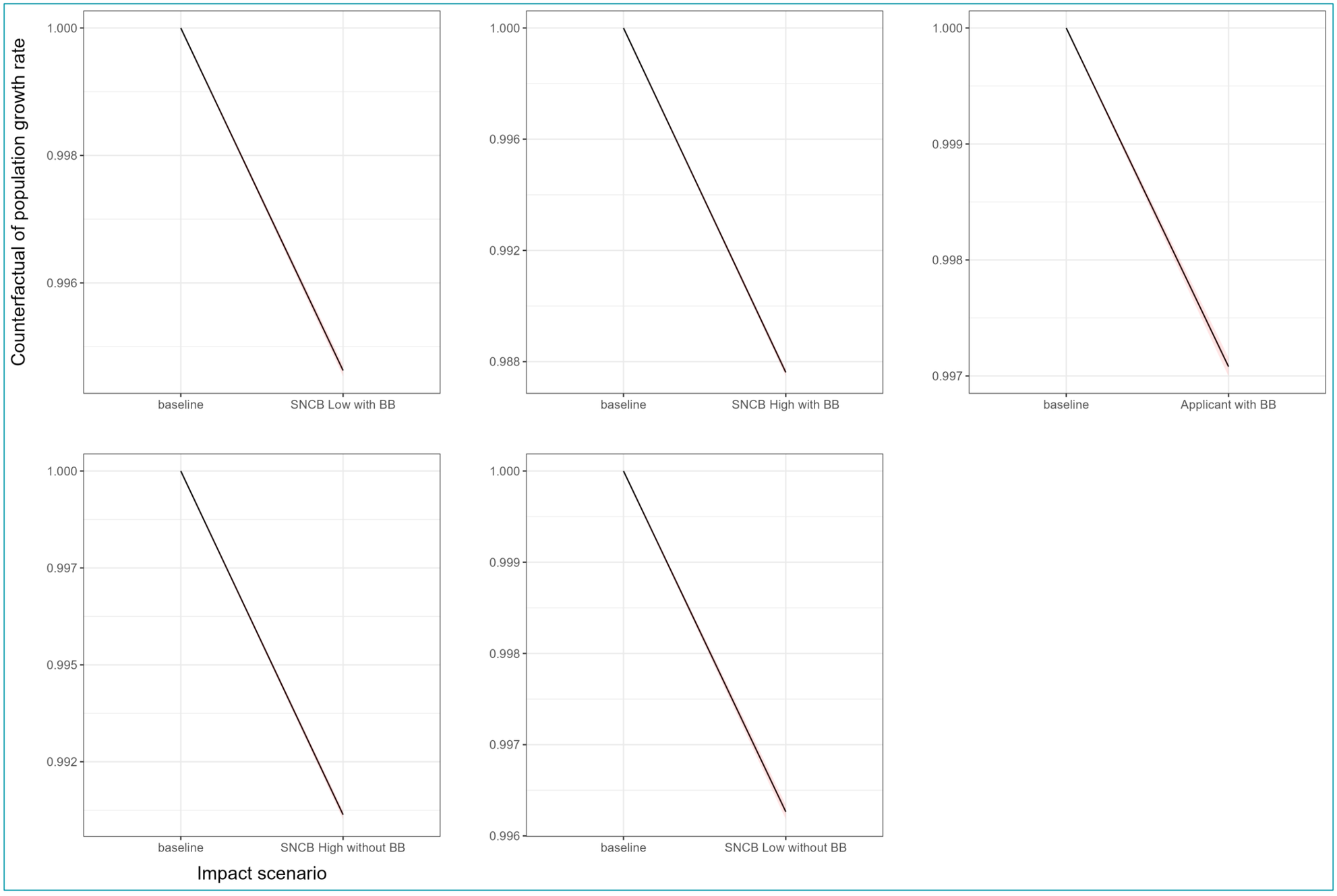

Figure 4.8 Ratio of Impacted Growth Rates after 35 Years for the Guillemot Population Annually under a Range of Impact Scenario

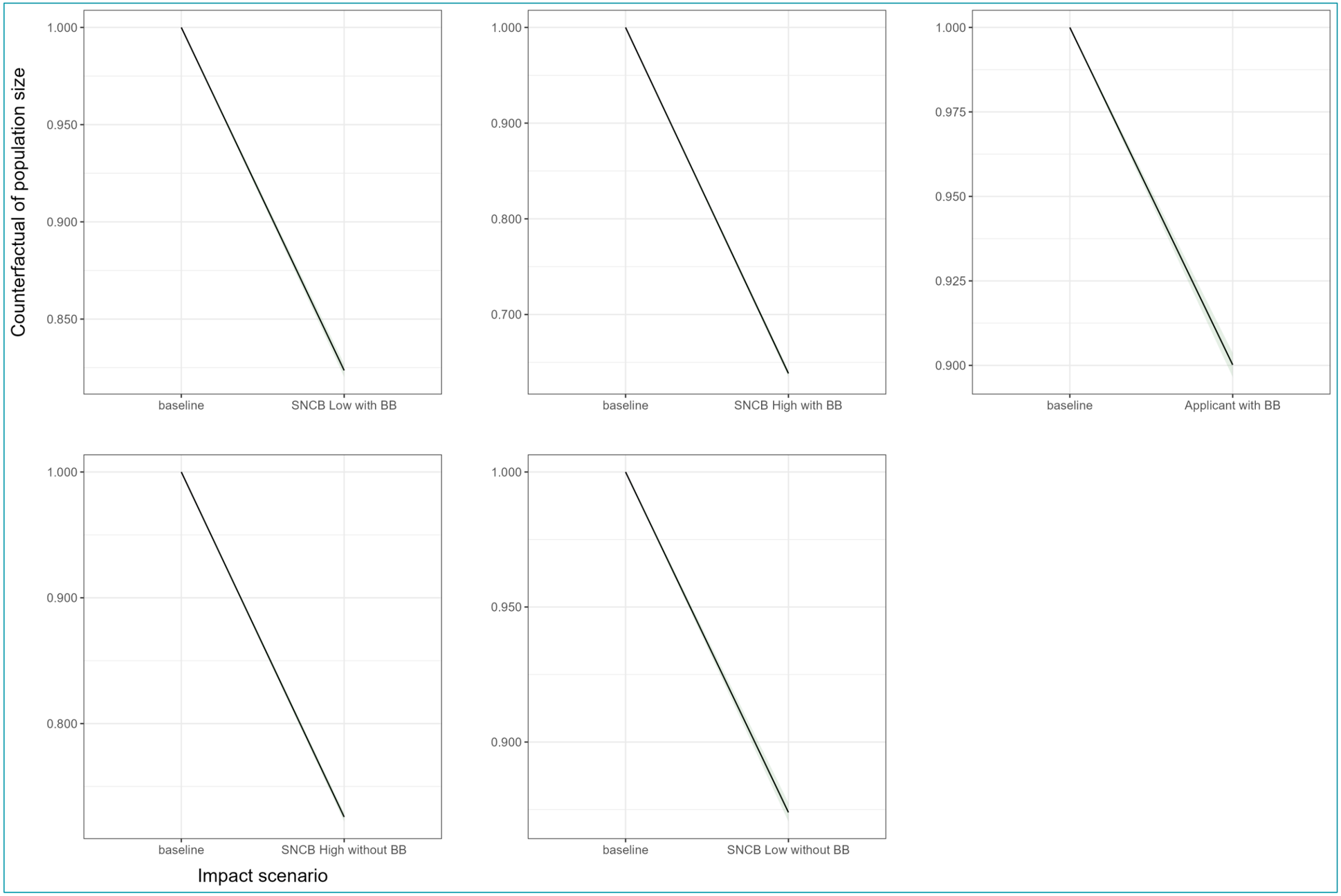

Figure 4.9 The Ratio of the Median Impacted Population Sizes for the Guillemot Population Annually from the Simulations after 35 Years under a Range of Impact Scenarios

4.2.2. RAZORBILL

46. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the razorbill UK BDMPS at the start of the operation and maintenance phase (2039) and for the expected lifespan of the Array (35 years) are presented in Table 4.8. The baseline 'unimpacted' scenario is also shown for comparison purposes.

47. As part of NatureScot guidance (2023b), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such the population size graphs are shown in Figure 4.10 for the breeding season, Figure 4.13 for the non-breeding season and Figure 4.16 for the annual projection. CPGR graphs are shown in Figure 4.11 for the breeding season Figure 4.14 for the non-breeding season and Figure 4.17 annually. Figure 4.12, Figure 4.15 and Figure 4.18 show the CPS values for the breeding, non-breeding season and for annually also.

48. Note that due to window width, impact scenarios had to be abbreviated to ensure the graphs could be clearly read. As such the following impact scenarios have been abbreviated in the figure headings:

- breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 3% mortality with Berwick Bank = SNCB Low with BB; and
  - NatureScot Approach – 60% displacement, 5% mortality with Berwick Bank Offshore Wind Farm = SNCB High with BB.
- non-breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = SNCB High with BB.
- annual with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = SNCB Low with BB; and
  - NatureScot Approach – 60% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = SNCB High with BB.
- breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = SNCB Low without BB; and
  - NatureScot Approach – 60% displacement, 5% mortality without Berwick Bank Offshore Wind Farm = SNCB High without BB.
- non-breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = SNCB High without BB.
- annual without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = SNCB Low without BB.
  - NatureScot Approach – 60% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = SNCB High without BB.

Table 4.8: Razorbill 35 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	336	0.9520	0.9747	0.3973	2.53%	60.27%	1.76	99.04
	NatureScot Approach - 60% displacement, 5% mortality	560	0.9354	0.9578	0.2119	4.22%	78.81%	0	100
Non-breeding	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	623	0.9702	0.9931	0.7800	0.69%	22.00%	27.40	72.40
Annual	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	1,213	0.9724	0.9953	0.8437	0.47%	15.63%	34.16	65.64
	NatureScot Approach - 60% displacement, 3% mortality	3,192	0.9649	0.9876	0.6382	1.24%	36.18%	14.60	85.64
Without Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	263	0.9574	0.9802	0.4865	1.98%	51.35%	4.48	96.32
	NatureScot Approach - 60% displacement, 5% mortality	439	0.9445	0.9669	0.2981	3.31%	70.19%	0.32	99.84
Non-breeding	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	597	0.9711	0.9942	0.8093	0.58%	19.07%	31.04	68.36
Annual	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	NatureScot Approach - 60% displacement, 1% mortality	1,034	0.9730	0.9960	0.8651	0.40%	13.49%	36.40	63.28
	NatureScot Approach - 60% displacement, 3% mortality	2,752	0.9665	0.9893	0.6789	1.07%	32.11%	18.04	82.16

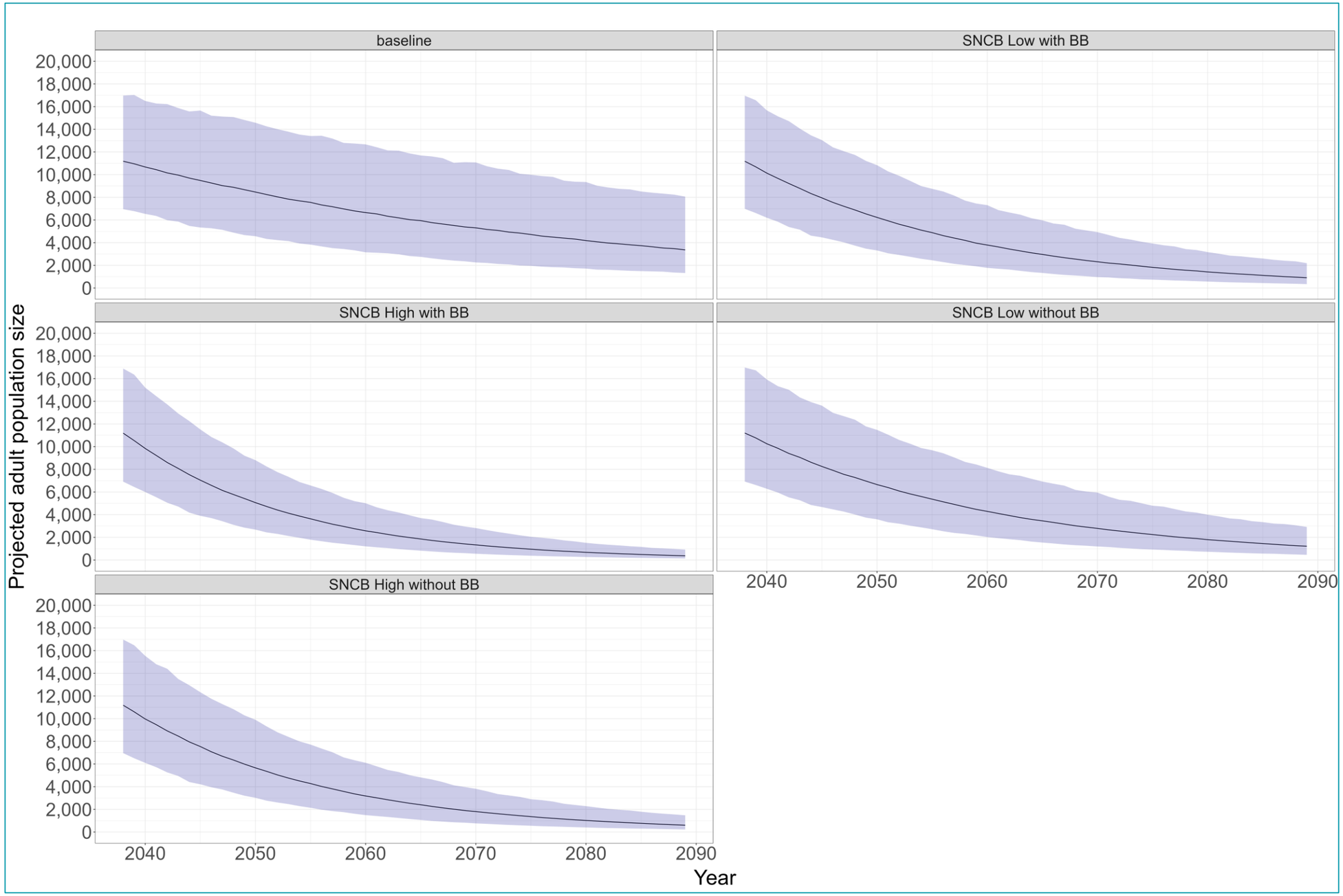

Figure 4.10 Razorbill Population Projection over 35 Years during the Breeding Season under a Range of Impact Scenarios

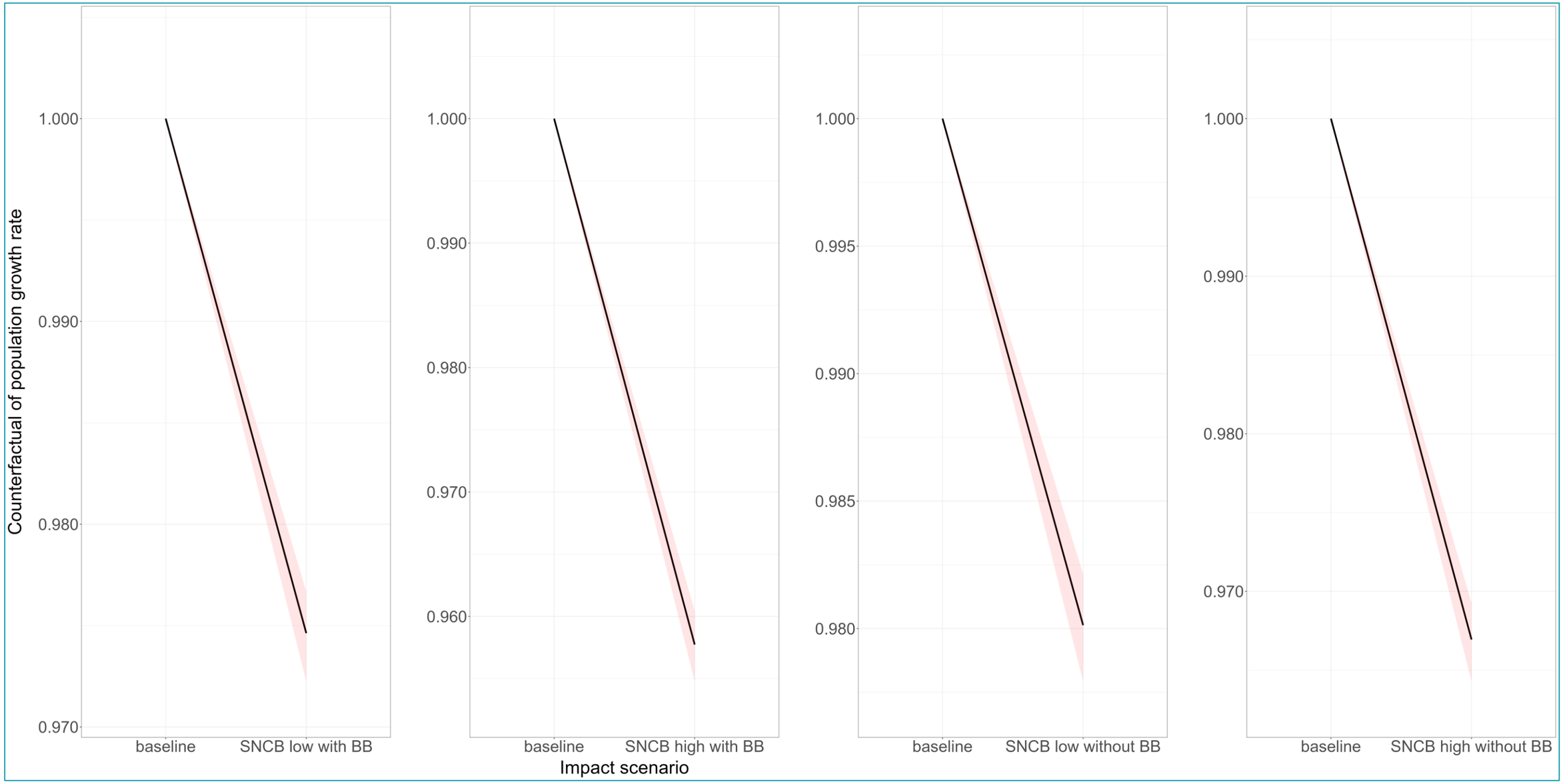

Figure 4.11 Ratio of Impacted Growth Rates after 35 Years for the Razorbill Population during the Breeding Season under a Range of Impact Scenarios

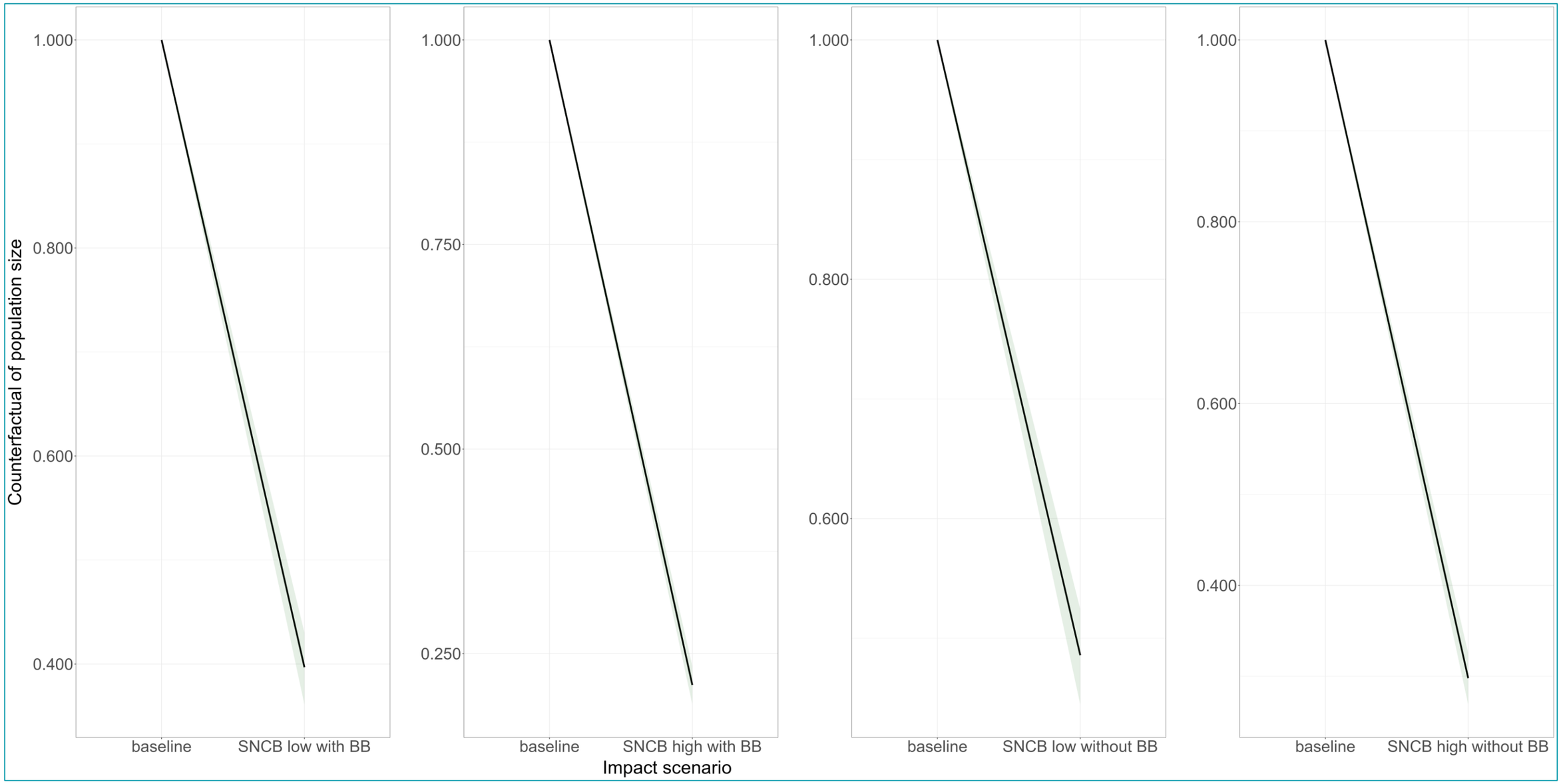

Figure 4.12 The Ratio of the Median Impacted Population Sizes for the Razorbill Population during the Breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

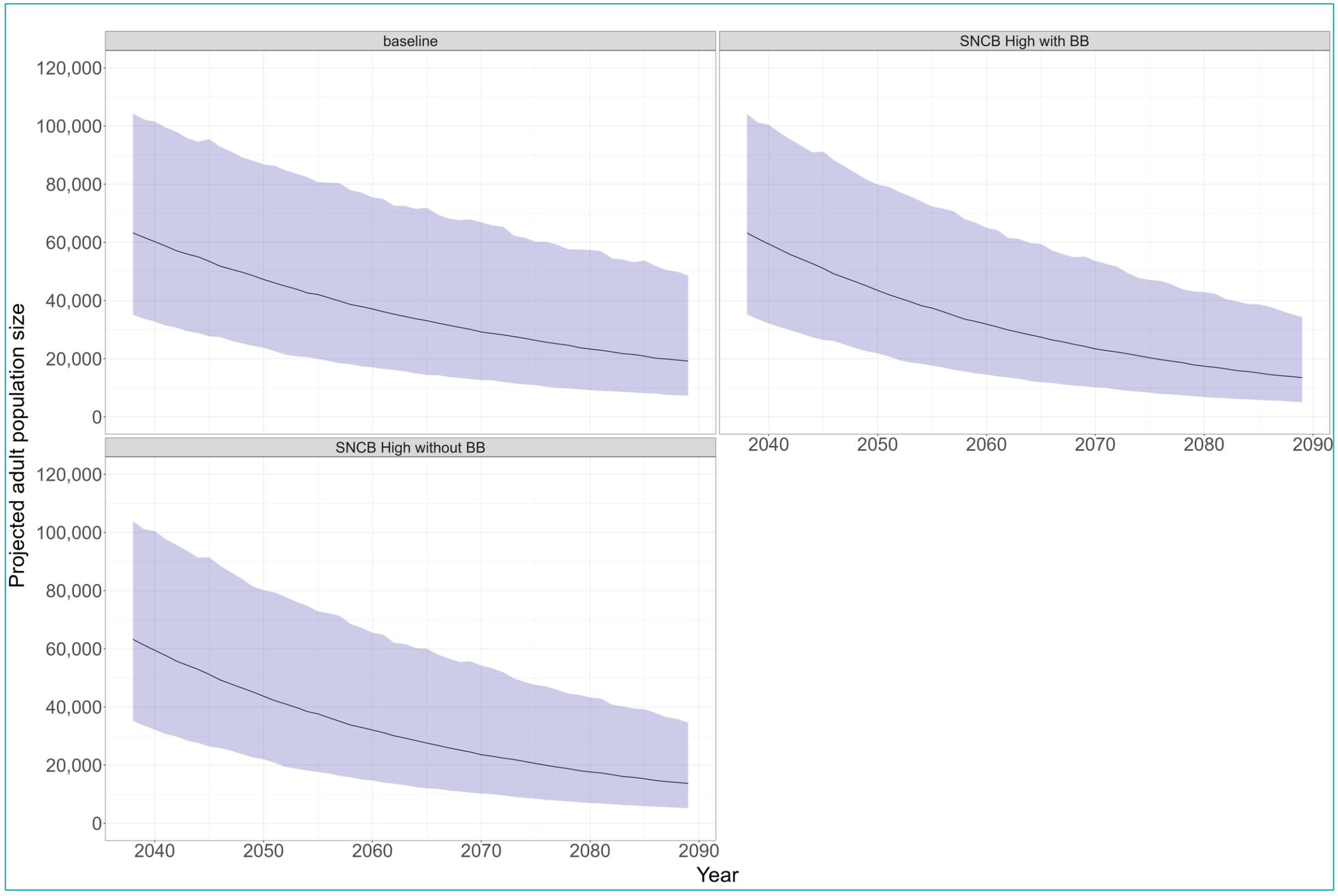

Figure 4.13 Razorbill Population Projection over 35 Years during the Non-breeding Season under a Range of Impact Scenarios

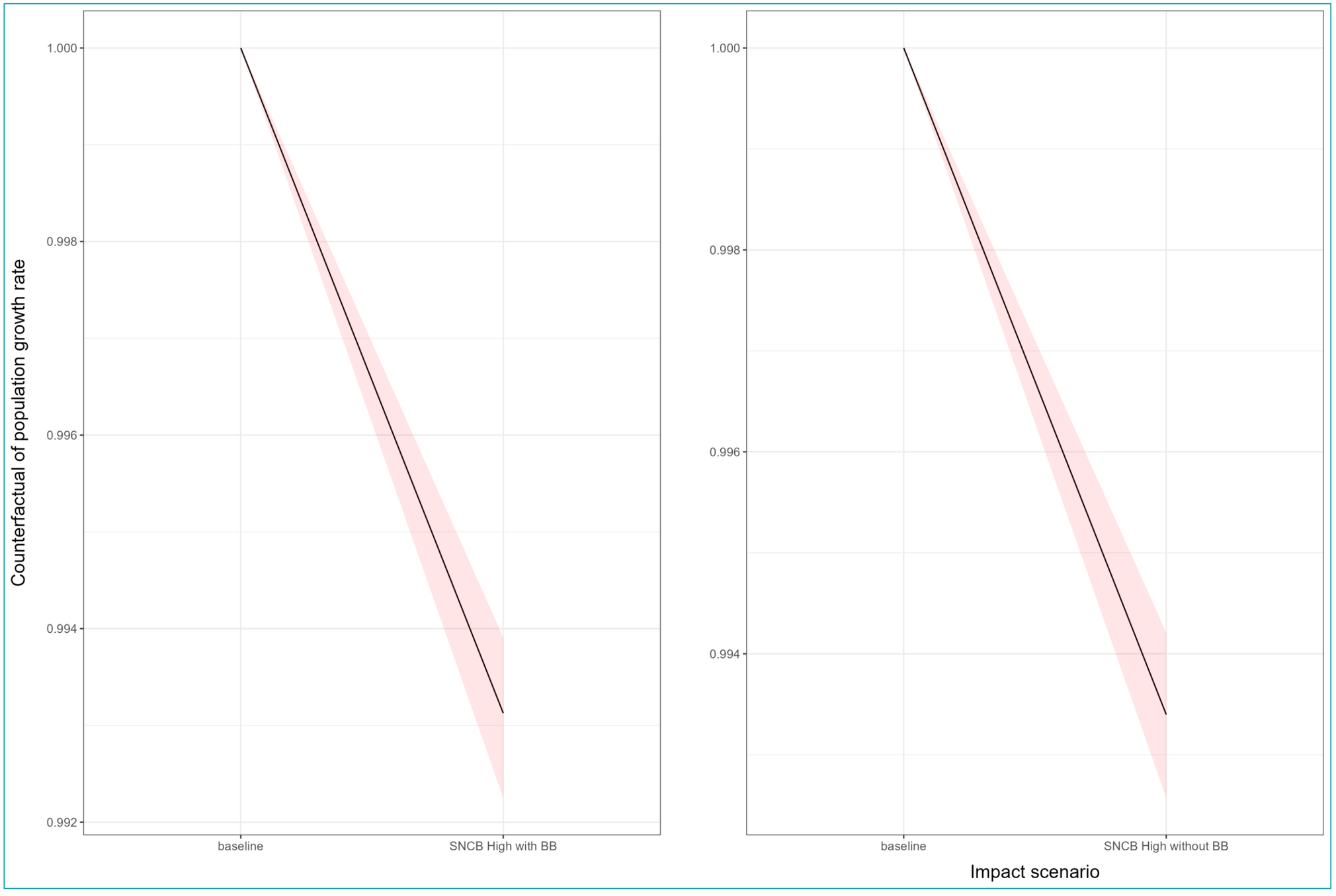

Figure 4.14 Ratio of Impacted Growth Rates after 35 Years for the Razorbill Population during the Non-breeding Season under a Range of Impact Scenarios

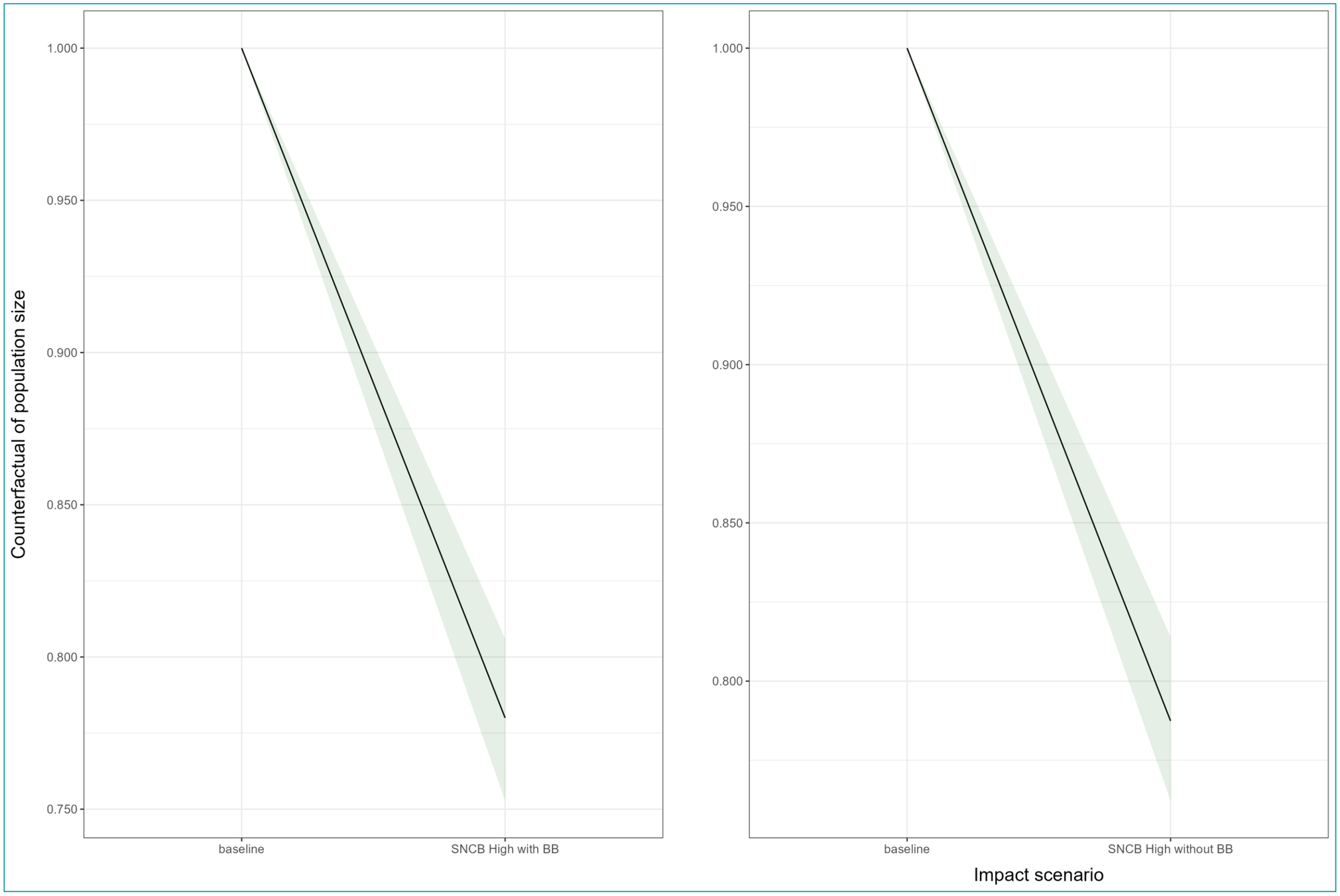

Figure 4.15 The Ratio of the Median Impacted Population Sizes for the Razorbill Population during the Non-breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

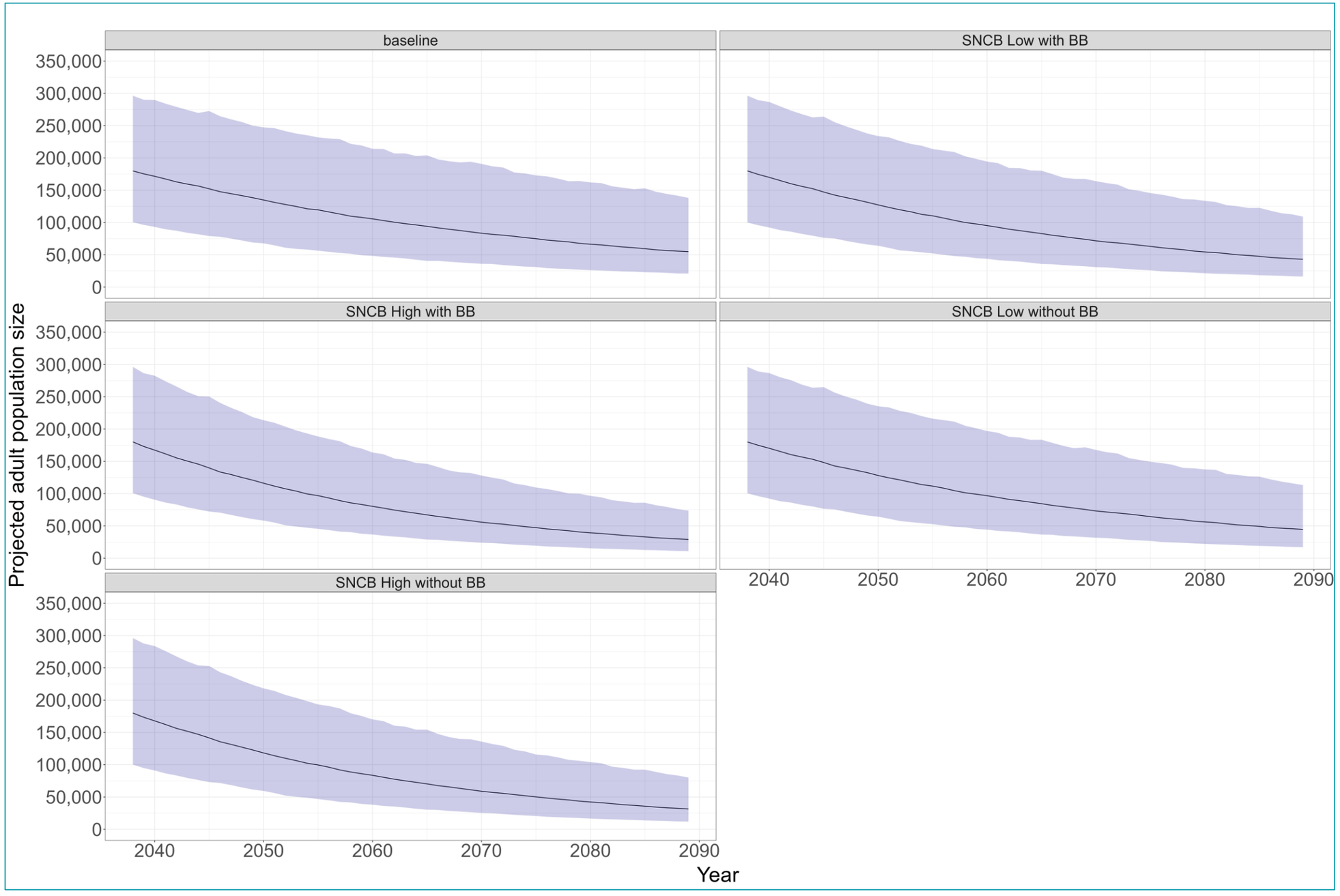

Figure 4.16 Annual Razorbill Population Projection over 35 Years under a Range of Impact Scenarios

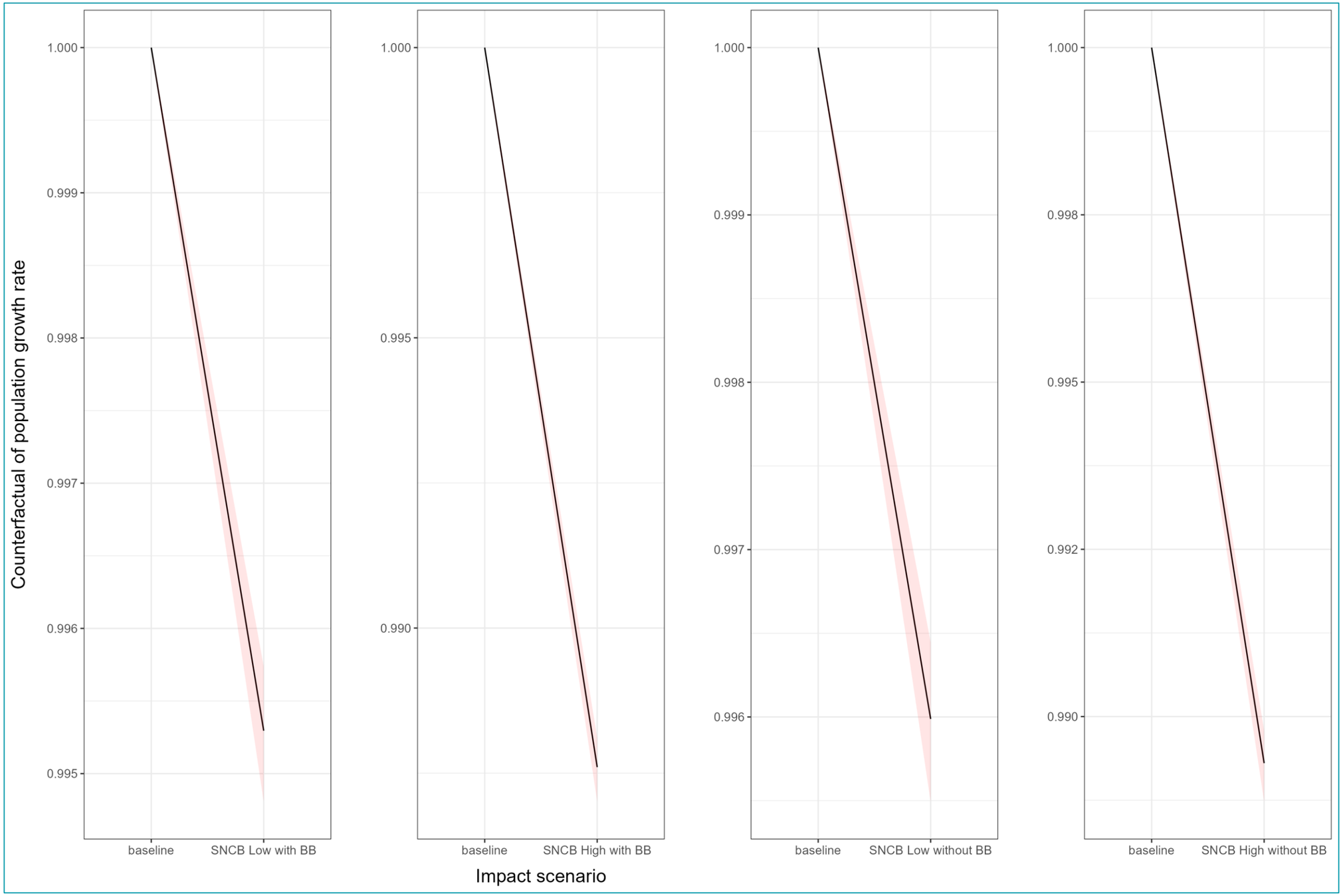

Figure 4.17 Ratio of Impacted Growth Rates after 35 Years for the Razorbill Population Annually under a Range of Impact Scenarios

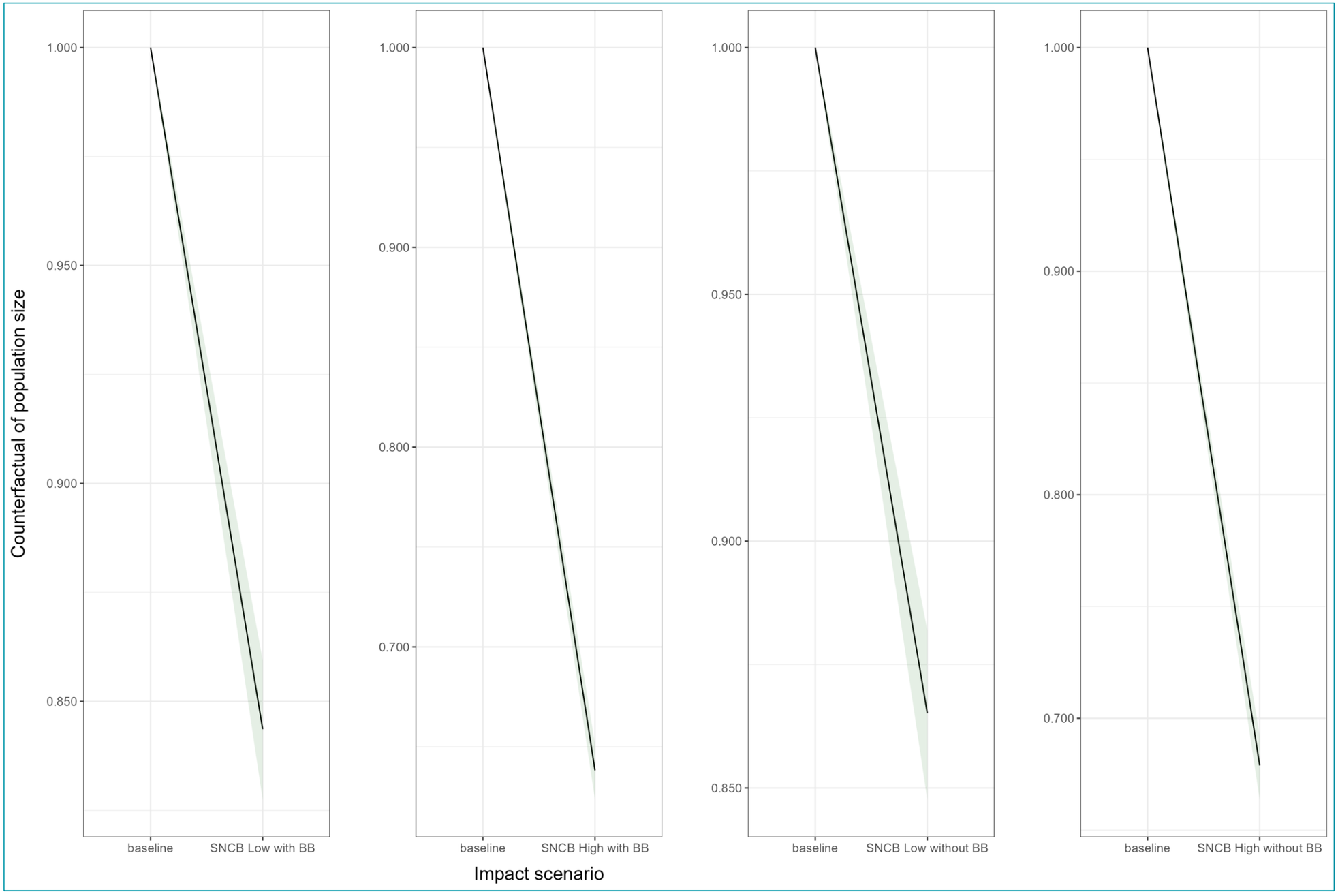

Figure 4.18 The Ratio of the Median Impacted Population Sizes for the Razorbill Population Annually from the Simulations after 35 Years under a Range of Impact Scenarios

4.2.3. PUFFIN

49. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the razorbill UK BDMPS at the start of the operation and maintenance phase (2039) and for the expected lifespan of the Array (35 years) are presented in Table 4.9. The baseline 'unimpacted' scenario is also shown for comparison purposes.

50. As part of NatureScot guidance (2023b), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such the population size graphs are shown in Figure 4.19 for the breeding season. CPGR graphs are shown in Figure 4.20 for the breeding season and Figure 4.21 shows the CPS values for the breeding season.

51. Note that due to window width, impact scenarios had to be abbreviated to ensure the graphs could be clearly read. As such the following impact scenarios have been abbreviated in the figure headings:

- breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 5% mortality with Berwick Bank Offshore Wind Farm = SNCB High with BB.
- breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 60% displacement, 5% mortality without Berwick Bank Offshore Wind Farm = SNCB High without BB.

Table 4.9: Puffin 35 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %l	l=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9801	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 5% mortality	774	0.9740	0.9941	0.8070	0.59%	19.30%	34.96	67
Without Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9801	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 5% mortality	638	0.9750	0.9951	0.8382	0.49%	16.18%	38	64.04

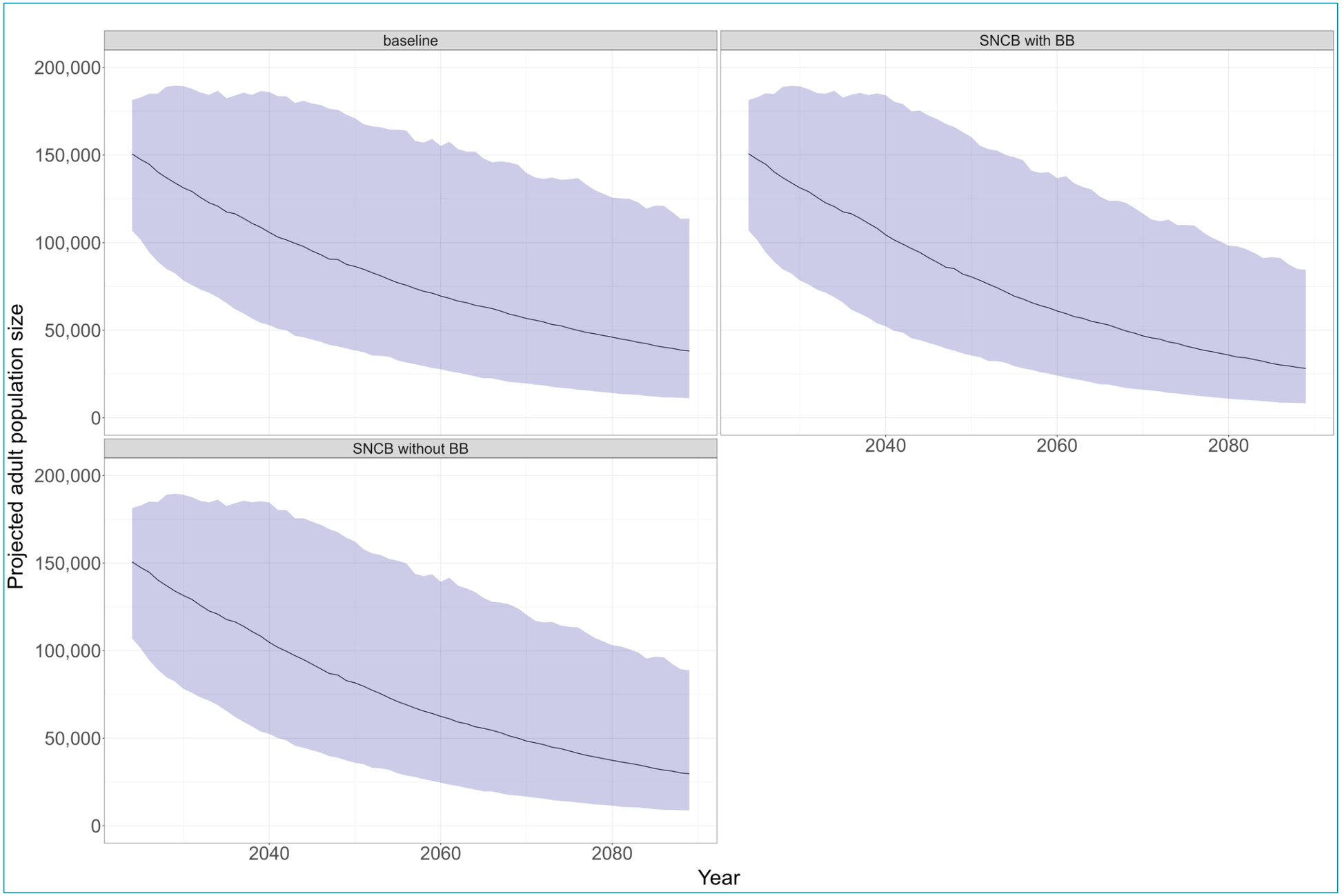

Figure 4.19 Puffin Population Projection over 35 Years during the Breeding Season under a Range of Impact Scenarios

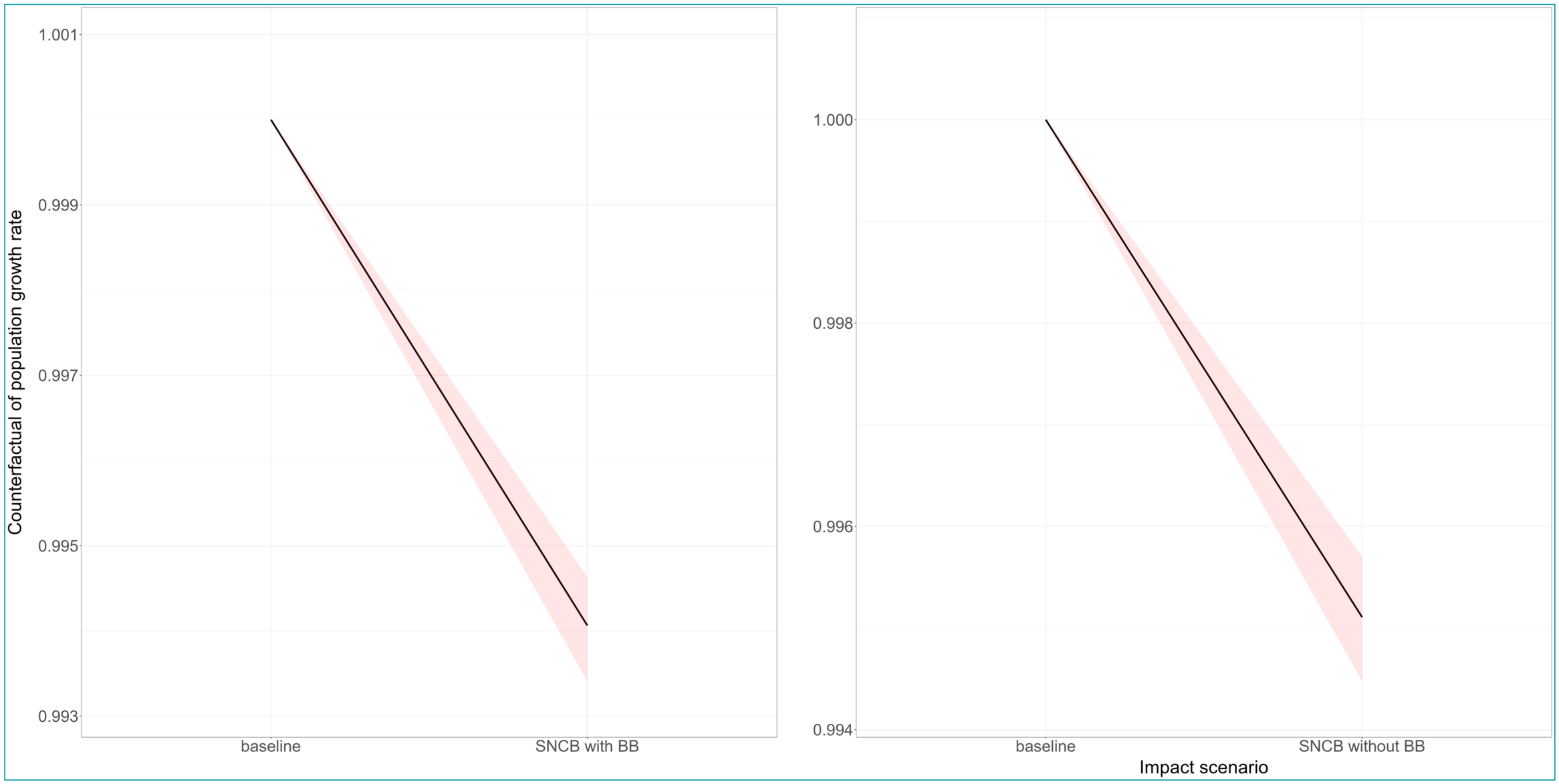

Figure 4.20 Ratio of Impacted Growth Rates after 35 Years for the Puffin Population during the Breeding Season under a Range of Impact Scenarios

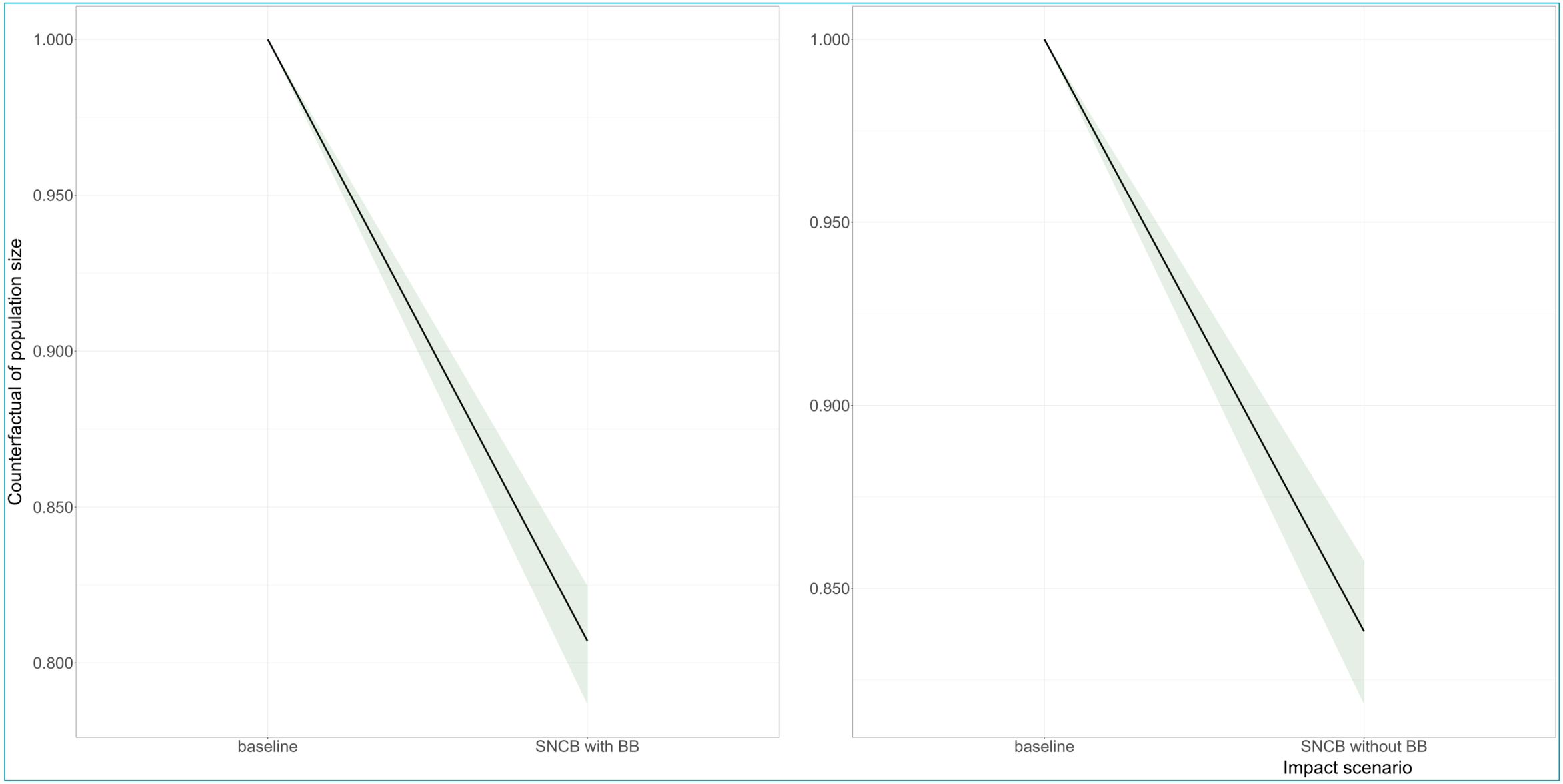

Figure 4.21 The Ratio of the Median Impacted Population Sizes for the Puffin Population during the Breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

4.2.4. GANNET

52. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the gannet UK BDMPS at the start of the operation and maintenance (2039) and for the expected lifespan of the Array (35 years) are presented in Table 4.10. The baseline 'unimpacted' scenario is also shown for comparison purposes.

53. As part of NatureScot guidance (2023b), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such the population size graphs are shown in Figure 4.22 for the breeding season, Figure 4.25 for the post-breeding season and Figure 4.28 for the annual projection. CPGR graphs are shown in Figure 4.23 for the breeding season Figure 4.26 for the post-breeding season and Figure 4.29 annually. Figure 4.24, Figure 4.27 and Figure 4.30 show the CPS values for the breeding, post-breeding season and for annually also.

54. Note that due to window width, impact scenarios had to be abbreviated to ensure the graphs could be clearly read. As such the following impact scenarios have been abbreviated in the figure headings:

- breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance, 70% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB High with BB.
- post-breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance with Berwick Bank Offshore Wind Farm = Collision SNCB with BB.
  - NatureScot Approach – 0.993 avoidance, 70% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB High with BB.
- annual with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance = Collision SNCB with BB;
  - NatureScot Approach – 0.993 avoidance, 70% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB Low with BB;
  - NatureScot Approach – 0.993 avoidance, 70% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB High with BB; and
  - Applicant's Approach – 0.993 avoidance, 70% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = Combined Applicant with BB.
- post-breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance, 70% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB High without BB.
- annual without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance = Collision SNCB without BB;
  - NatureScot Approach – 0.993 avoidance, 70% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB Low without BB;
  - NatureScot Approach – 0.993 avoidance, 70% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB High without BB; and
  - Applicant's Approach – 0.993 avoidance, 70% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = Combined Applicant without BB.

Table 4.10: Gannet 35 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,662	1.0074	0.9954	0.8457	0.46%	15.43%	23.76	77.68
Post-breeding	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,052.48	1.0069	0.9949	0.8311	0.51%	16.89%	22.16	77.36
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,218	1.0061	0.9941	0.8074	0.59%	19.26%	19.72	81.36
Annual	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,966.19	1.0066	0.9945	0.8200	0.55%	18.00%	20.76	81.68
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,349	1.0054	0.9933	0.7854	0.67%	21.46%	15.80	86.12
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	3,249	1.0029	0.9909	0.7202	0.91%	27.98%	9.64	92.80
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,394	1.0054	0.9933	0.7853	0.67%	21.47%	15.88	86.16
Without Berwick Bank Offshore Wind Farm Impacts									

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %l	l=50 %U
Post-breeding	Baseline	0	1.0120	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,169	1.0063	0.9943	0.8142	0.57%	18.58%	20.56	79.96
Annual	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,774.78	1.0071	0.9950	0.8362	0.50%	16.38%	22.56	79.16
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,157	1.0060	0.9940	0.8044	0.60%	19.56%	18.56	84.28
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	2,992	1.0036	0.9916	0.7392	0.84%	26.08%	11.08	90.88
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,157	1.0060	0.9940	0.8043	0.60%	19.57%	18.44	84.16

Figure 4.22 Gannet Population Projection over 35 Years during the Breeding Season under a Range of Impact Scenarios

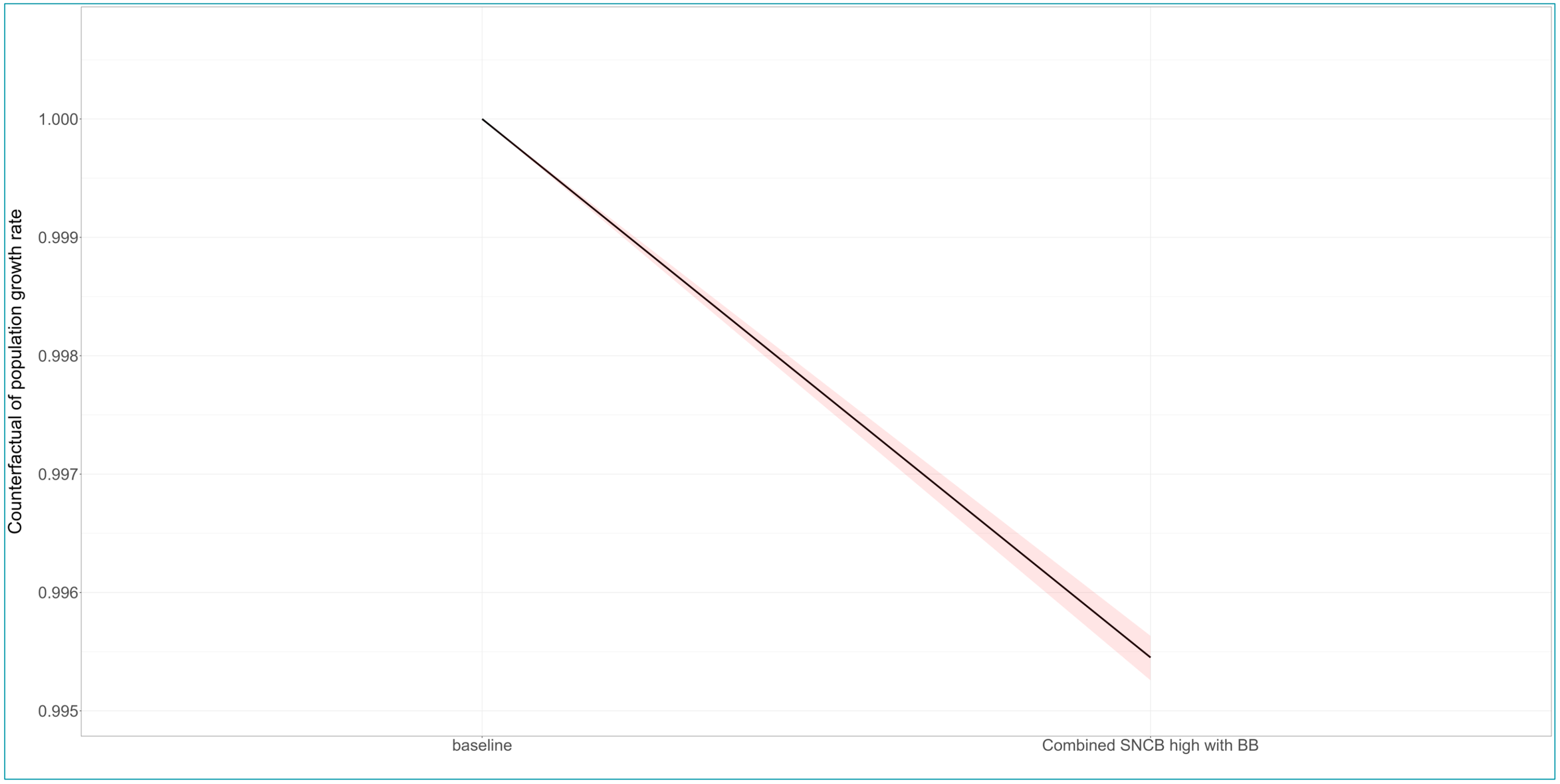

Figure 4.23 Ratio of Impacted Growth Rates after 35 Years for the Gannet Population during the Breeding Season under a Range of Impact Scenarios

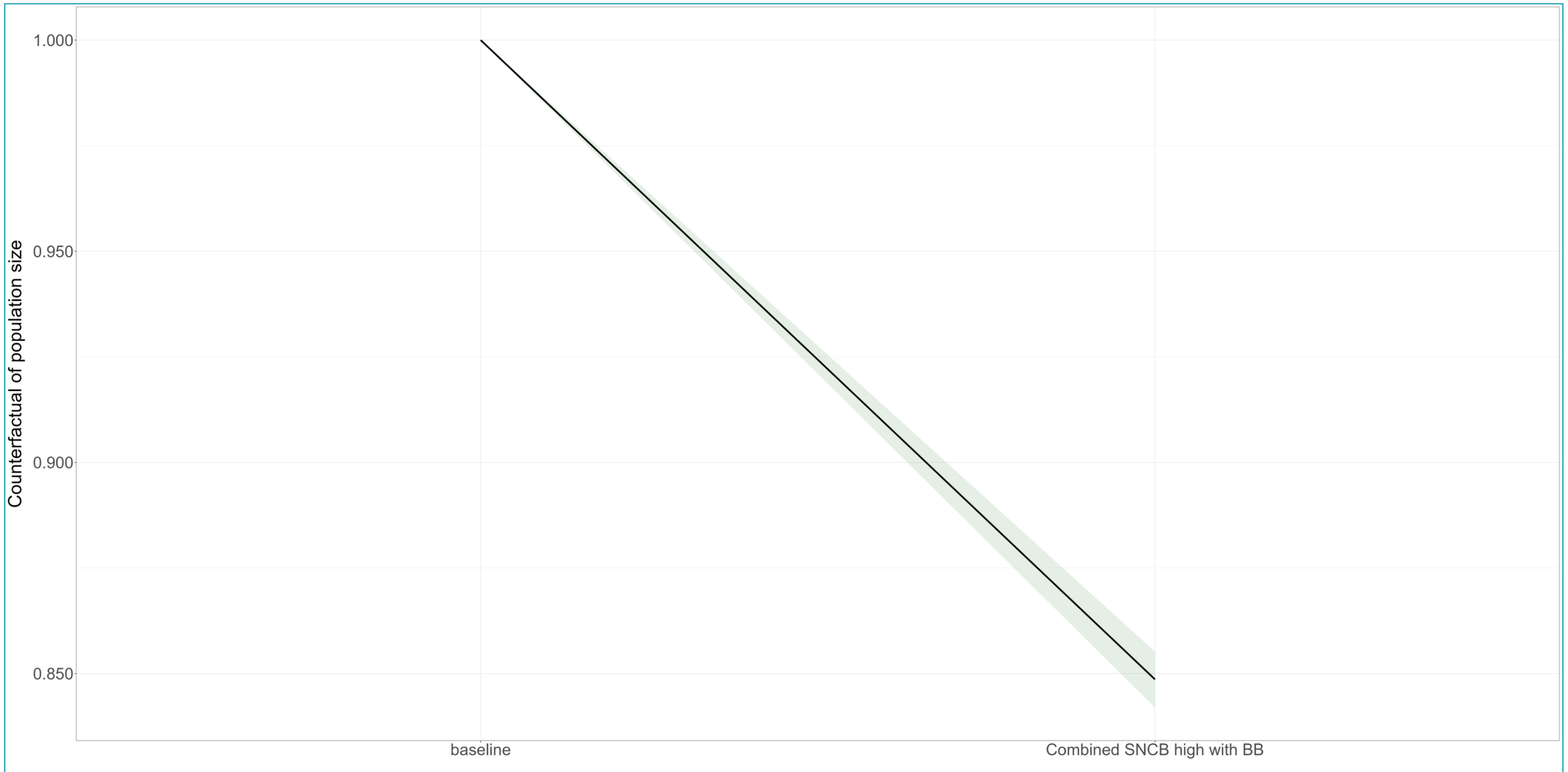

Figure 4.24 The Ratio of the Median Impacted Population Sizes for the Gannet Population during the Breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

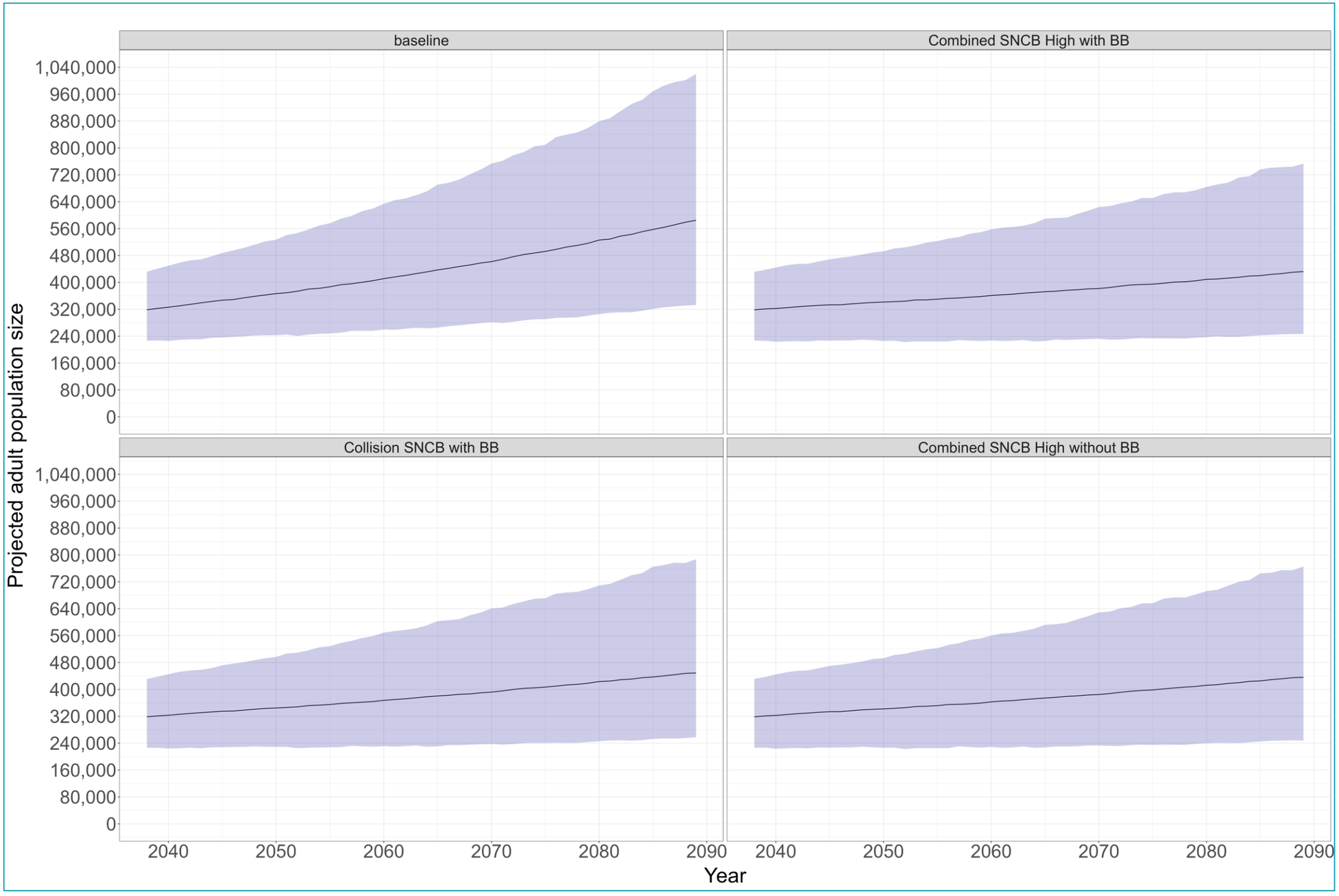

Figure 4.25 Gannet Population Projection over 35 Years during the Post-breeding Season under a Range of Impact Scenarios

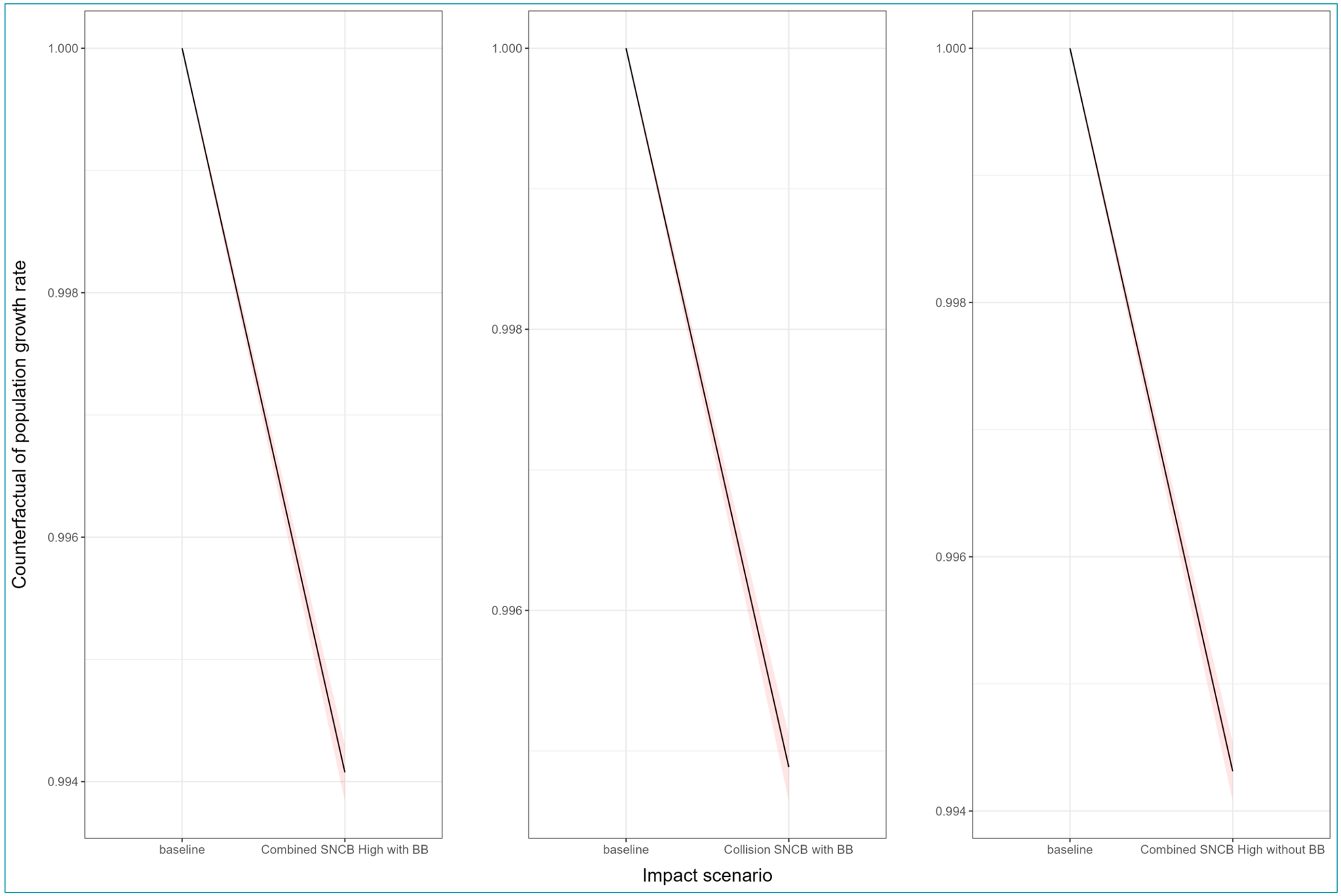

Figure 4.26 Ratio of Impacted Growth Rates after 35 Years for the Gannet Population during the Post-breeding Season under a Range of Impact Scenarios

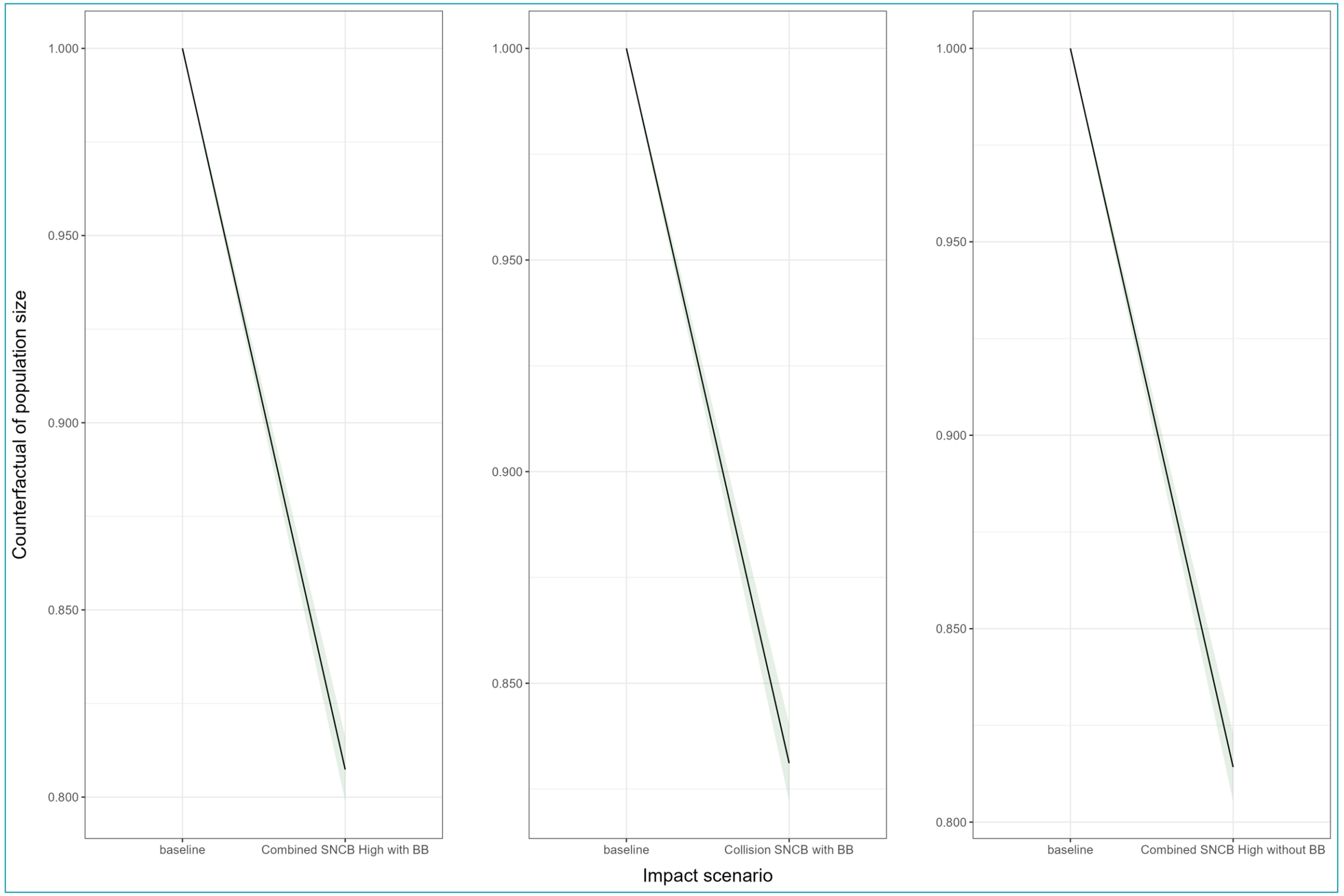

Figure 4.27 The Ratio of the Median Impacted Population Sizes for the Gannet Population during the Post-breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

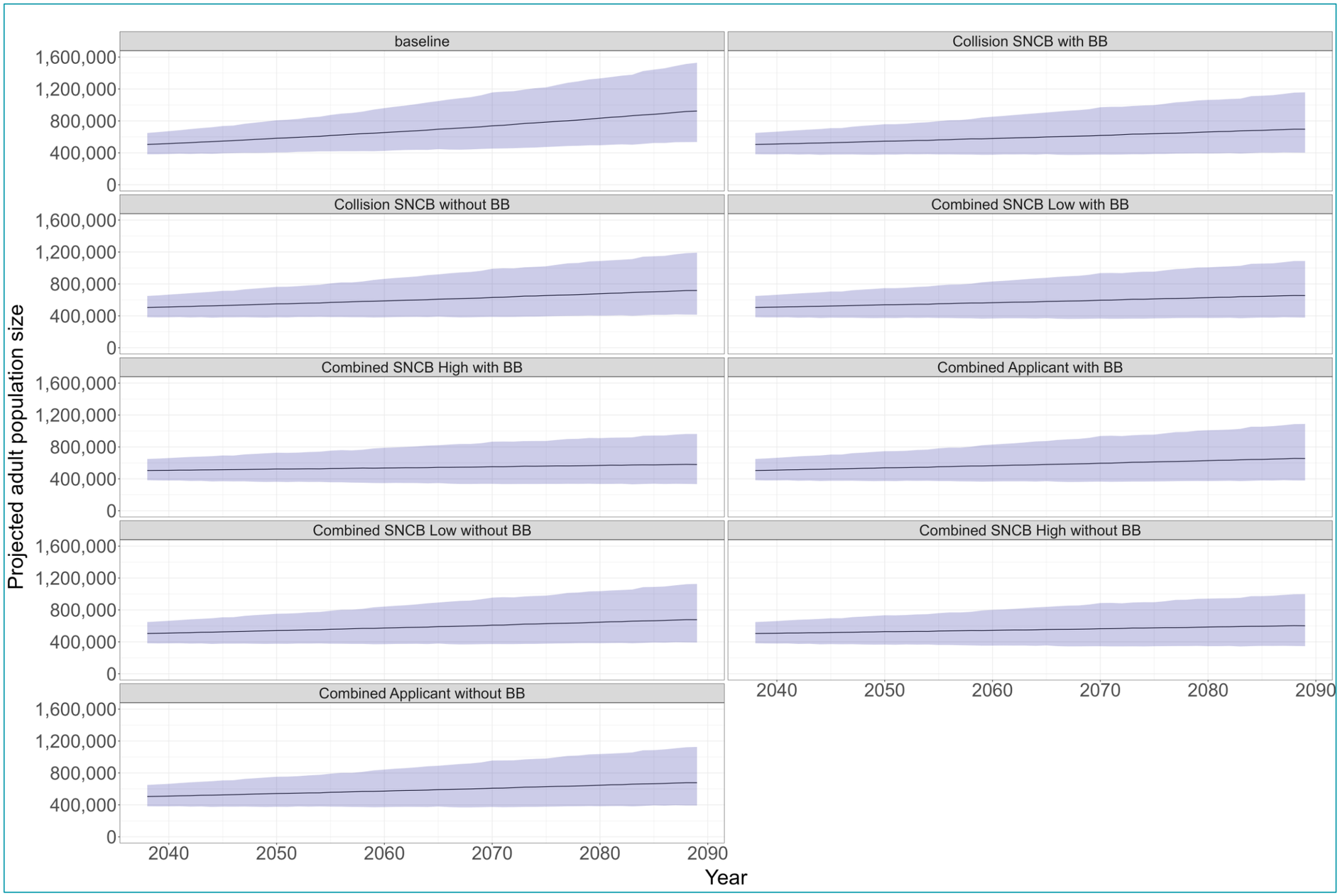

Figure 4.28 Annual Gannet Population Projection over 35 Years under a Range of Impact Scenarios

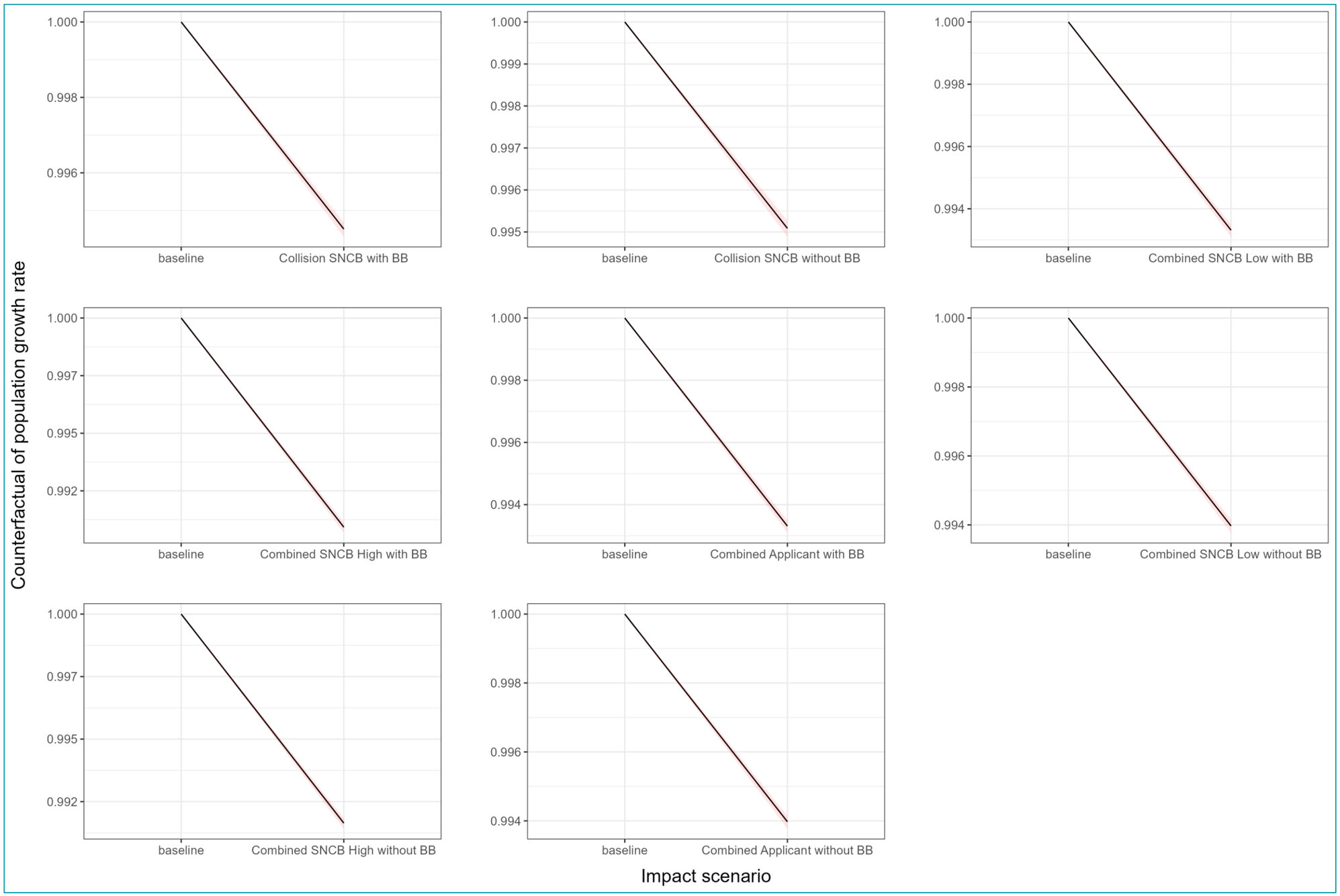

Figure 4.29 Ratio of Impacted Growth Rates after 35 Years for the Gannet Population Annually under a Range of Impact Scenarios

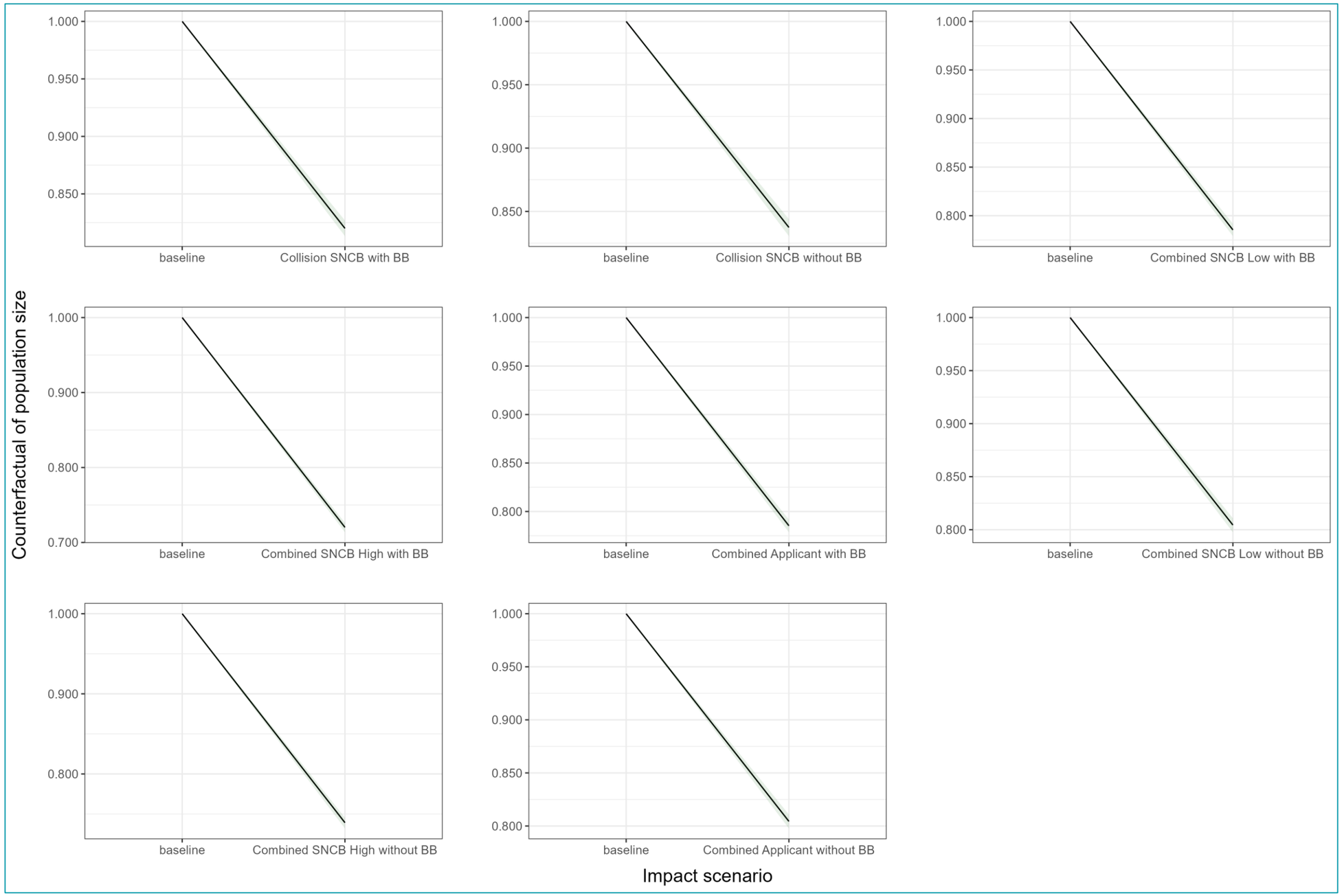

Figure 4.30 The Ratio of the Median Impacted Population Sizes for the Gannet Population Annually from the Simulations after 35 Years under a Range of Impact Scenarios

4.2.5. KITTIWAKE

55. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the kittiwake UK BDMPS at the start of the operation and maintenance phase (2039) and for the expected lifespan of the Array (35 years) are presented in Table 4.11. The baseline 'unimpacted' scenario is also shown for comparison purposes.

56. As part of NatureScot guidance (2023b), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such the population size graphs are shown in Figure 4.31 for the pre-breeding season, Figure 4.34 for the breeding season, Figure 4.37 for the post-breeding season and Figure 4.40 for the annual projection. CPGR graphs are shown in Figure 4.32 for the pre-breeding season, Figure 4.35 for the breeding season, Figure 4.38 for the post-breeding season and Figure 4.41 annually. Figure 4.33, Figure 4.36, Figure 4.39 and Figure 4.42 show the CPS values for the pre-breeding, breeding, post-breeding season and for annually also.

57. Note that due to window width, impact scenarios had to be abbreviated to ensure the graphs could be clearly read. As such the following impact scenarios have been abbreviated in the figure headings:

- pre-breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance = Collision SNCB with BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB Low with BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB High with BB; and
  - Applicant's Approach - 0.993 avoidance, 30% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = Combined Applicant with BB.
- breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance = Collision SNCB with BB;
  - NatureScot Approach – 30% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Displacement SNCB High with BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB Low with BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB High with BB; and
  - Applicant's Approach - 0.993 avoidance, 30% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = Combined Applicant with BB.
- post-breeding season with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB High with BB.
- annual with Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance = Collision SNCB with BB;
  - NatureScot Approach – 30% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Displacement SNCB High with BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB Low with BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 3% mortality with Berwick Bank Offshore Wind Farm = Combined SNCB High with BB; and
  - Applicant's Approach - 0.993 avoidance, 30% displacement, 1% mortality with Berwick Bank Offshore Wind Farm = Combined Applicant with BB.
- pre-breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB Low without BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB High without BB; and
  - Applicant's Approach - 0.993 avoidance, 30% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = Combined Applicant without BB.
- breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance = Collision SNCB without BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB Low without BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB High without BB; and
  - Applicant's Approach - 0.993 avoidance, 30% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = Combined Applicant without BB.
- post-breeding season without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB High without BB.
- annual without Berwick Bank Offshore Wind Farm:
  - NatureScot Approach – 0.993 avoidance = Collision SNCB without BB:
  - NatureScot Approach – 30% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = Displacement SNCB High without BB:
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB Low without BB;
  - NatureScot Approach – 0.993 avoidance, 30% displacement, 3% mortality without Berwick Bank Offshore Wind Farm = Combined SNCB High without BB; and
  - Applicant's Approach - 0.993 avoidance, 30% displacement, 1% mortality without Berwick Bank Offshore Wind Farm = Combined Applicant without BB.

Table 4.11: Kittiwake 35 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Pre-breeding	Baseline	0	0.9990	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance	1,020.62	0.9918	0.9968	0.8906	0.32%	10.94%	42.92	56.32
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,225	0.9912	0.9961	0.8703	0.39%	12.97%	41.40	57.92
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,634	0.9899	0.9949	0.8307	0.51%	16.93%	38.76	60.44
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,225	0.9912	0.9961	0.8702	0.39%	12.98%	41.16	57.88
Breeding	Baseline	0	0.9987	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,514.40	0.9823	0.9871	0.6262	1.29%	37.38%	21.76	77.56
	NatureScot Approach – 30% displacement, 3% mortality	566	0.9902	0.9952	0.8404	0.48%	15.96%	39.36	61.24
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 1% mortality	1,703	0.9807	0.9855	0.5910	1.45%	40.90%	19.52	80.48
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 3% mortality	2,080	0.9774	0.9823	0.5254	1.77%	47.46%	15.40	85.24
	Applicant's Approach – 0.993 avoidance rate, 30% displacement, 1% mortality	1,703	0.9806	0.9855	0.5910	1.45%	40.90%	19.56	80.56
Post-breeding	Baseline	0	0.9955	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 3% mortality	1,781	0.9907	0.9956	0.8536	0.44%	14.64%	40.2	58.76
Annual	Baseline	0	0.9990	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate	3,572.30	0.9863	0.9912	0.7275	0.88%	27.25%	30.92	67.64
	NatureScot Approach - 30% displacement, 3% mortality	1,923	0.9903	0.9953	0.8431	0.47%	15.69%	39.48	59.80
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	4,213	0.9847	0.9896	0.6872	1.04%	31.28%	28.12	70.60
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	5,495	0.9816	0.9865	0.6122	1.35%	38.78%	22.92	76.64

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	4,213	0.9847	0.9896	0.6872	1.04%	31.28%	28.08	70.60
Without Berwick Bank Offshore Wind Farm Impacts									
Pre-breeding	Baseline	0	0.9990	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,005	0.9919	0.9968	0.8921	0.32%	10.79%	43.04	56.20
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,331	0.9909	0.9958	0.8598	0.42%	14.02%	40.68	58.52
	Applicants Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,005	0.9919	0.9968	0.8923	0.32%	10.77%	43.24	56.20
Breeding	Baseline	0	0.9987	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate	897.44	0.9875	0.9924	0.7587	0.76%	24.13%	33.00	68.00
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,023	0.9863	0.9913	0.7298	0.87%	27.02%	30.04	70.36
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,273	0.9843	0.9892	0.6754	1.08%	32.46%	26.00	74.20
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,023	0.9864	0.9913	0.7301	0.87%	26.99%	30.12	70.32
Post-breeding	Baseline	0	0.9955	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,490	0.9914	0.9963	0.8763	0.37%	12.37%	42.20	57.44
Annual	Baseline	0	0.9990	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	2,586.30	0.9888	0.9936	0.7947	0.64%	20.53%	36.32	63.00
	NatureScot Approach- 30% displacement, 3% mortality	1,508	0.9914	0.9963	0.8747	0.37%	12.53%	41.88	57.72
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 1% mortality	3,089	0.9875	0.9924	0.7598	0.76%	24.02%	33.60	65.36
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 3% mortality	4,094	0.9850	0.9899	0.6944	1.01%	30.56%	28.68	70.24

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 30% displacement, 1% mortality	3,089	0.9875	0.9924	0.7598	0.76%	24.02%	33.12	68.00

Figure 4.31 Kittiwake Population Projection over 35 Years during the Pre-breeding Season under a Range of Impact Scenarios

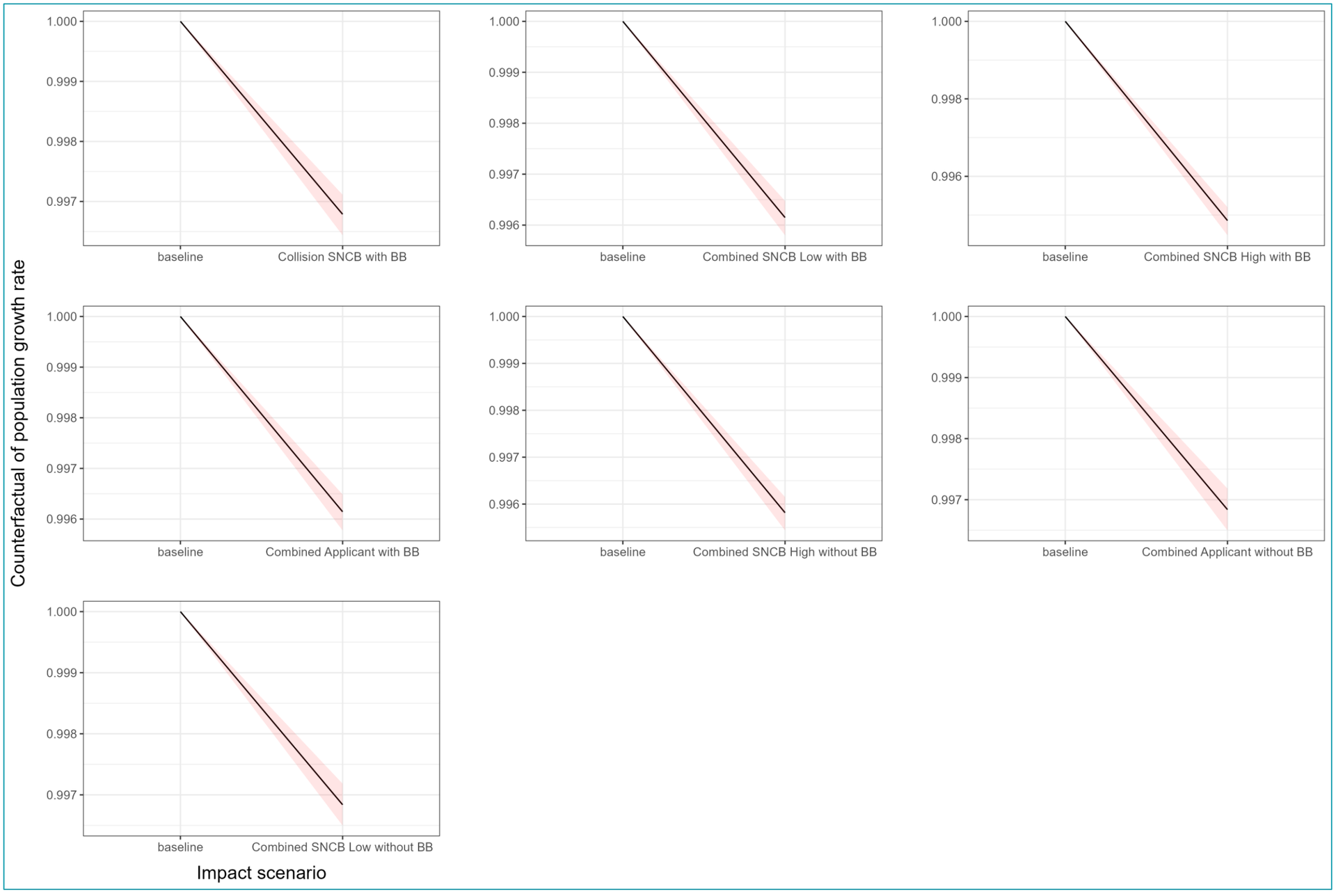

Figure 4.32 Ratio of Impacted Growth Rates after 35 Years for the Kittiwake Population during the Pre-breeding Season under a Range of Impact Scenarios

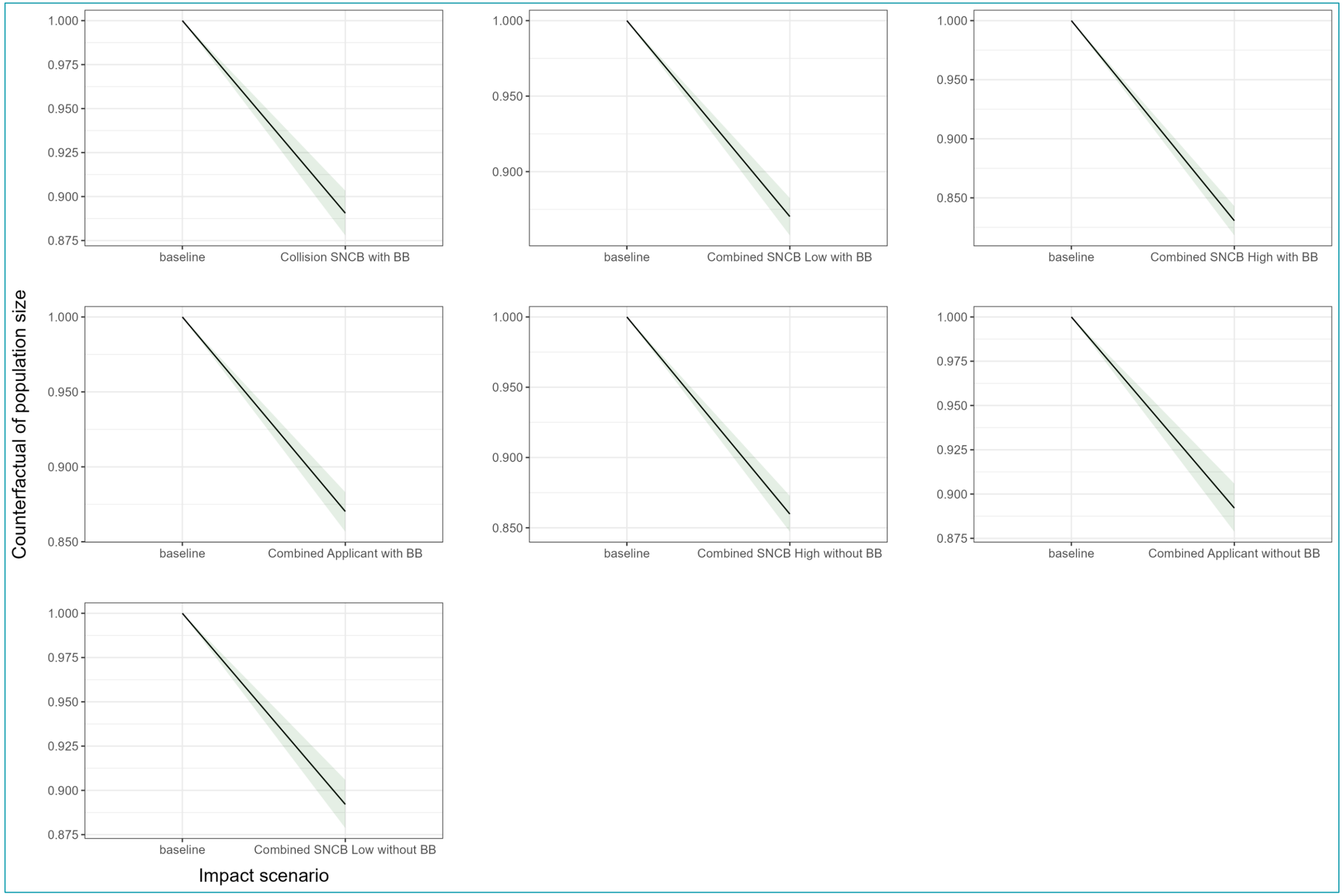

Figure 4.33 The Ratio of the Median Impacted Population Sizes for the Kittiwake Population during the Pre-breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

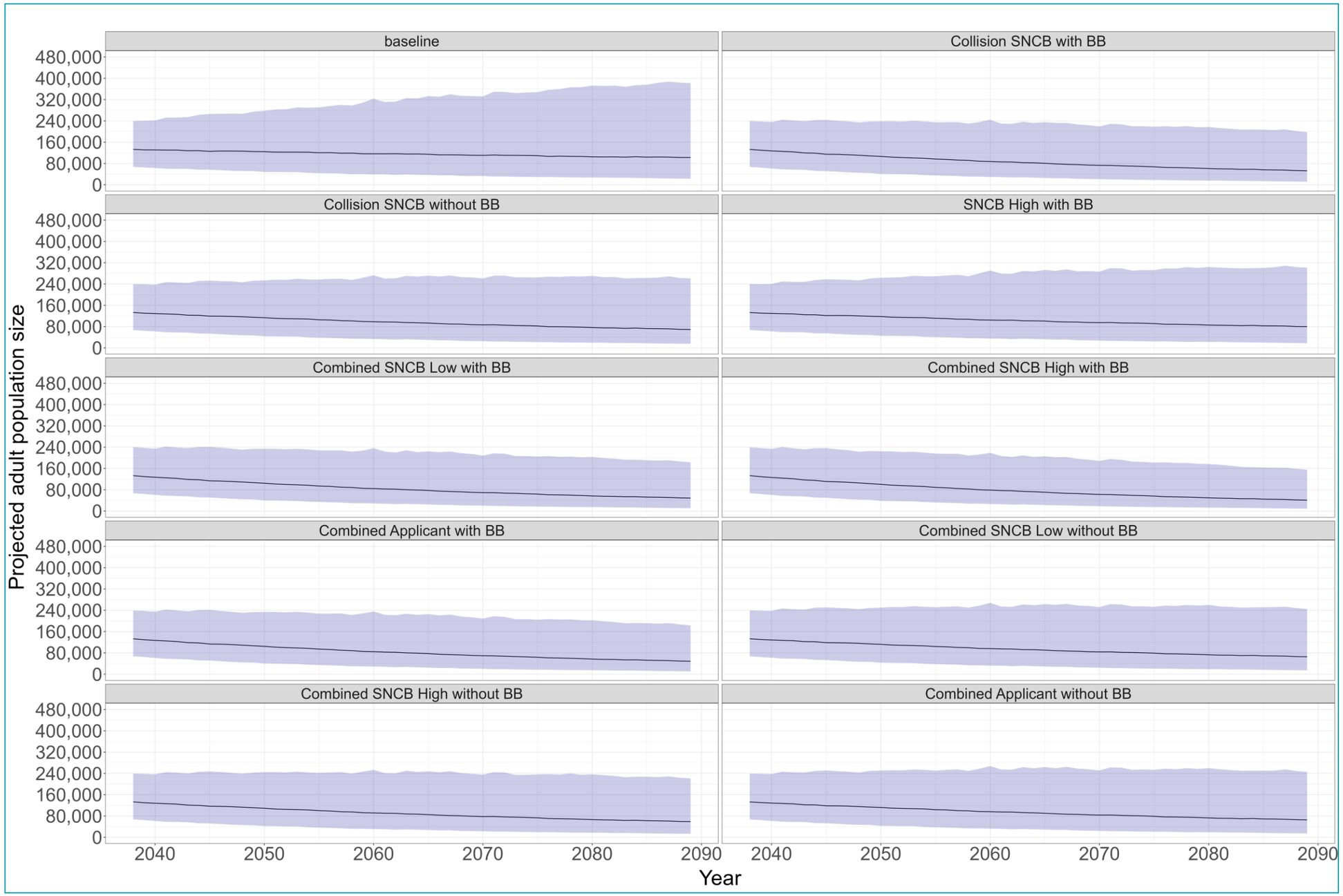

Figure 4.34 Kittiwake Population Projection over 35 Years during the Breeding Season under a Range of Impact Scenarios

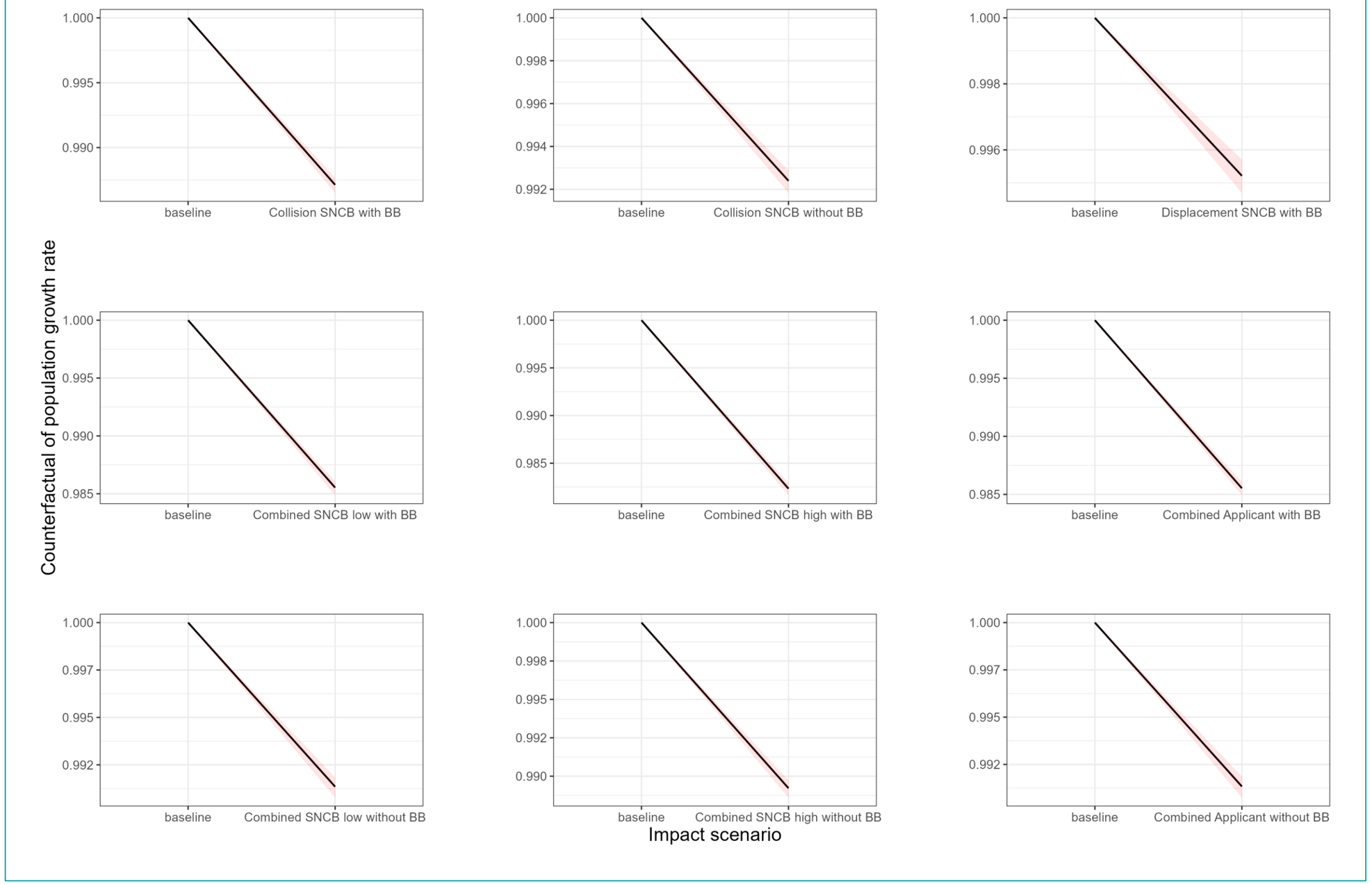

Figure 4.35 Ratio of Impacted Growth Rates after 35 Years for the Kittiwake Population during the Breeding Season under a Range of Impact Scenarios

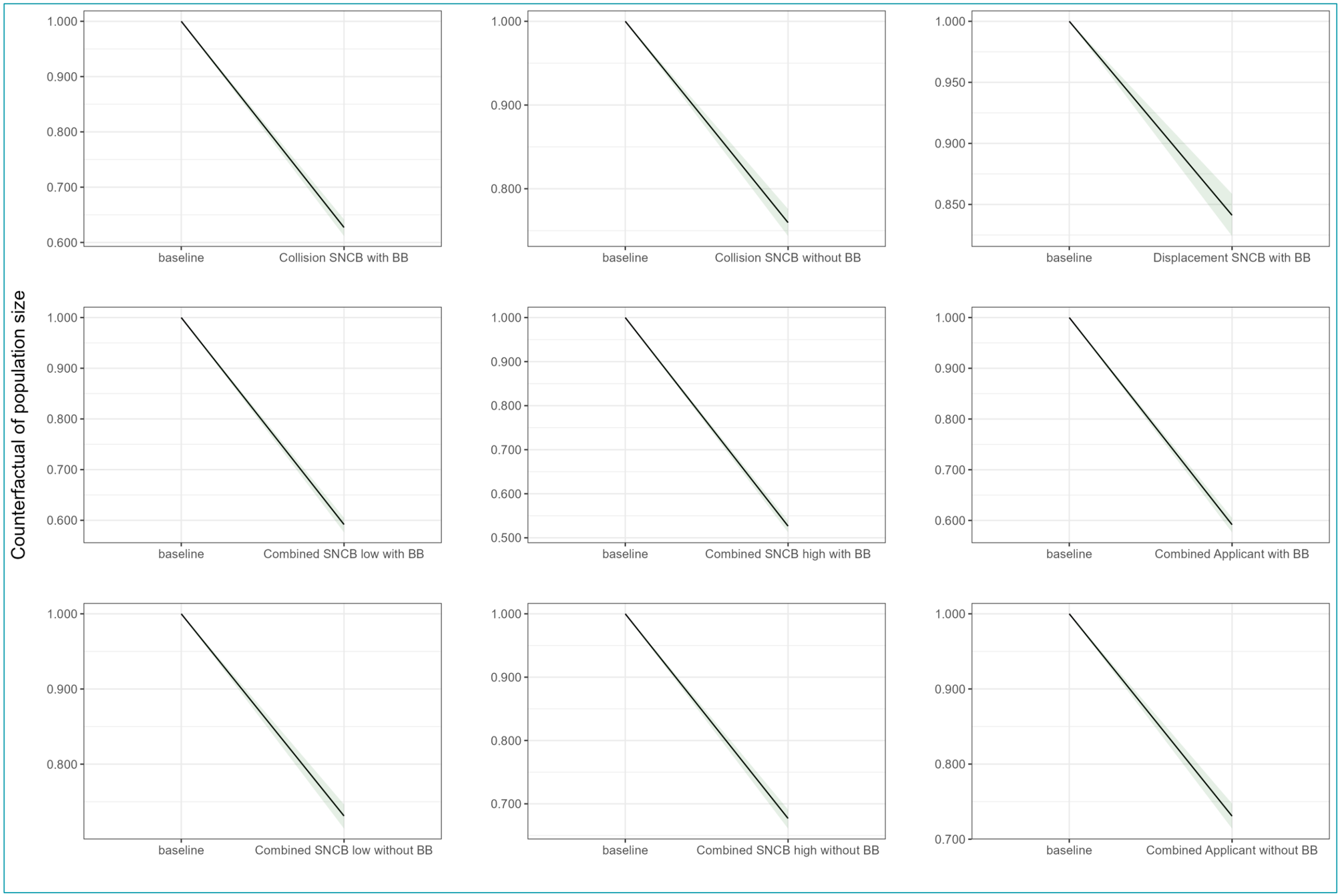

Figure 4.36 The Ratio of the Median Impacted Population Sizes for the Kittiwake Population during the Breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

Figure 4.37 Kittiwake Population Projection over 35 Years during the Post-breeding Season under a Range of Impact Scenarios

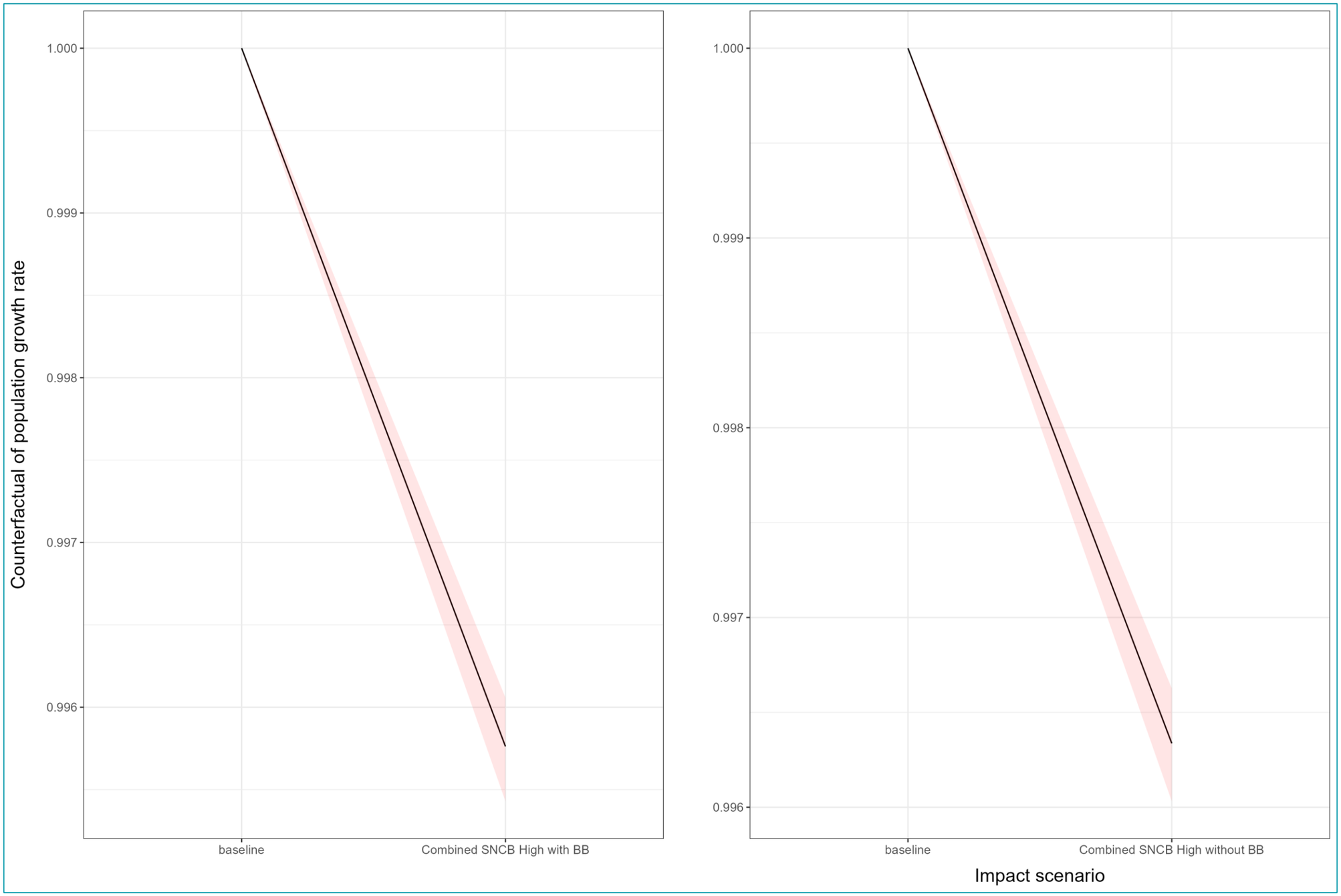

Figure 4.38 Ratio of Impacted Growth Rates after 35 Years for the Kittiwake Population during the Post-breeding Season under a Range of Impact Scenarios

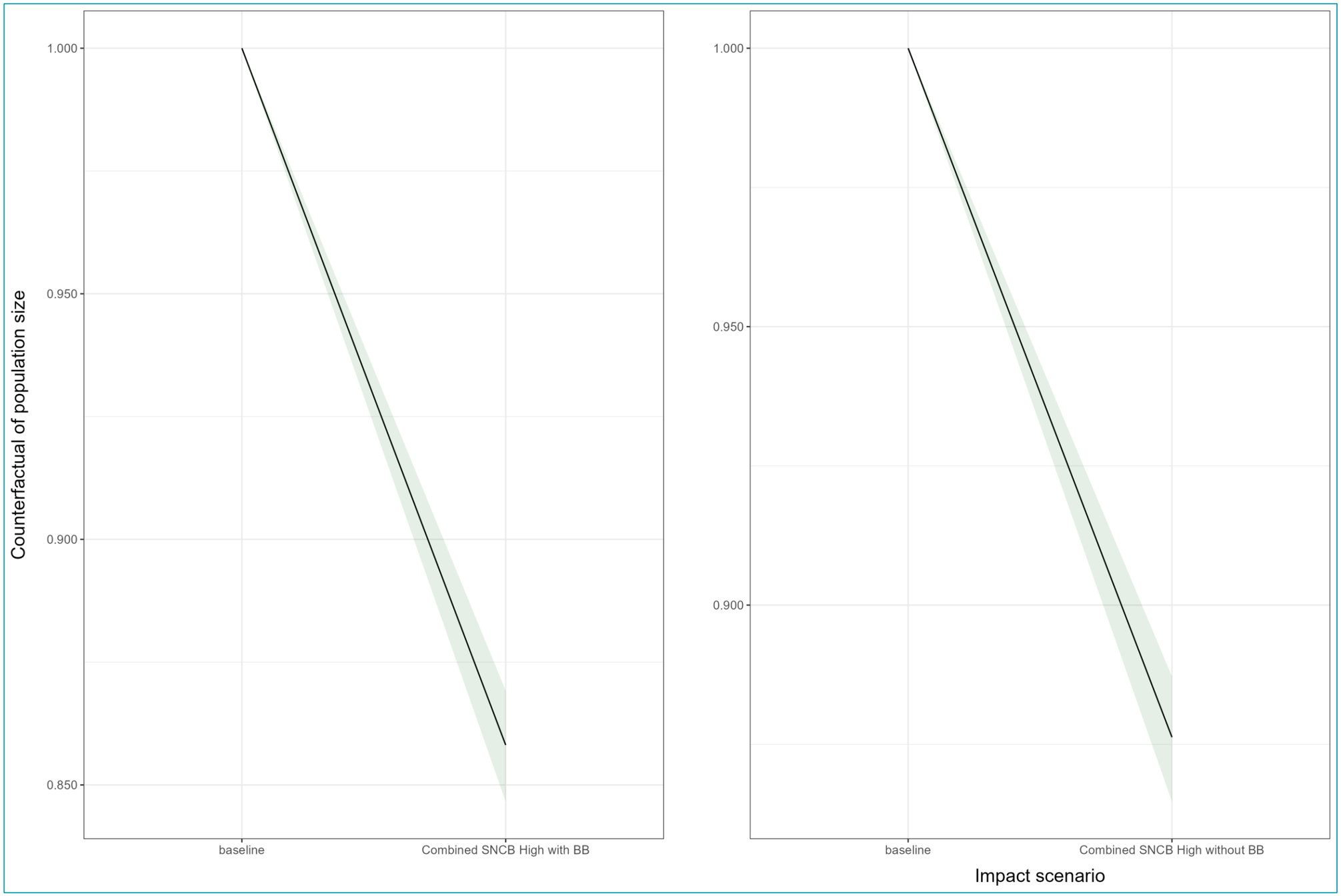

Figure 4.39 The Ratio of the Median Impacted Population Sizes for the Kittiwake Population during the Post-breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

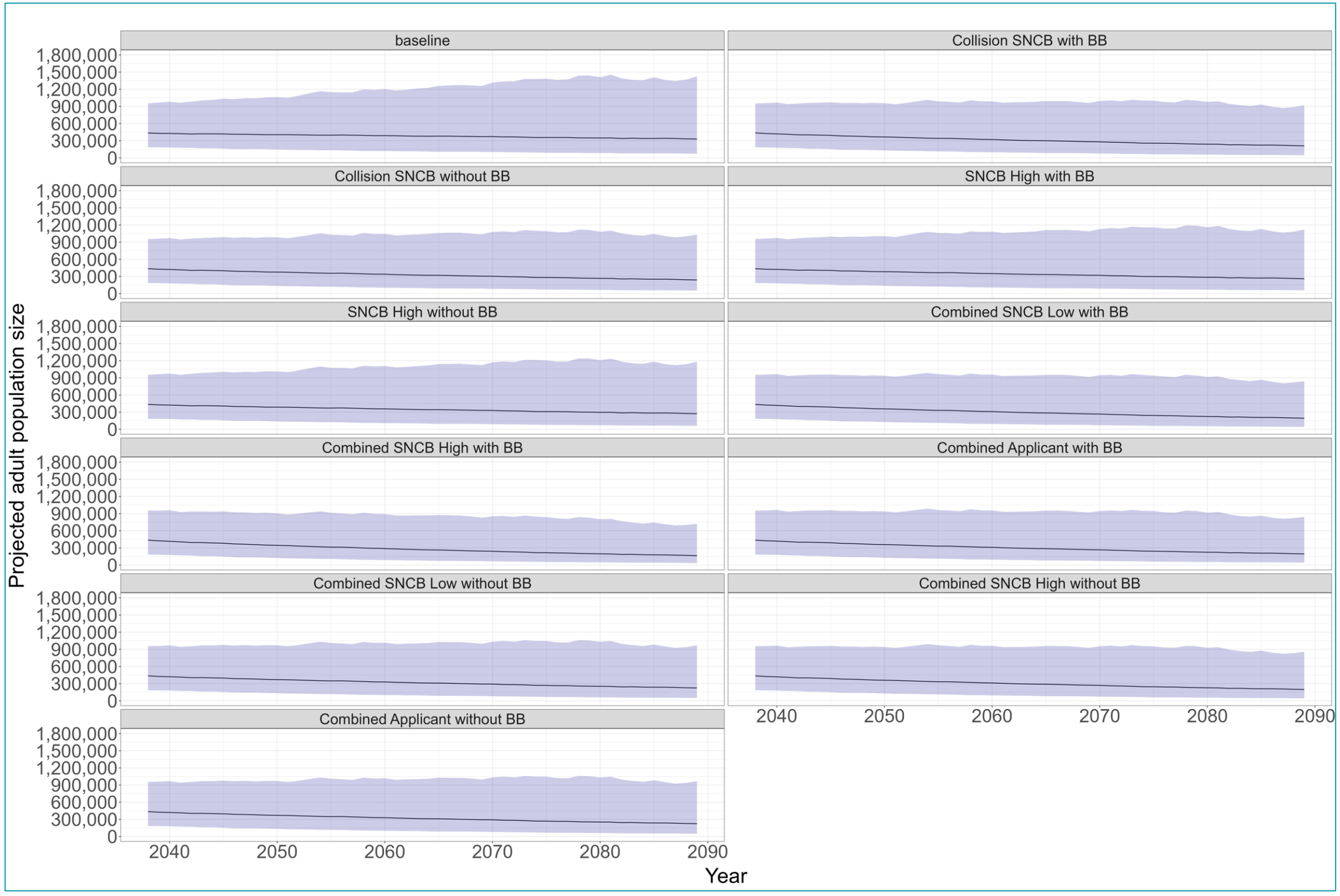

Figure 4.40 Annual Kittiwake Population Projection over 35 Years under a Range of Impact Scenarios

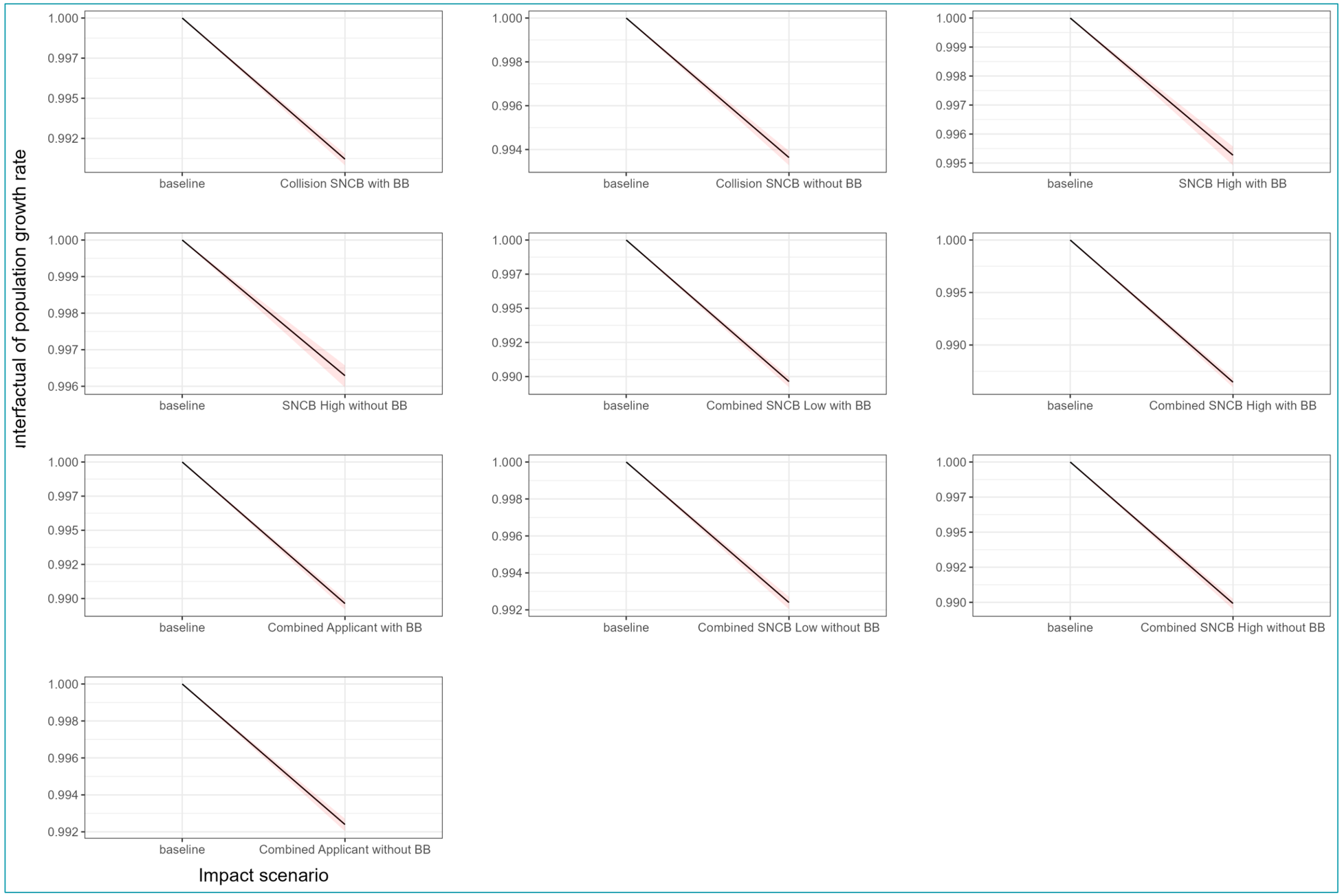

Figure 4.41 Ratio of Impacted Growth Rates after 35 Years for the Kittiwake Population Annually under a Range of Impact Scenarios

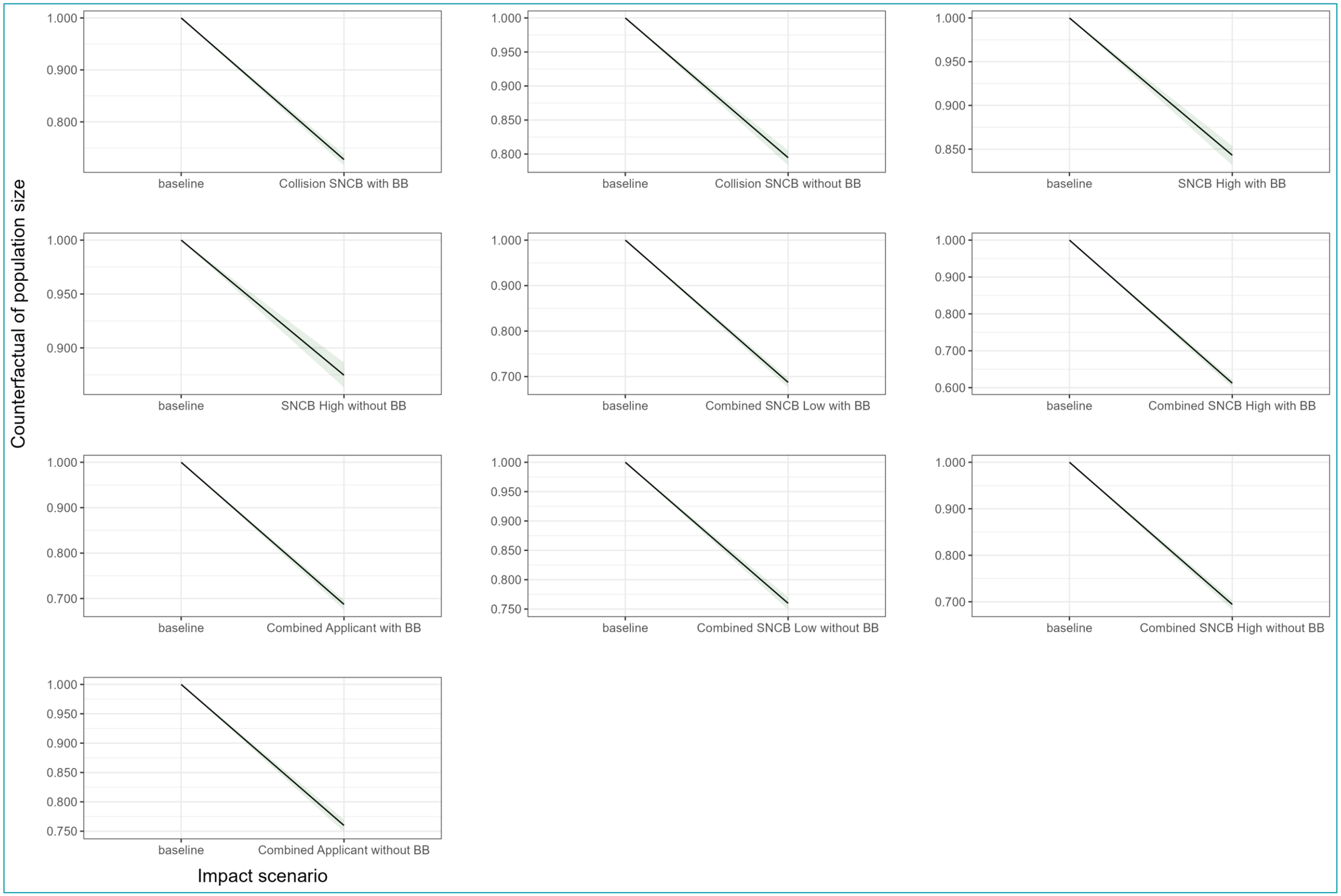

Figure 4.42 The Ratio of the Median Impacted Population Sizes for the Kittiwake Population Annually from the Simulations after 35 Years under a Range of Impact Scenario

4.2.6. HERRING GULL

58. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the herring gull UK BDMPS at the start of the operation and maintenance (2039) and for the expected lifespan of the Array (35 years) are presented in Table 4.12. The baseline 'unimpacted' scenario is also shown for comparison purposes.

59. As part of NatureScot guidance (2023b), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such the population size graphs are shown in Figure 4.43 for the breeding season, CPGR graphs are shown in Figure 4.44 for the breeding season and Figure 4.45 shows the CPS values for the breeding season (all 'with' Berwick Bank Offshore Wind Farm).

Table 4.12: Herring Gull 35 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 35 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9497	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.994 avoidance rate	64.4	0.9443	0.9943	0.8153	0.57%	18.47%	33.32	67.2

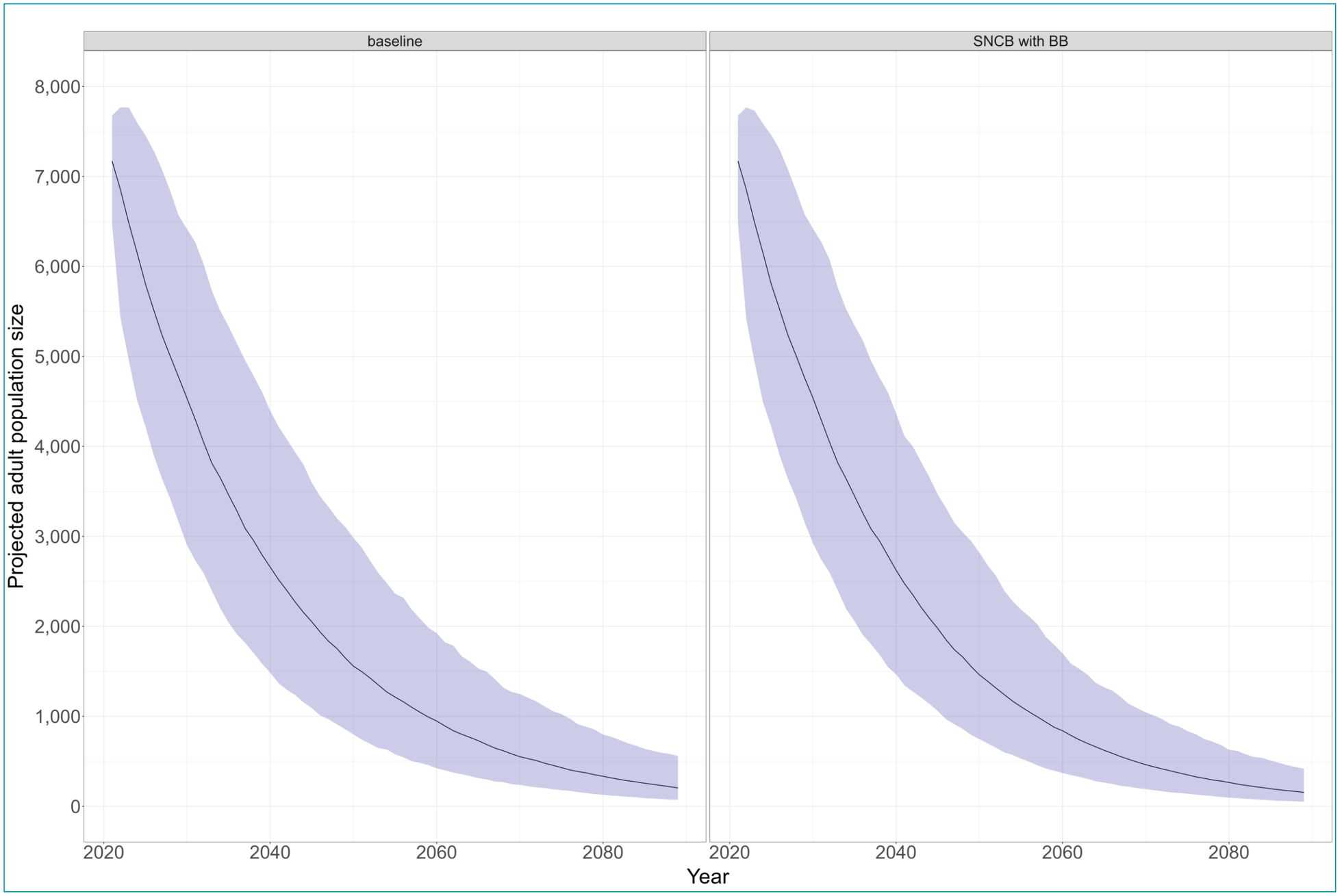

Figure 4.43 Herring Gull Population Projection over 35 Years during the Breeding Season under a Range of Impact Scenarios

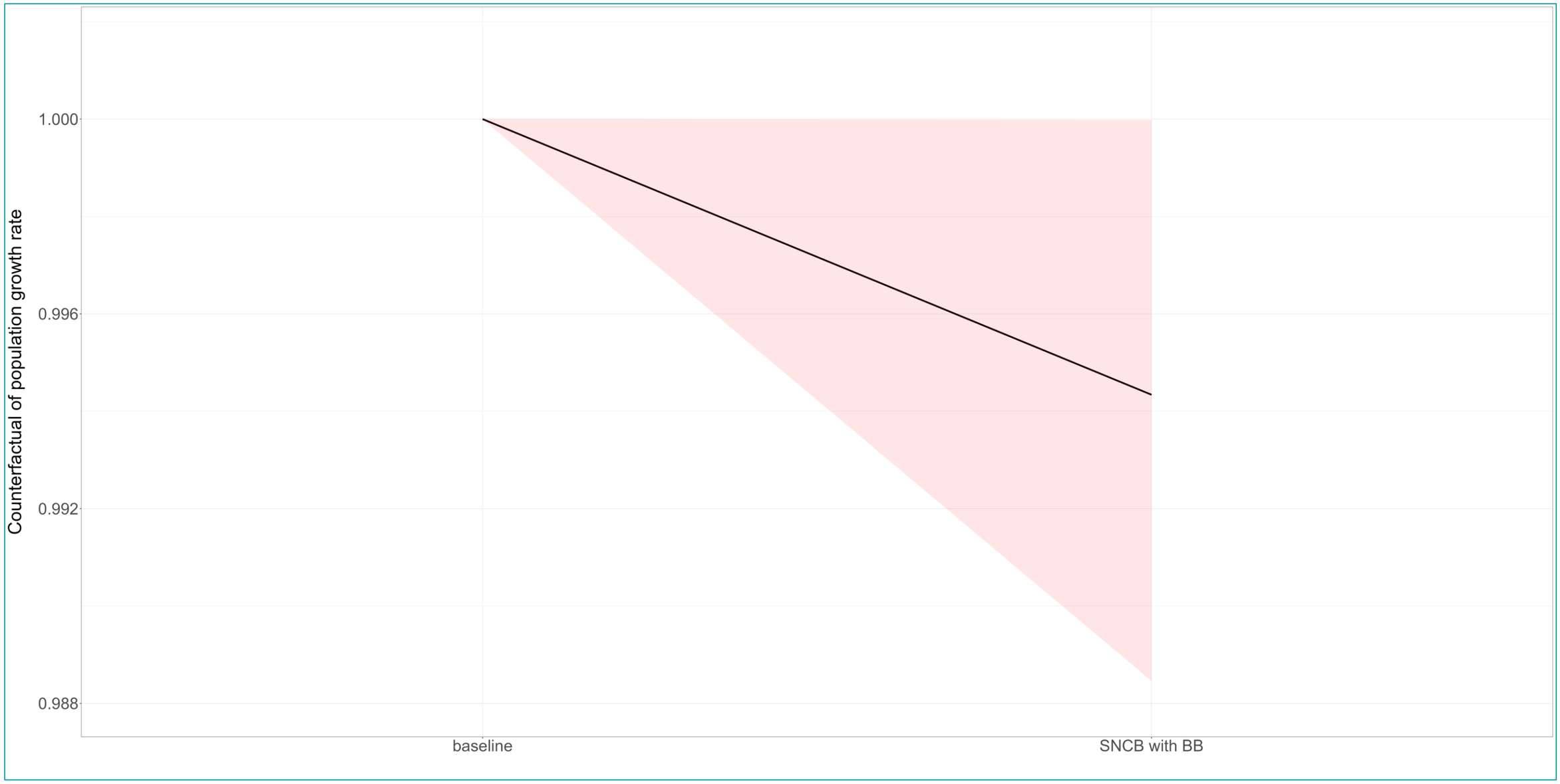

Figure 4.44 Ratio of Impacted Growth Rates after 35 Years for the Herring Gull Population during the Breeding Season under a Range of Impact Scenarios

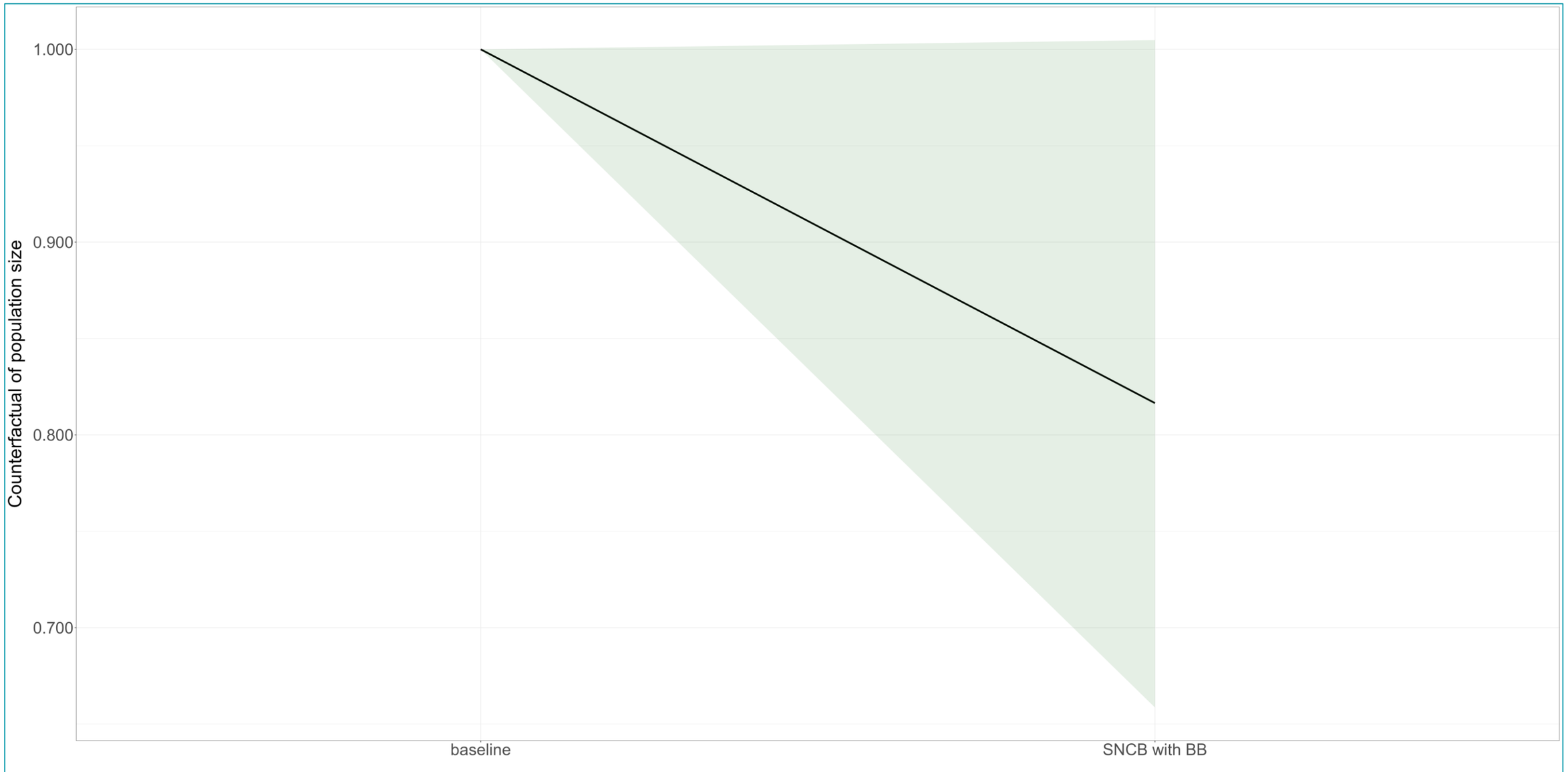

Figure 4.45 The Ratio of the Median Impacted Population Sizes for the Herring Gull Population during the Breeding Season from the Simulations after 35 Years under a Range of Impact Scenarios

4.3. RESULTS: AFTER 50 YEARS

4.3.1. GUILLEMOT

60. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the guillemot UK BDMPS at the start of the operation and maintenance phase (2039) and for 50 years at the request of NatureScot (2023b) are presented in Table 4.13. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.13: Guillemot 50 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	2,406	0.9913	0.9669	0.1799	3.31%	82.01%	0	100
	NatureScot Approach - 60% displacement, 5% mortality	4,010	0.9687	0.9449	0.0555	5.51%	94.45%	0	100
Non-breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	2,395	1.0223	0.9972	0.8668	0.28%	13.32%	28.12	73.56
	NatureScot Approach - 60% displacement, 3% mortality	7,184	1.0165	0.9916	0.6505	0.84%	34.95%	4.28	96.92
Annual	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	4,801	1.0194	0.9944	0.7505	0.56%	24.95%	12.32	88.72
	NatureScot Approach - 60% displacement, 3% mortality	11,194	1.0117	0.9869	0.5109	1.31%	48.91%	0.36	99.88
	Applicant's Approach - 50% displacement, 1% mortality	2,664	1.0220	0.9969	0.8529	0.31%	14.71%	26.04	75.68
Without Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 5% mortality	1,786	1.0000	0.9754	0.2814	2.46%	71.86%	0	100
Non-breeding	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	6,839	1.0170	0.9920	0.6641	0.80%	33.59%	4.80	96.08
Annual	Baseline	0	1.0253	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	3,201	1.0213	0.9963	0.8260	0.37%	17.40%	22.28	80.04
	NatureScot Approach - 60% displacement, 3% mortality	8,175	1.0153	0.9904	0.6128	0.96%	38.72%	2.52	98.52

4.3.2. RAZORBILL

61. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the razorbill UK BDMPS at the start of the operation and maintenance phase (2039) and for 50 years at the request of NatureScot (2023b) are presented in Table 4.14. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.14: Razorbill 50 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	336	0.9519	0.9747	0.2701	2.53%	72.99%	0.4	99.84
	NatureScot Approach - 60% displacement, 5% mortality	560	0.9353	0.9577	0.1103	4.23%	88.97%	0	100
Non-breeding Season	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	623	0.9702	0.9931	0.7029	0.69%	29.71%	23.32	77.44
Annual	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	1,213	0.9724	0.9953	0.7859	0.47%	21.41%	30.72	70.20
	NatureScot Approach - 60% displacement, 3% mortality	3,192	0.9649	0.9876	0.5289	1.24%	47.11%	10.28	90.72
Without Berwick Bank Offshore Wind Farm Impacts									
Breeding Season	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 3% mortality	263	0.9573	0.9802	0.3596	1.98%	64.04%	2.04	98.76
	NatureScot Approach - 60% displacement, 5% mortality	439	0.9442	0.9669	0.1796	3.31%	82.04%	0	100
	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
Non-breeding Season	NatureScot Approach - 60% displacement, 3% mortality	597	0.9705	0.9934	0.7130	0.66%	28.70%	24.36	76.96
Annual	Baseline	0	0.9768	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 1% mortality	1,034	0.9731	0.9960	0.8140	0.40%	18.60%	33.84	67.56
	NatureScot Approach - 60% displacement, 3% mortality	2,752	0.9665	0.9893	0.5774	1.07%	42.26%	13.64	87.80

4.3.3. PUFFIN

62. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the puffin UK BDMPS at the start of the operation and maintenance phase (2039) and for 50 years at the request of NatureScot (2023b) are presented in Table 4.15. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.15: Puffin 50 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9801	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 60% displacement, 5% mortality	774	0.9738	0.9941	0.7381	0.59%	26.19%	31.28	70.24
Without Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9801	1.0000	1.0000	N/A	N/A	N/A	N/A

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	NatureScot Approach - 60% displacement, 5% mortality	638	0.9748	0.9951	0.7786	0.49%	22.14%	34.4	67

4.3.4. GANNET

63. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the gannet UK BDMPS at the start of the operation and maintenance phase (2039) and for 50 years at the request of NatureScot (2023b) are presented in Table 4.16. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.16: Gannet 50 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,662	1.0073	0.9953	0.7883	0.47%	21.17%	19.00	82.16
Post-breeding	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,052.40	1.0069	0.9949	0.7691	0.51%	23.09%	17.48	83.00
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,218	1.0061	0.9941	0.7381	0.59%	26.19%	14.24	86.36
Annual	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,966.19	1.0065	0.9945	0.7546	0.55%	24.54%	14.56	86.28
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,394	1.0053	0.9933	0.7097	0.67%	29.03%	10.52	90.44
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	3,249	1.0029	0.9909	0.6276	0.91%	37.24%	4.88	96.24
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,394	1.0053	0.9933	0.7096	0.67%	29.04%	10.52	90.40
Without Berwick Bank Offshore Wind Farm Impacts									
Post-breeding Season	Baseline	0	1.0121	1.000	1.000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	1,169	1.0063	0.9943	0.7471	0.57%	25.29%	14.88	85.56
Annual	Baseline	0	1.0120	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,774.78	1.0070	0.9950	0.7756	0.50%	22.44%	17.48	83.32
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,157	1.0060	0.9940	0.7341	0.60%	26.59%	12.60	87.88

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	2,992	1.0036	0.9916	0.6511	0.84%	34.89%	6.16	94.80
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	2,157	1.0059	0.9940	0.7342	0.60%	26.58%	12.56	87.80

4.3.5. KITTIWAKE

64. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the kittiwake UK BDMPS at the start of the operation and maintenance phase (2039) and for 50 years at the request of NatureScot (2023b) are presented in Table 4.17. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.17: Kittiwake 50 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Pre-breeding	Baseline	0	0.9988	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance	1,020.62	0.9919	0.9968	0.8488	0.32%	15.12%	39.80	58.72
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,225	0.9913	0.9961	0.8212	0.39%	17.88%	37.84	60.72
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,634	0.9900	0.9949	0.7686	0.51%	23.14%	35.36	63.92
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,225	0.9912	0.9961	0.8212	0.39%	17.88%	38.12	60.80
Breeding	Baseline	0	0.9984	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	1,514.44	0.9822	0.9871	0.5151	1.29%	48.49%	18.52	83.64
	NatureScot Approach – 30% displacement, 3% mortality	566	0.9902	0.9952	0.7816	0.48%	21.84%	36.52	64.00
	NatureScot Approach – 30% displacement, 1% mortality	1,703	0.9806	0.9855	0.4744	1.45%	52.56%	16.20	86.52
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 3% mortality	2,080	0.9774	0.9823	0.4016	1.77%	59.84%	10.84	91.40
	Applicant's Approach – 0.993 avoidance rate, 30% displacement, 1%	1,703	0.9805	0.9855	0.4745	1.45%	52.55%	16.12	86.48
Post-breeding	Baseline	0	0.9954	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate, 30% displacement, 3% mortality	1,781	0.9908	0.9956	0.7991	0.44%	20.09%	36.96	62.24

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Annual	Baseline	0	0.9988	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate	3,572.30	0.9863	0.9912	0.6373	0.88%	36.27%	27.20	72.16
	NatureScot Approach - 30% displacement, 3% mortality	1,923	0.9904	0.9953	0.7850	0.47%	21.50%	36.20	63.00
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	4,213	0.9847	0.9896	0.5877	1.04%	41.23%	23.88	75.76
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	5,495	0.9816	0.9865	0.4990	1.35%	50.10%	17.84	82.00
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	4,213	0.9848	0.9896	0.5878	1.04%	41.22%	24.08	75.84
Without Berwick Bank Offshore Wind Farm Impacts									
Pre-breeding	Baseline	0	0.9988	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,005	0.9919	0.9968	0.8508	0.32%	14.92%	39.96	58.76
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,331	0.9909	0.9958	0.8071	0.42%	19.29%	37.40	61.72
	Applicants Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,005	0.9920	0.9968	0.8508	0.32%	14.92%	39.96	58.56
Breeding	Baseline	0	0.9984	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate	897.44	0.9875	0.9924	0.6761	0.76%	32.39%	29.32	71.40
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,023	0.9863	0.9913	0.6398	0.87%	36.02%	26.68	74.36
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,273	0.9842	0.9892	0.5736	1.08%	42.64%	22.24	79.72
	Applicant's Approach - 0.993 avoidance rate, 30% displacement, 1% mortality	1,023	0.9863	0.9913	0.6399	0.87%	36.01%	26.64	74.40
Post-breeding	Baseline	0	0.9954	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.993 avoidance rate, 30% displacement, 3% mortality	1,490	0.9914	0.9963	0.8292	0.37%	17.08%	38.76	59.92
Annual	Baseline	0	0.9988	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach – 0.993 avoidance rate	2,586.30	0.9888	0.9936	0.7220	0.64%	27.80%	32.84	66.68
	NatureScot Approach- 30% displacement, 3% mortality	1,508	0.9914	0.9963	0.8272	0.37%	17.28%	38.32	60.04

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	3,089	0.9875	0.9924	0.6776	0.76%	32.24%	29.72	69.48
	NatureScot Approach – 0.993 avoidance rate, 70% displacement, 3% mortality	4,090	0.9851	0.9899	0.5964	1.01%	40.36%	24.40	74.96
	Applicant's Approach - NatureScot Approach – 0.993 avoidance rate, 70% displacement, 1% mortality	3,089	0.9875	0.9924	0.6775	0.76%	32.25%	29.48	71.28

4.3.6. HERRING GULL

65. The results of the PVA runs for impacts from the Array cumulatively with other offshore wind farms to the herring gull UK BDMPS at the start of the operation and maintenance phase (2039) and for 50 years at the request of NatureScot (2023b) are presented in Table 4.18. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 4.18: Herring Gull 50 Year PVA Results

Season	Scenario	Predicted Mortality (Original Impact) (no. of birds)	Growth Rate (Annual GR)	Density-Independence (after 50 years)				Quantiles	
				Median CPGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
With Berwick Bank Offshore Wind Farm Impacts									
Breeding	Baseline	0	0.9496	1.0000	1.0000	N/A	N/A	N/A	N/A
	NatureScot Approach - 0.994 avoidance rate	64.4	0.9444	0.9943	0.7479	0.57%	25.21%		

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