Spiorad na Mara Offshore Wind Farm

Offshore Project

Environmental Impact Assessment Report

Appendix 14.5: EIA Population Viability Analysis Report, Volume 2c

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1 INTRODUCTION

1.1 OVERVIEW

1.1.1.1 This appendix of the Environmental Impact Assessment Report (EIAR) presents the Population Viability Analysis (PVA) modelling undertaken for the proposed Spiorad na Mara Offshore Wind Farm (hereafter referred to as 'the Offshore Project') with respect to Marine and Nearshore Ornithology. This appendix accompanies Chapter 14: Marine and Nearshore Ornithology, Volume 2a of the EIAR.

1.1.1.2 This appendix should be read in conjunction with the project description provided in Chapter 3: Project Description, Volume 1a and the relevant parts of the following chapters and appendices (including their respective annexes):

- Chapter 14, Volume 2a
- Appendix 14.1: Ornithology Baseline Report, Volume 2c;
- Appendix 14.2: Displacement Report, Volume 2c;
- Appendix 14.3: Collision Risk Modelling Report, Volume 2c;
- Appendix 14.6: EIA Ornithology Consultation, Volume 2c;
- Offshore Report to Inform Appropriate Assessment (RIAA) Appendix E: HRA Population Viability Analysis.

1.1.2 PROJECT BACKGROUND

1.1.2.1 Spiorad na Mara Limited (hereafter referred to as 'the Applicant') is proposing to develop the Project. The Project is an offshore wind farm (OWF) that will consist of up to 60 fixed-bottom wind turbine generators (WTGs).

1.1.2.2 The Project will include both offshore and onshore infrastructure. This Offshore EIAR supports the application for the offshore components of the Project as outlined in Chapter 1: Introduction, Volume 1a. The offshore components of the Project include all infrastructure and activities located seaward of Mean High Water Springs (MHWS) within the Array Area and Offshore Cable Area of Search (OCAS) (Figure 1.2: Offshore Project Location, Volume 1b). Further detailed information is provided in Chapter 3, Volume 1a.

1.1.2.3 The Offshore Project is situated off the northwest coast of Isle of Lewis/*Eilean Leòdhais* and the Array Area is located approximately 5-13 km offshore and is approximately 161 km^2 in size. It will comprise WTGs, foundations, Offshore Cables, Offshore Substation Platform (OSP) (if required), and Landfall. The Array Area combined with the OCAS is defined as the Offshore Project Boundary. The water depths across the Array Area range from 37 m-67 m with the southwest corner of the

Array Area reaching 72 m. The proposed WTGs and fixed foundations will be located within a Turbine Area of approximately 140 km^2, within the Array Area.

1.2 PURPOSE OF THIS APPENDIX

1.2.1.1 This appendix presents the PVA process and results conducted for the Environmental Impact Assessment (EIA) for the Offshore Project alone and cumulatively with other plans and projects. This appendix describes the following:

- Section 1: sets out the potential for offshore wind farms to impact seabirds, and the utility of PVA in understanding how those impacts may affect populations over time;
- Section 2: sets out the methodology used for the PVA modelling carried out, including generic input parameters such as species demographic rates;
- Section 3: sets out the specific input parameters related to the impacts of the Offshore Project; i.e. the number of mortalities expected and the assessment scenarios leading to them;
- Section 4: sets out the results of PVA modelling for impacts from the Offshore Project alone;
- Section 5: sets out the results of PVA modelling for impacts from the Offshore Project cumulatively with other developments.

1.2.1.2 For PVAs specific to individual designated site populations, refer to the Offshore RIAA.

1.2.2 IMPACT BACKGROUND

1.2.2.1 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 WTGs. These processes affect individuals, but the cumulative effects (when the project alone effects are considered alongside any effects from other projects on the same receptor) have the potential to affect the productivity or elevate the baseline mortality of a population. The EIA process allows for evaluating the potential impacts of offshore wind farms on different population scales.

1.2.2.2 In the case of 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.

1.2.2.3 One method to estimate the potential impact that the Offshore Project alone or cumulatively may have on a population is through PVA. PVA provides a robust framework using demographic parameters to predict changes in the population, using statistical population models to forecast future changes over a set period. Comparisons are made between ‘baseline’ conditions whereby conditions remain unimpacted and under ‘impact 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.

1.2.2.4 PVA was carried out for the predicted impacts of the Offshore Project, both for the Offshore Project alone and cumulatively with other plans and projects ((Sections 14.9 and 14.13 of Chapter 14, Volume 2a, respectively). PVAs were undertaken because as the predicted impact from Sections 14.9 and 14.13 of Chapter 14, Volume 2a indicated that mortality from the operation and maintenance phase (alone and cumulatively) would exceed the 0.02 percentage point decrease in annual survival rate for several seabird populations. A 0.02 percentage point decrease in annual survival rate is the level at which further assessments, such as PVA, are considered necessary for the relevant regional populations (NatureScot, 2023c).

1.2.2.5 As part of the Offshore Project alone and cumulative assessments (Sections 14.9 and 14.13 of Chapter 14, Volume 2a), the species and associated populations selected for PVA are presented in Table 1-1. Only species which have a change in survival of >0.02 percentage points are required to undertake a PVA.

Table 1-1 Species Considered for PVA modelling from the Offshore Project alone and/or cumulatively

Species	Impact	Season	Alone and/or cumulatively
Kittiwake	Displacement	Breeding	Cumulatively
		Annual	
	Collisions	Pre-breeding	Cumulatively
		Breeding	
		Post-breeding	
		Annual	
	Displacement and collisions combined	Pre-breeding	Cumulatively
		Breeding	
		Post-breeding	
		Annual	
Great black-backed gull	Collisions	Non-breeding	Cumulatively
Herring gull	Collisions	Non-breeding	Cumulatively
Arctic tern	Collisions	Breeding	Alone and cumulatively
Gannet	Displacement	Breeding	Cumulatively
		Annual	
	Collisions	Breeding	Cumulatively
		Annual	
		Breeding	Cumulatively

Species	Impact	Season	Alone and/or cumulatively
	Displacement and collisions combined	Annual	
Guillemot	Displacement	Annual	Alone and cumulatively
Razorbill	Displacement	Breeding	Alone and cumulatively
		Non-breeding	Cumulatively
		Annual	Cumulatively
Puffin	Displacement	Breeding	Cumulatively
		Annual	Cumulatively
Red-throated diver	Displacement	Breeding	Alone and cumulatively
		Annual	Alone and cumulatively
Great northern diver	Displacement	Non-breeding	Alone and cumulatively
		Annual	Alone and cumulatively

2 METHODOLOGY

2.1 PVA OVERVIEW

2.1.1.1 The PVAs were undertaken using the Seabird PVA Tool developed by Natural England (Searle *et al.*, 2019). This tool provides a user-friendly interface for conducting PVA for seabird species, particularly in the context of assessing potential impacts from offshore wind developments. The PVAs were run using NatureScot's recommended approach (NatureScot, 2023c), which includes using Natural England's PVA Tool.

2.1.1.2 The Seabird PVA tool was implemented in the R statistical environment, and its functionality is underpinned by the nepva R package, which provides a suite of functions for running stochastic PVA simulations. While the graphical interface is suitable for general use, this assessment utilised the underlying R code directly, allowing for greater flexibility and transparency in model configuration and output handling.

2.1.1.3 Specifically, the analysis was based on version 2.0 of the Seabird PVA Tool and version 4.17 of the nepva R package, as maintained in the official Natural England GitHub repository (Natural England, 2020). All modelling was conducted using R version 4.5.1 for Windows (R Core Team, 2025).

2.1.1.4 The PVAs implemented in this assessment is based on a stochastic Leslie Matrix model, a widely used demographic modelling framework for age-structured populations. The Leslie Matrix projects population dynamics over time by applying age-specific survival and fecundity rates to a population vector, allowing for the estimation of future population size and structure under different scenarios.

2.1.1.5 In this case, the model was configured to simulate stochastic variation in demographic parameters, reflecting natural variability in survival and reproduction. The code allows for the assessment of a wide range of potential impacts, including changes to demographic rates (e.g. reduced survival or productivity), fixed annual removals (e.g. culling or collision mortality), or combinations of both. This flexibility enables the model to simulate realistic population responses to pressures such as those associated with offshore wind farm developments.

2.1.1.6 PVAs were run for a 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 as presented in Table 2-3[1]). Following engagement with NatureScot (09 June 2025), it was confirmed that a 25-year modelling period was not required and is therefore not presented in this appendix.

[1] NatureScot guidance typically provides an upper and lower range of parameters for assessment (see Table 2-3).

2.1.1.7 All model inputs were aligned with those used in the Natural England Seabird PVA Tool (Searle *et al*., 2019), ensuring consistency with established guidance and facilitating comparability with other assessments.

2.1.1.8 The following sections provided specific information, which is included within the PVAs. Section 2.2 (Modelling Approach) covers how the model was run and what outputs are considering the most important in interpreting the results. Within Section 2.3 (Simulation Parameters) presents how many simulations where run within each PVA, and finally within Section 2.4 (Model Parameterisation) the specific input parameters used within the Offshore Project alone and cumulative PVAs for the species and scenarios considered.

2.2 MODELLING APPROACH

2.2.1.1 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.

2.2.1.2 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 by which this operates are largely uncertain, and individual populations may show negative, positive or no density dependence (e.g. Merrall *et al.,* 2024, Horswill *et al.,* 2017). If density dependence is mis-specified in an assessment, the modelled predictions may be unreliable. Therefore, unless density dependence is known for the modelled population then it is more typical to use density independent models for seabird assessments, accepting that if depensatory density dependence is occurring then this approach may underestimate impacts, but that if compensatory population growth is occurring then this approach may be considered precautionary (Ridge *et al*., 2019). For the PVA runs undertaken within this technical report all models were therefore run using density independence, which is in line with NatureScot guidance (NatureScot, 2023c). This modelling approach has been discussed in Offshore RIAA, Appendix E.

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

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

2.2.1.5 PVA outputs are as expressed as the Counterfactual of Population Size (CPS) or the Counterfactual of Growth Rate (CGR). The choice of which metric to focus on depends on whether density dependence is included in the model.

2.2.1.6 In this assessment, the models have been run under density-independent assumptions, which means that population growth is not limited by factors such as resource availability or carrying capacity. Under these conditions, the CGR is generally considered the more robust and informative metric, as it reflects the proportional change in the long-term growth rate of the population due to the impact being assessed.

2.2.1.7 While both CPS and CGR outputs are presented in line with NatureScot's (NatureScot, 2023c) guidance, the interpretation of results in Chapter 14, Volume 2a focuses on CGR, as it provides a clearer indication of potential long-term population-level effects in the absence of density regulation. This is in line with ecological modelling principles described by White (2016), where it is noted that the interpretation of the CGR is better suited to density-independent models, as it shows how a population responds to external pressures without the added complexity of feedback effects. In contrast, CPS is more appropriate metric when density dependence is explicitly included in the model, as it reflects how population size changes over time in response to natural constraints such as resource limitation and carrying capacity.

2.2.1.8 Additionally, the quantile from the unimpacted population that matched the 50% quantile for the impacted population (Unimpacted=50% of Impacted) and the quantile from the impacted population that matched the 50% quantile for the unimpacted population (Impacted=50% of Unimpacted) 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.

2.3 SIMULATION PARAMETERS

2.3.1.1 All PVA modelling in this Appendix 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 over a 50 year period to cover the lifetime of the Offshore Project and beyond. Results are presented for both a 35 year period (reflecting the predicted lifetime of the Offshore Project) and a 50 year period, as recommended in NatureScot guidance (NatureScot, 2023c).

2.3.1.2 Modelling has been undertaken including a 5 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 after the Offshore Project is anticipated to become fully operational. It is anticipated that the construction phase will finished in 2033 (Chapter 3, Volume 1a), therefore the PVAs were set to commence from 2034 and run for 35 and 50 years. The PVA models often cannot accommodate the 5 year burn in period when the starting populations are small, therefore if a population is <2000 individuals then the burn in period was set to 0 years.

2.3.1.3 For the purpose of informing Chapter 14, Volume 2a, the assessment has considered the impact on birds of all age classes (e.g. juveniles, immatures and adults) 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 Section 14 of the Offshore RIAA.

2.3.1.4 Impacted vs unimpacted comparisons were based on a matched runs approach, whereby stochasticity is applied to the population before impacts are applied (i.e. survival and productivity rates simulated at each time step are the same for the unimpacted and impacted populations before additional impact mortalities are deducted from simulated survivals for the impacted populations). This approach 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 Project on offshore ornithology.

2.4 MODEL PARAMETERISATION

2.4.1 DEMOGRAPHIC RATES

2.4.1.1 The species listed in Table 2-1 are those following assessment in Section 14.10 (the Offshore Project alone assessment) and 14.13 (the cumulative assessment) of Chapter 14, Volume 2c resulted in an increase of more than 0.02 percentage points in the baseline mortality rate. As such, demographic rates were required for these species to enable further assessment.

2.4.1.2 Age-specific survival rates for each species from Horswill and Robinson (2015) were entered into a matrix population model. Updated productivity values were provided by Joint Nature Conservation Committee (JNCC)/British Trust for Ornithology (BTO) (JNCC *et al*., 2024), with the UK average over the course of 2010-2019 calculated and used. Not all species and colonies had updated counts after 2014, and so the national average from Horswill and Robinson (2015) was used if no updated rates from JNCC/BTO were made available. Productivity values were used to calculate the expected proportions in each age class. Each age class survival rate was multiplied by its proportion and the total for all ages summed to give the average survival rate for all ages. The average mortality rate was subsequently calculated by subtracting the survival rate from 1. The demographic rates, age class proportions and average mortality rates calculated are presented in Table 2-1.

2.4.1.3 For red-throated diver, when running the model with the juvenile survival rates presented in Horswill and Robinson (2015), the model population quickly declines to zero. This is therefore both uninformative (i.e. there is no difference between the unimpacted and impacted populations, as both are zero), and contrary to the observed population trend of increasing numbers (Dillon et al., 2009). Horswill and Robinson (2015) noted methodological concerns about the studies from which the red-throated diver juvenile survival rates were obtained, and recommend using the rates for great northern diver instead. Therefore, the juvenile survival rates used for PVA for red-throated diver (as presented in Table 2-1) are the great northern diver juvenile survival rates from Horswill and Robinson (2015). Whilst the PVA model still produces a declining population trend using these rates, the population does not decline to zero within the modelled period and therefore the results can be used.

Table 2-1 Demographic rates from JNCC/BTO (JNCC *et al.*, 2024) and Horswill and Robinson (2015)

Species	Age at First Breeding	Maximum Eggs per Pair	Survival by Age Class (mean ± SD)							Productivity (Chicks per Pair) (mean ± SD)
			0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	Adult	
Kittiwake	4	2	0.790 ± 0.077	0.854 ± 0.077	0.854 ± 0.077	0.854 ± 0.077	N/A	N/A	0.854 ± 0.077	0.619 ± 0.077
Great black-backed gull	5	3	0.798 ± 0.092	0.930 ± 0.034	0.930 ± 0.034	0.930 ± 0.034	0.930 ± 0.034	N/A	0.930 ± 0.034	1.061 ± 0.132
Herring gull	5	3	0.798 ± 0.092	0.834 ± 0.034	0.834 ± 0.034	0.834 ± 0.034	0.834 ± 0.034	N/A	0.834 ± 0.079	0.498 ± 0.113
Arctic tern	4	3	0.441	0.837 ± 0.035	0.837 ± 0.035	0.837 ± 0.035	N/A	N/A	0.837 ± 0.035	0.380 ± 0.325
Guillemot	6	1	0.560 ± 0.058	0.792 ± 0.152	0.917 ± 0.098	0.939 ± 0.107	0.939 ± 0.025	0.939 ± 0.025	0.939 ± 0.025	0.583 ± 0.079
Razorbill	5	1	0.630 ± 0.067	0.630 ± 0.067	0.895 ± 0.067	0.895 ± 0.067	0.895 ± 0.067	N/A	0.895 ± 0.067	0.532 ± 0.089
Puffin	5	1	0.709 ± 0.108	0.709 ± 0.108	0.709 ± 0.108	0.760 ± 0.093	0.805 ± 0.083	N/A	0.907 ± 0.083	0.557 ± 0.115
Red-throated diver	3	3	0.770 ± 0.020	0.770 ± 0.020	0.770 ± 0.020	N/A	N/A	N/A	0.840 ± 0.074	0.571 ± 0.222
Great northern diver	6	3	0.770 ± 0.020	0.770 ± 0.020	0.770 ± 0.020	N/A	N/A	N/A	0.870 ± 0.070	0.543 ± 0.170
Gannet	5	1	0.424 ± 0.045	0.829 ± 0.026	0.891 ± 0.019	0.895 ± 0.019	0.919 ± 0.042	N/A	0.919 ± 0.042	0.766 ± 0.054

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2.4.2 POPULATIONS

2.4.2.1 The species listed in Table 2-2 are those following assessment in Section 14.9 (the Offshore Project alone assessment) and 14.13 (the cumulative assessment) of Chapter 14, Volume 2a resulted in an increase of more than 0.02 percentage points in the baseline mortality rate. and thus required PVA. Regional populations used within the PVAs are shown in Table 2-2.

2.4.2.2 Regional populations for the breeding season were estimated by summing the most recent population counts, extracted from Seabirds Count data (Burnell *et al.*, 2023) for all breeding colonies within the foraging range distance from the Study Area for each species (refer to Table 5-1 in Appendix 14.1, Volume 2c for a list of the species-specific foraging ranges used).

2.4.2.3 During the pre-breeding, post-breeding and non-breeding seasons the population is the BDMPS for each species (Furness, 2015).

2.4.2.4 For the annual assessment, the population is defined as the largest of the individual seasonal regional populations, as further detailed within Section 14.6.1 of Chapter 14, Volume 2a.

Table 2-2 Seasonal population used within the PVAs

Species	Season	Region	Regional Population (number of birds - all age classes)
Kittiwake	Pre-breeding	UK western waters & Channel	691,526
	Breeding	Foraging Range	221,825
	Post-breeding	UK western waters & Channel	911,586
	Annual	UK western waters & Channel	911,586
Great black-backed gull	Breeding	Foraging Range	1,645
	Non-breeding	UK west of Scotland/*Alba* waters	34,380
	Annual	UK west of Scotland/*Alba* waters	34,380
Herring gull	Breeding	Foraging Range	3,148
	Non-breeding	UK western waters	173,299
	Annual	UK western waters	173,299
Arctic tern	Pre-breeding	UK western waters	71,398
	Breeding	Foraging Range	1,814
	Post-breeding	UK western waters	71,398
	Annual	UK western waters	71,398
Gannet	Pre-breeding	UK western waters	661,888
	Breeding	Foraging Range	922,238
	Post-breeding	UK western waters	545,954

Species	Season	Region	Regional Population (number of birds - all age classes)
	Annual	Foraging Range	922,238
Guillemot	Breeding	Foraging Range	278,589
	Non-breeding	Foraging Range	278,589
	Annual	Foraging Range	278,589
Razorbill	Pre-breeding	UK western waters	606,914
	Breeding	Foraging Range	55,523
	Post-breeding	UK western waters	606,914
	Non-breeding	UK western waters	341,422
	Annual	UK western waters	606,914
Puffin	Breeding	Foraging Range	1,194,457
	Non-breeding	UK western waters	304,557
	Annual	Foraging Range	1,194,457
Red-throated diver	Pre-breeding	UK western waters plus Channel	4,373
	Breeding	Foraging Range	278
	Post-breeding	UK western waters plus Channel	4,373
	Non-breeding	West of Scotland/*Alba*	861
	Annual	UK western waters plus Channel	4,373
Great northern diver	Non-breeding	West of Scotland/*Alba*	2,000
	Annual	West of Scotland/*Alba*	2,000

2.4.3 IMPACT SCENARIOS

2.4.3.1 The first step in the PVA process was to determine whether any predicted impacts, either from the Offshore Project alone or cumulatively with other plans and projects, exceeded the 0.02 percentage point survival threshold. This threshold acts as a screening tool to identify impacts that could meaningfully influence population dynamics and therefore require further assessment through PVA. These calculations are presented within the Section 14.9 (the Offshore Project alone assessment) and Section 14.13 (the cumulative assessment) of Chapter 14, Volume 2a. Any scenarios that did not surpass the 0.02 percentage point threshold are not presented within this Appendix.

2.4.3.2 As presented within Table 1-1 which summaries the assessment conclusions from Section 14.9 (the Offshore Project alone assessment) and 14.13 (the cumulative assessment) of Chapter 14, Volume 2a there were 36 scenarios which required a PVA.

2.4.3.3 Impacts from collision risk and displacement were assessed against the relevant seasonal regional populations (Table 2-2) for each species. To determine whether the 0.02 percentage point threshold was exceeded, predicted mortality was divided by the species' regional population (Table 2-2).

2.4.3.4 For displacement, model-based estimates were used wherever available, in line with NatureScot advice that these should take precedence over design-based estimates (NatureScot, 2023a). Where model-based estimates could not be derived because MRSea modelling was not possible (due to low levels of recorded observations), design-based estimates were used instead (see Section 14.9.2 of Chapter 14, Volume 2a and Appendix 14.2, Volume 2c for additional information).

2.4.3.5 Within both the alone and cumulative PVAs a range of displacement rates are used, those recommended by NatureScot (2023c) which are presented as the 'Upper' and 'Lower' scenarios and an Applicant's approach. These rates are presented in Table 2-3. The Applicant's approach and NatureScot rates are often the same.

Table 2-3: Displacement scenarios considered within the alone and cumulative PVAs

Feature	Scenario Name	Impact Rates
Kittiwake	Displacement NatureScot Lower and Applicant (30/1)	30% displacement and 1% mortality (breeding and non-breeding seasons)
	Displacement NatureScot Upper (30/3)	30% displacement and 3% mortality (breeding and non-breeding seasons)
Guillemot	Displacement NatureScot Lower (60/3/1)	60% displacement and 3% mortality (breeding season) and 1% mortality (non-breeding season)
	Displacement NatureScot Upper (60/5/3)	60% displacement and 5% mortality (breeding season) and 3% mortality (non-breeding season)
	Displacement Applicant (50/1/1)	50% displacement and 1% mortality (breeding and non-breeding seasons)
Razorbill	Displacement NatureScot Lower (60/3/1)	60% displacement and 3% mortality (breeding season) and 1% mortality (non-breeding season)
	Displacement NatureScot Upper (60/5/3)	60% displacement and 5% mortality (breeding season) and 3% mortality (non-breeding season)
	Displacement Applicant (50/1/1)	50% displacement and 1% mortality (breeding and non-breeding seasons)
Puffin	Displacement NatureScot Lower (60/3/1)	60% displacement and 3% mortality (breeding season) and 1% mortality (non-breeding season)
	Displacement NatureScot Upper (60/5/3)	60% displacement and 5% mortality (breeding season) and 3% mortality (non-breeding season)
	Displacement Applicant (50/1/1)	50% displacement and 1% mortality (breeding and non-breeding seasons)
Red-throated diver	Displacement NatureScot and Applicant (100/10)	100% displacement and 10% mortality (breeding and non-breeding seasons)
Great northern diver	Displacement NatureScot (100/10)	100% displacement and 10% mortality (breeding and non-breeding seasons)
	Displacement Applicant Lower (100/1)	100% displacement and 1% mortality (breeding and non-breeding seasons)

Feature	Scenario Name	Impact Rates
	Displacement Applicant Upper (100/5)	100% displacement and 5% mortality (breeding and non-breeding seasons)
Gannet	Displacement NatureScot Lower and Applicant (70/1)	70% displacement and 1% mortality (breeding and non-breeding seasons)
	Displacement NatureScot Upper (70/3)	70% displacement and 3% mortality (breeding and non-breeding seasons)

2.4.3.6 For collision risk, impacts were first grouped by the appropriate seasons (e.g. pre-breeding, breeding, post-breeding, and non-breeding seasons, as applicable). Following NatureScot guidance (NatureScot, 2025), where a month spanned 2 seasons (for example, April being part of both the pre-breeding and breeding seasons), collision estimates for that month were split evenly, with 50% assigned to each relevant season (see Section 14.9.1 of Chapter 14, Volume 2a and Appendix 14.3, Volume 2c for additional information).

2.4.3.7 Collision risk estimates from Collision Risk Modelling (CRM) can be undertaken both stochastically or deterministically, which accounts for, or ignores environmental variability. NatureScot (and the other Statutory Nature Conservation Bodies (SNCB)) recommend different avoidance rates to be used within the stochastic and deterministic CRMs (Joint SNCBs, 2024). Within the cumulative assessment the other developments predicted collision estimates have been updated to the latest advised avoidance rate (Joint SNCBs, 2024). The avoidance rate used within the correction calculation depends on if the original CRM (from the other development) was run stochastically or deterministically. The Joint SNCBs guidance (Joint SNCBs, 2024) specifies both the stochastic avoidance rate and the deterministic avoidance rate. For clarity the avoidance rates used are presented in Table 2-4. Within this Appendix, the impact scenario used within the PVA is presented as 'Collisions' only.

Table 2-4: Avoidance rates used to correct predicted collisions considered within the cumulative PVAs

Feature	Stochastic Avoidance Rate	Deterministic Avoidance Rate
Kittiwake	0.9929	0.9923
Great black-backed gull	0.9940	0.9936
Herring gull	0.9940	0.9936
Arctic tern	0.9908	0.9902
Gannet	0.9929	0.9923

2.4.3.8 The combined impact of collision and displacement was also considered for kittiwake and gannet. The combined impact of collision and displacement was calculated by simply summing the displacement and collision mortality estimates. It should be noted that this simple summing approach has the potential to overestimate impacts due to double counting – birds that are displaced from a wind farm are not vulnerable to collision, whilst birds that suffer mortality due to collision are no longer liable to be displaced. Whilst a 70% macro avoidance is accounted for in collision estimates for gannet in the non-breeding season (in line with NatureScot advice, see Appendix 14.6, Volume 2c), no macro avoidance is applied to kittiwake or to gannet in the breeding season.

2.4.3.9 As outlined in Chapter 14, Volume 2a and Appendix 14.6, Volume 2c, and in-line with Marine Directorate – Licensing Operations Team (MD-LOT) and NatureScot advice (via email 8 July 2025 and 16 April 2025, respectively), compensated birds from consented projects have been excluded from the cumulative PVAs. Consequently, impacts from Berwick Bank, Green Volt, Salamander, and West of Orkney have been adjusted accordingly. Full details of the approach and methodology for the cumulative assessment, including the treatment of compensated impacts, are provided in Chapter 14, Volume 2a.

2.4.3.10 There was also an additional request from MD-LOT (see Appendix 14.6, Volume 2c) to present a 'with' and 'without Berwick Bank' impact scenario, albeit that consent was received in August 2025. Berwick Bank only has connectivity with gannet during the breeding season and therefore only gannet have the 'with Berwick Bank' and 'without Berwick Bank' impact scenarios.

The scenarios presented 'without Berwick Bank' for gannet predict a greater impact due to the level of compensation required for the development. The number of predicted compensated birds is greater than the predicted impact as compensation ratios are applied to the derogation case.

3 INPUT PARAMETERS

3.1 INPUT PARAMETERES OVERVIEW

3.1.1.1 For scenarios where a PVA was undertaken, the impact from the Offshore Project alone, as well as cumulatively with other plans and projects was parametrised as a relative harvest. This means the impact was modelled as an reduction in annual survival as a result of the predicted mortality. Specifying a relative harvest means that the absolute number of birds expected to suffer mortality is proportional to the population size, which aligns with the approach used for both collision risk and displacement analysis.

3.1.1.2 Each simulation run within the model was paired with an impact scenario that included additional population-level mortality PVA due to wind turbine collision or displacement impacts. This additional mortality was calculated as a proportion of the starting population and applied to all age classes.

3.2 OFFSHORE PROJECT ALONE

3.2.1.1 Out of all impact scenarios considered (Section 14.9 of Chapter 14, Volume 2a), 11 required further assessment: 1 scenario for Arctic tern (Table 3-1), 1 for guillemot (Table 3-2), 1 for razorbill (Table 3-3), 4 for red-throated diver (Table 3-4) and 4 for great northern diver (Table 3-5). The relative harvest associated with each of these scenarios is detailed in the relevant species sections below. The relative harvest is expressed as a point change in survival rate, calculated by dividing the number of mortalities by the total population size. This gives a dimensionless proportion representing the fractional reduction in annual survival applied in the PVA.

3.2.2 ARCTIC TERN

3.2.2.1 The impact scenarios taken through to PVA for Arctic tern are presented in Table 3-1 for the Offshore Project alone. The specific avoidance rates used for Arctic tern within each impact scenarios are presented in Table 2-4.

Table 3-1 Impact scenarios taken through to PVA for Arctic tern

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Collisions	1.75	0.000967

3.2.3 GUILLEMOT

3.2.3.1 The impact scenarios taken through to PVA for guillemot are presented in Table 3-2 for the Offshore Project alone. The specific displacement and mortality rates used for guillemot within each impact scenarios are presented in Table 2-3.

Table 3-2 Impact scenarios taken through to PVA for guillemot

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Annual	Displacement NatureScot Upper (60/5/3)	62.43	0.000224

3.2.4 RAZORBILL

3.2.4.1 The impact scenarios taken through to PVA for razorbill are presented in Table 3-3 for the Offshore Project alone. The specific displacement and mortality rates used for razorbill within each impact scenarios are presented in Table 2-3.

Table 3-3 Impact scenarios taken through to PVA for razorbill

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Displacement NatureScot Upper (60/5)	12.30	0.000222

3.2.5 RED-THROATED DIVER

3.2.5.1 The impact scenarios taken through to PVA for red-throated diver are presented in Table 3-4 for the Offshore Project alone. The specific displacement and mortality rates used for red-throated diver within each impact scenarios are presented in Table 2-3.

Table 3-4 Impact scenarios taken through to PVA for red-throated diver

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Displacement NatureScot and Applicant (100/10)	0.40	0.001439
Annual	Displacement NatureScot and Applicant (100/10)	1.20	0.000274

3.2.6 GREAT NORTHERN DIVER

3.2.6.1 The impact scenarios taken through to PVA for great northern diver are presented in Table 3-5 for the Offshore Project alone. The specific displacement and mortality rates used for great northern diver within each impact scenarios are presented in Table 2-3.

Table 3-5 Impact scenarios taken through to PVA for great northern diver

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Non-breeding	Displacement NatureScot (100/10)	2.70	0.00135
Annual		2.70	0.00135
Non-breeding	Displacement Applicant Upper (100/5)	1.35	0.000675
Annual		1.35	0.000675

3.3 CUMULATIVE

3.3.1.1 Out of all PVA cumulative scenarios considered 59 required further assessment: 18 for kittiwake (Table 3-6), 1 scenario for great black-backed gull (Table 3-7), 1 scenario for herring gull (Table 3-8), 1 scenario for Arctic tern (Table 3-9), 20 for gannet (Table 3-10), 1 for guillemot (Table 3-11), 5 for razorbill (Table 3-12), 4 for puffin (Table 3-13), 4 for red-throated diver (Table 3-14) and 4 for great northern diver (Table 3-15). The relative harvest associated with each of these scenarios is detailed in the relevant species sections below. The relative harvest is expressed as a point change in survival rate, calculated by dividing the number of mortalities by the total population size. This gives a dimensionless proportion representing the fractional reduction in annual survival applied in the PVA.

3.3.1.2 As set out in Section 2.4.3, several scenarios have been requested by the statutory consultees, one of which considers ‘with Berwick Bank’ and ‘without Berwick Bank’ options. Due to Berwick Banks location, only gannet have the potential to be impacted by both the Offshore Project and Berwick Bank, therefore all other species do not present a ‘with’ and ‘without’ option.

3.3.2 KITTIWAKE

3.3.2.1 The impact scenarios taken through to cumulative PVA for kittiwake are presented in Table 3-6. The specific avoidance rates and displacement and mortality rates used for kittiwake within each impact scenarios are presented in Table 2-3 (displacement and mortality rates) and Table 2-4 (avoidance rates).

Table 3-6 Impact scenarios taken through to cumulative PVA for kittiwake

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Collisions	215.55	0.000972
	Displacement NatureScot Upper (30/3)	124.38	0.000561
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	255.78	0.001153
	Combined Collisions and Displacement NatureScot Upper (30/3)	339.94	0.001532
Post-breeding	Collisions	250.63	0.000275
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	282.44	0.000310
	Combined Collisions and Displacement NatureScot Upper (30/3)	346.82	0.000380
Pre-breeding	Collisions	256.79	0.000371
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	277.98	0.000402
	Combined Collisions and Displacement NatureScot Upper (30/3)	321.99	0.000466
Annual	Collisions	722.96	0.000793
	Displacement NatureScot Upper (30/3)	285.79	0.000314
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	816.20	0.000895

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
	Combined Collisions and Displacement NatureScot Upper (30/3)	1,008.75	0.001107

3.3.3 GREAT BLACK-BACKED GULL

3.3.3.1 The impact scenarios taken through to cumulative PVA for great black-backed gull are presented in Table 3-7. The specific avoidance rates used for great black-backed gull within each impact scenarios are presented Table 2-4.

Table 3-7 Impact scenarios taken through to cumulative PVA for great black-backed gull

Season	Impact Scenario	Predicted Mortality (no. of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Non-breeding	Collisions	15.28	0.000445

3.3.4 HERRING GULL

3.3.4.1 The impact scenarios taken through to cumulative PVA for herring gull are presented in Table 3-8. The specific avoidance rates used for herring gull within each impact scenarios are presented in Table 2-4.

Table 3-8 Impact scenarios taken through to cumulative PVA for herring gull

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Non-breeding	Collisions	169.20	0.000976

3.3.5 ARCTIC TERN

3.3.5.1 The impact scenarios taken through to cumulative PVA for Arctic tern are presented in Table 3-9. The specific avoidance rates used for Arctic tern within each impact scenarios are presented in Table 2-4.

Table 3-9 Impact scenarios taken through to cumulative PVA for Arctic tern

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Collisions	1.75	0.000967

3.3.6 GANNET

3.3.6.1 The impact scenarios taken through to cumulative PVA for gannet are presented in Table 3-10. The specific avoidance rates and displacement and mortality rates used for gannet within each impact scenarios are presented in Table 2-3 (displacement and mortality rates) and Table 2-4 (avoidance rates).

Table 3-10 Impact scenarios taken through to cumulative PVA for gannet

Season	Impact Scenario	Predicted Mortality (no. of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Collisions (with Berwick Bank)	580.66	0.000630
	Collisions (without Berwick Bank)	620.13	0.000672
	Displacement NatureScot Upper (70/3) (with Berwick Bank)	386.94	0.000420
	Displacement NatureScot Upper (70/3) (without Berwick Bank)	375.48	0.000407
	Combined Collisions and displacement NatureScot Lower and Applicant (70/1) (with Berwick Bank)	650.07	0.000705
	Combined Collisions and displacement NatureScot Lower and Applicant (70/1) (without Berwick Bank)	744.30	0.000807
	Combined Collisions and displacement NatureScot Upper (70/3) (with Berwick Bank)	967.60	0.001049
	Combined Collisions and displacement NatureScot Upper (70/3) (without Berwick Bank)	995.54	0.001079
Annual	Collisions (with Berwick Bank)	609.17	0.000661
	Collisions (without Berwick Bank)	614.56	0.000666
	Displacement NatureScot Upper (70/3) (with Berwick Bank)	441.23	0.000478
	Displacement NatureScot Upper (70/3) (without Berwick Bank)	460.12	0.000499
	Combined Collisions and displacement NatureScot Lower and Applicant (70/1) (with Berwick Bank)	677.36	0.000734
	Combined Collisions and displacement NatureScot Lower and Applicant (70/1) (without Berwick Bank)	752.61	0.000816
	Combined Collisions and displacement NatureScot Upper (70/3) (with Berwick Bank)	1,050.40	0.001139
	Combined Collisions and displacement NatureScot Upper (70/3) (without Berwick Bank)	1,059.36	0.001149

3.3.7 GUILLEMOT

3.3.7.1 The impact scenarios taken through to cumulative PVA for guillemot are presented in Table 3-11. The specific displacement and mortality rates used for guillemot within each impact scenarios are presented in Table 2-3.

Table 3-11 Impact scenarios taken through to cumulative PVA for guillemot

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Annual	Displacement NatureScot Upper (60/5/3)	62.43	0.000224

3.3.8 RAZORBILL

3.3.8.1 The impact scenarios taken through to cumulative PVA for razorbill are presented in Table 3-12. The specific displacement and mortality rates used for razorbill within each impact scenarios are presented in Table 2-3.

Table 3-12 Impact scenarios taken through to cumulative PVA for razorbill

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Displacement NatureScot Upper (60/5)	12.30	0.000221
Post-breeding	Displacement NatureScot Upper (60/3)	125.45	0.000207
Non-breeding	Displacement NatureScot Upper (60/3)	152.35	0.000445
Annual	Displacement NatureScot Lower (60/3/1)	145.03	0.000239
	Displacement NatureScot Upper (60/5/3)	409.60	0.000675

3.3.9 PUFFIN

3.3.9.1 The impact scenarios taken through to cumulative PVA for puffin are presented in Table 3-13. The specific displacement and mortality rates used for puffin within each impact scenarios are presented in Table 2-3.

Table 3-13 Impact scenarios taken through to cumulative PVA for puffin

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Displacement NatureScot Lower (60/3)	441.69	0.000370
	Displacement NatureScot Upper (60/5)	736.15	0.000616
Annual	Displacement NatureScot Lower (60/3/1)	454.14	0.000380
	Displacement NatureScot Upper (60/5/3)	793.08	0.000664

3.3.10 RED-THROATED DIVER

The impact scenarios taken through to cumulative PVA for red-throated diver are presented in Table 3-14. The specific displacement and mortality rates used for red-throated diver within each impact scenarios are presented in Table 2-3.

Table 3-14 Impact scenarios taken through to cumulative PVA for red-throated diver

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Breeding	Displacement NatureScot and Applicant (100/10)	0.40	0.001439
Annual		1.76	0.000403

3.3.11 GREAT NORTHERN DIVER

3.3.11.1 The impact scenarios taken through to cumulative PVA for great northern diver are presented in Table 3-15. The specific displacement and mortality rates used for great northern diver within each impact scenarios are presented in Table 2-3.

Table 3-15 Impact scenarios taken through to cumulative PVA for great northern diver

Season	Impact Scenario	Predicted Mortality (no. of birds - all age classes)	Predicted Impact on Survival Rate (relative harvest)
Non-breeding	Displacement NatureScot (100/10)	2.70	0.001350
	Displacement Applicant Upper (100/5)	1.35	0.000675
Annual	Displacement NatureScot (100/10)	2.70	0.001350
	Displacement Applicant Upper (100/5)	1.35	0.000675

4 OFFSHORE PROJECT ALONE ASSESSMENT OUTPUTS

4.1 Offshore Project Alone Assessment Outputs Overview

4.1.1.1 The results of the PVA runs for impacts from the Offshore Project alone, are presented for each species listed in Section 3.2 (Project Alone). These results reflect impacts from the first full year operation in 2034 (with construction estimated to finish in 2033) and cover the expected 35 year operational lifespan of the Offshore Project, which forms the basis for the assessment conclusions. In accordance with NatureScot guidance (NatureScot, 2023c), results for 50-year time periods are also provided for context, although they are not used to inform the conclusions of the assessment.

4.1.1.2 The baseline 'unimpacted' scenarios (i.e. assuming no additional mortality other than baseline mortality exists) are also shown for comparison purposes. Graphs relating to population size, CPS, and CGR for each impact scenario for the lifetime of the Offshore Project are also presented for the 35 year period in line with guidance (NatureScot, 2023c).

4.1.1.3 All plates which depict the population projection have been modelled from 2024 (before the impact starts) to 50 years from the first year of full operation (estimated in 2034), these plates are only presented in Section 4.2 (35 year results) and are not repeated in Section 4.3 (50 year results).

4.2 RESULTS: AFTER 35 YEARS

4.2.1 ARCTIC TERN

4.2.1.1 The results of the PVA runs for impacts from the Offshore Project alone to the Arctic tern regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 4-1. The specific avoidance rates used for Arctic tern within the collision scenario are presented in Table 2-4.

4.2.1.2 As part of NatureScot guidance (2023c), 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 Plate 4-1 for the breeding season. Plate 4-2 show the CGR values for the breeding season and Plate 4-3 show the CPS values for the breeding season. Plate 4-1 presents the impact up to 50 years post commencement.

Table 4-1 Arctic tern 35 Year PVA Offshore Project Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9007	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	1.75	0.8995	0.9985	0.9459	0.1500	5.4100	48.92	57.50

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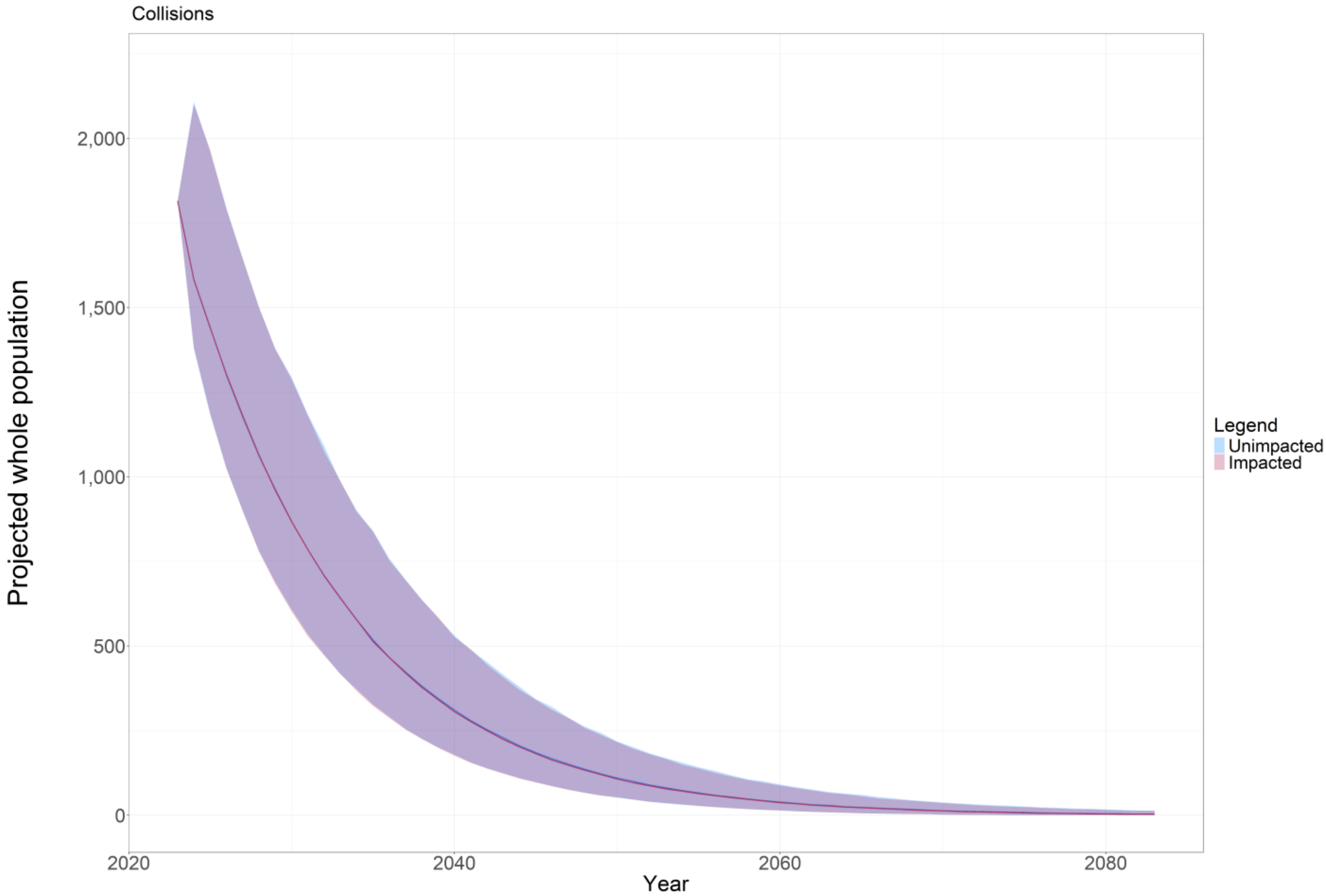
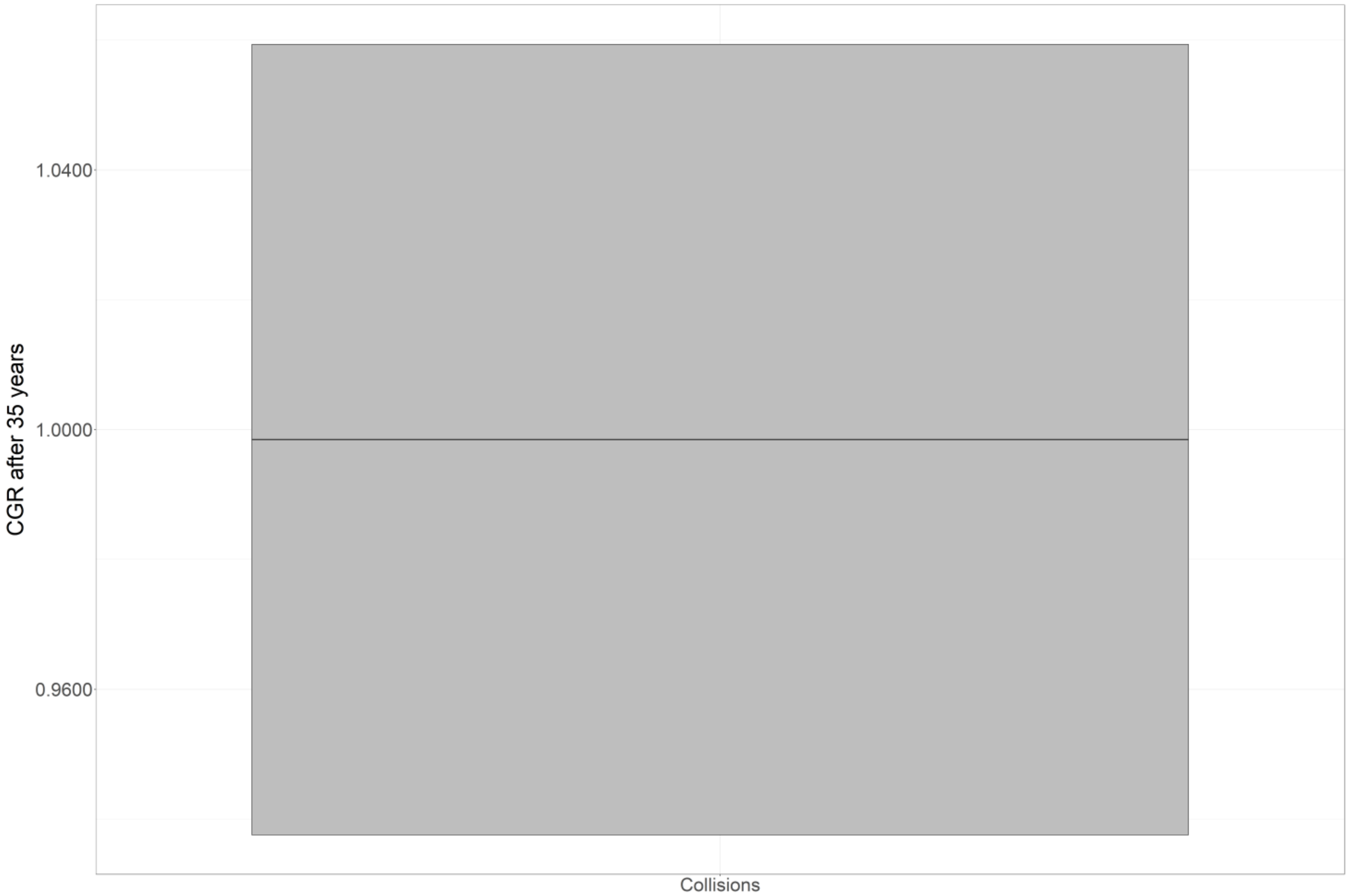
4.2.1.3 Within Plate 4-1 the unimpacted population is shown in blue, with the impacted population overlaid in red. The blue shading represents the 95% confidence interval for the unimpacted population, while the red shading represents the 95% confidence interval for the impacted population. Where the red and blue overlap, the combined colour (purple) indicates a similar population projection.

Plate 4-1 Arctic Tern Population Projection over 35-50 years during the Breeding Season under the modelled impact scenario.



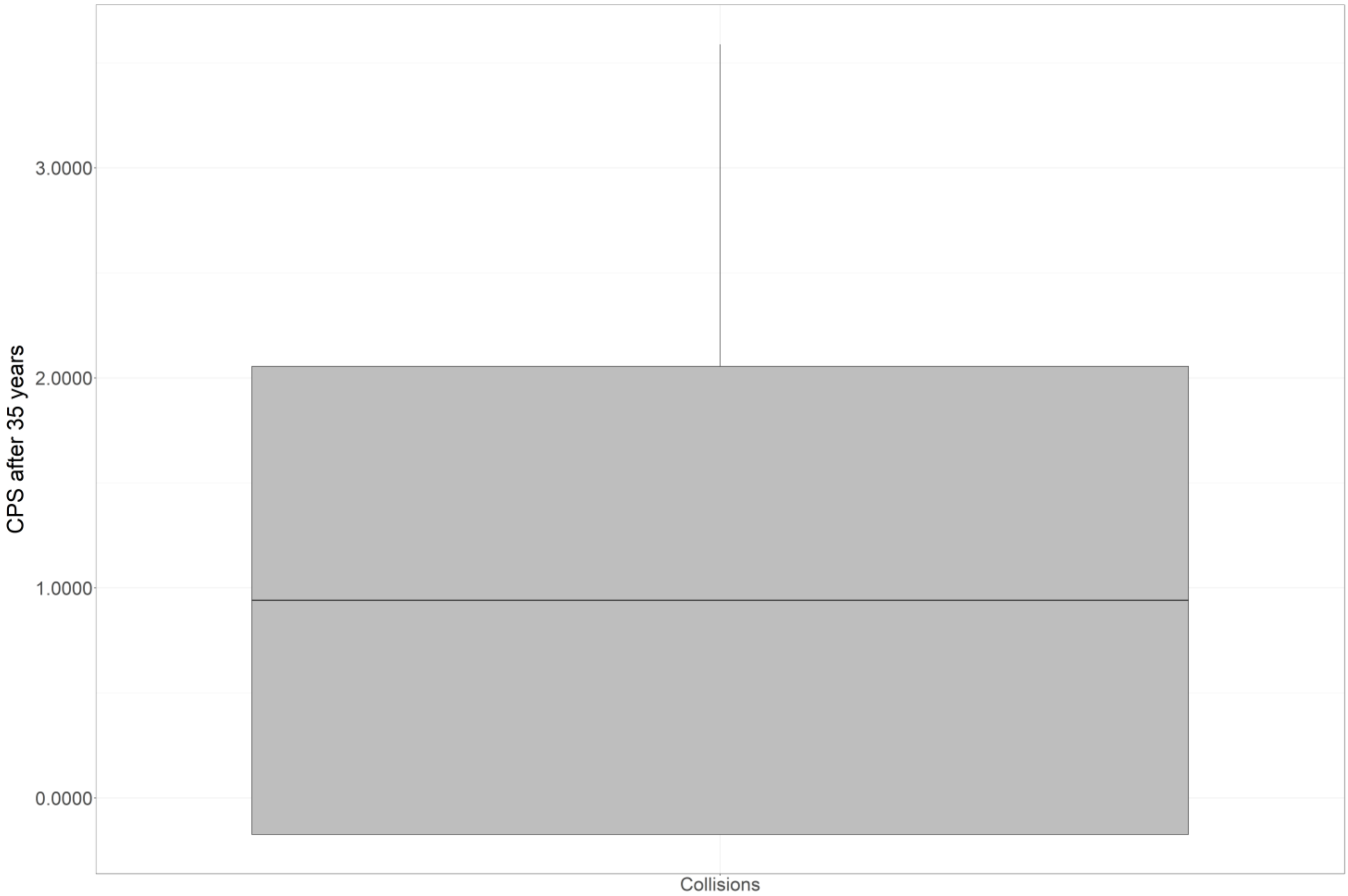
4.2.1.4 Within Plate 4-2 the central line represents the median, and the shaded box represents 1 SD above and below the median.

Plate 4-2 CGR after 35 Years for the Arctic Tern Population during the Breeding Season under the modelled impact scenario.



4.2.1.5 Within Plate 4-3 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-3 CPS for the Arctic Tern Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenario.



4.2.2 GUILLEMOT

4.2.2.1 The results of the PVA runs for impacts from the Offshore Project alone to the guillemot regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 4-2.

4.2.2.2 As part of NatureScot guidance (2023c), 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 Plate 4-4 for the annual projection. Plate 4-5 shows the CGR values annually and Plate 4-6 shows the CPS values annually. Plate 4-4 presents the impact up to 50 years post commencement.

Table 4-2 Guillemot 35 Year PVA Offshore Project Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Annual	Baseline	0	1.0251	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/5/3)	62.43	1.0249	0.9997	0.9910	0.0300	0.9000	48.42	51.94

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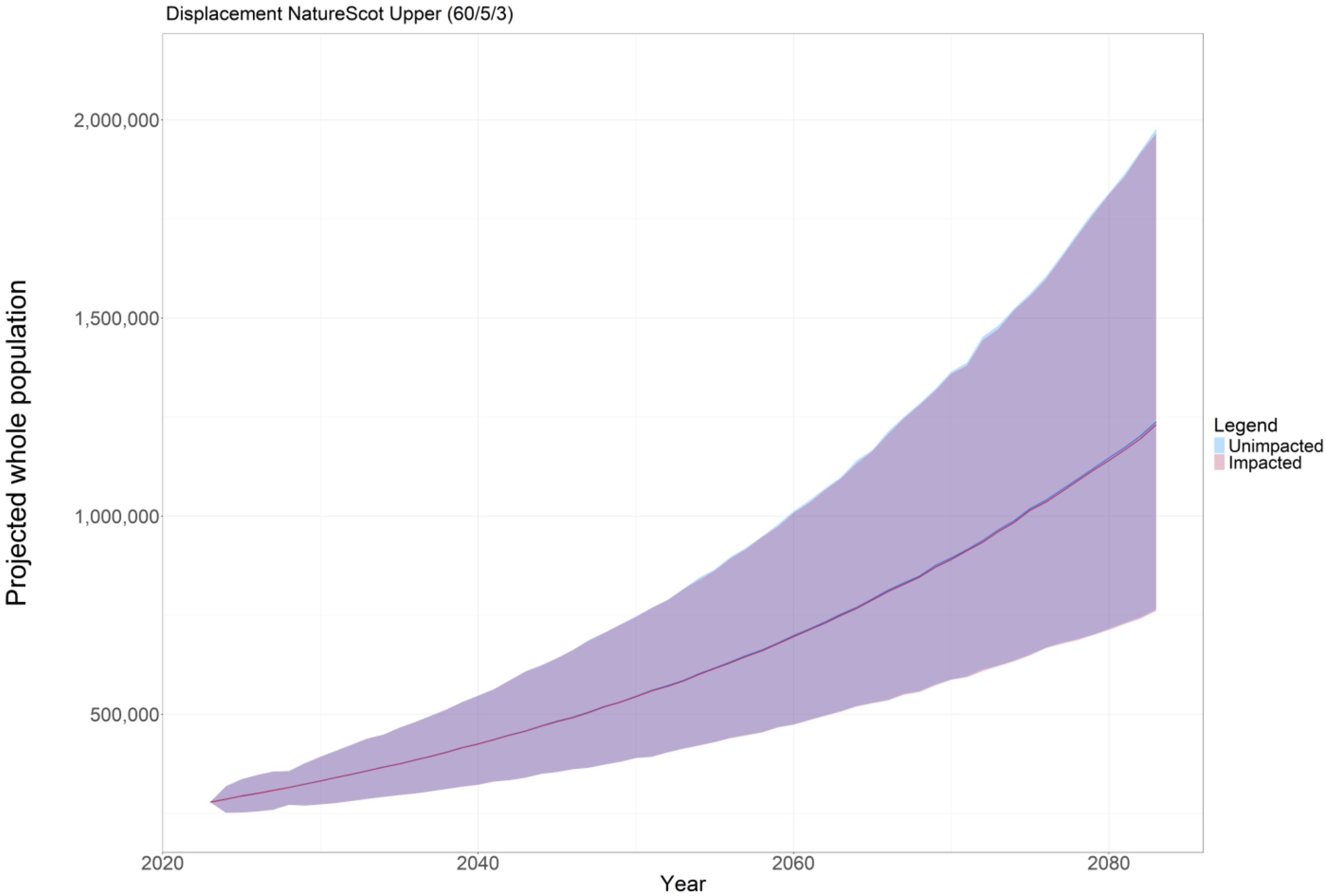
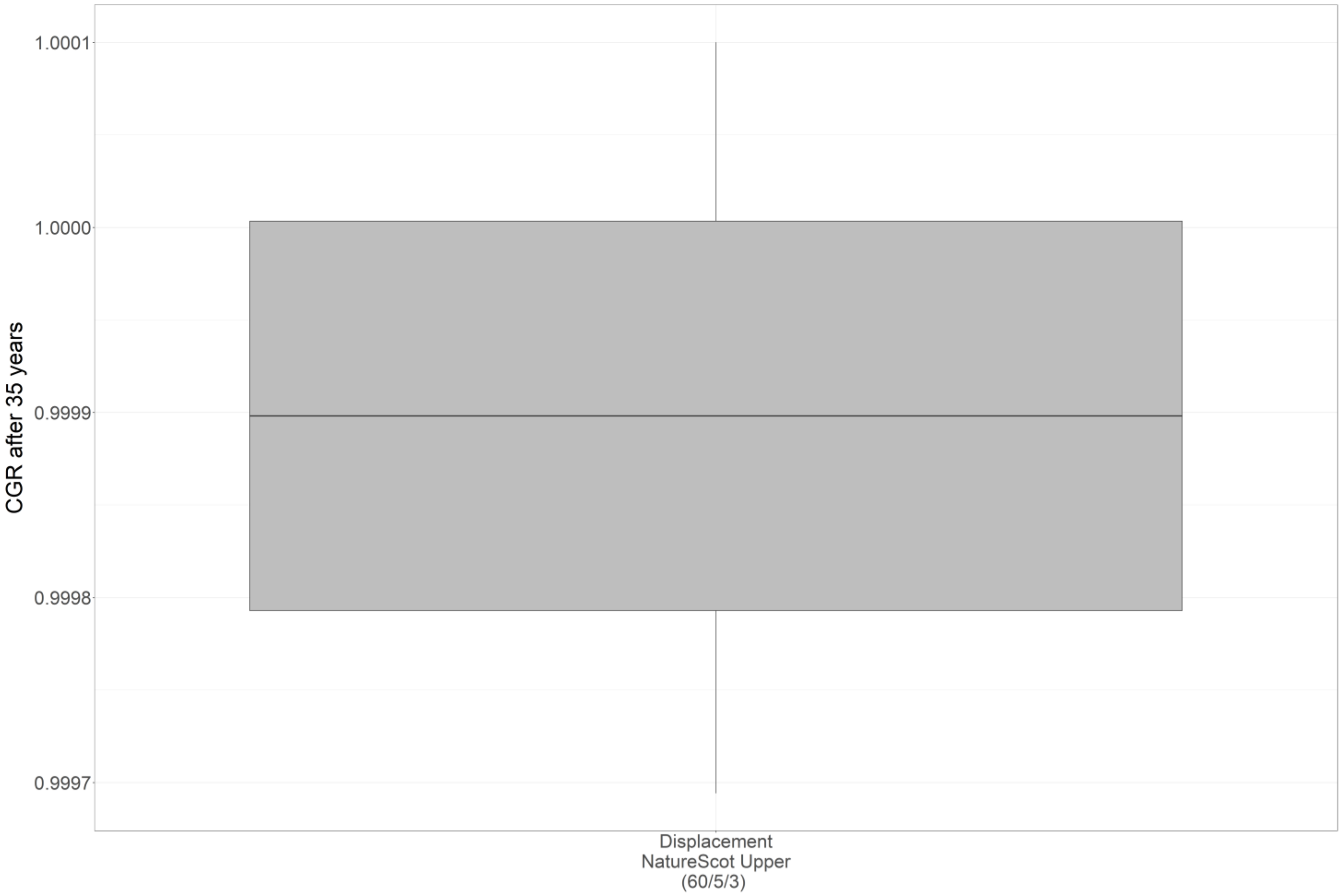
4.2.2.3 Within Plate 4-4 the unimpacted population is shown in blue, with the impacted population overlaid in red. The blue shading represents the 95% confidence interval for the unimpacted population, while the red shading represents the 95% confidence interval for the impacted population. Where the red and blue overlap, the combined colour (purple) indicates a similar population projection.

Plate 4-4 Annual Guillemot Population Projection over 35-50 years under the modelled impact scenario.



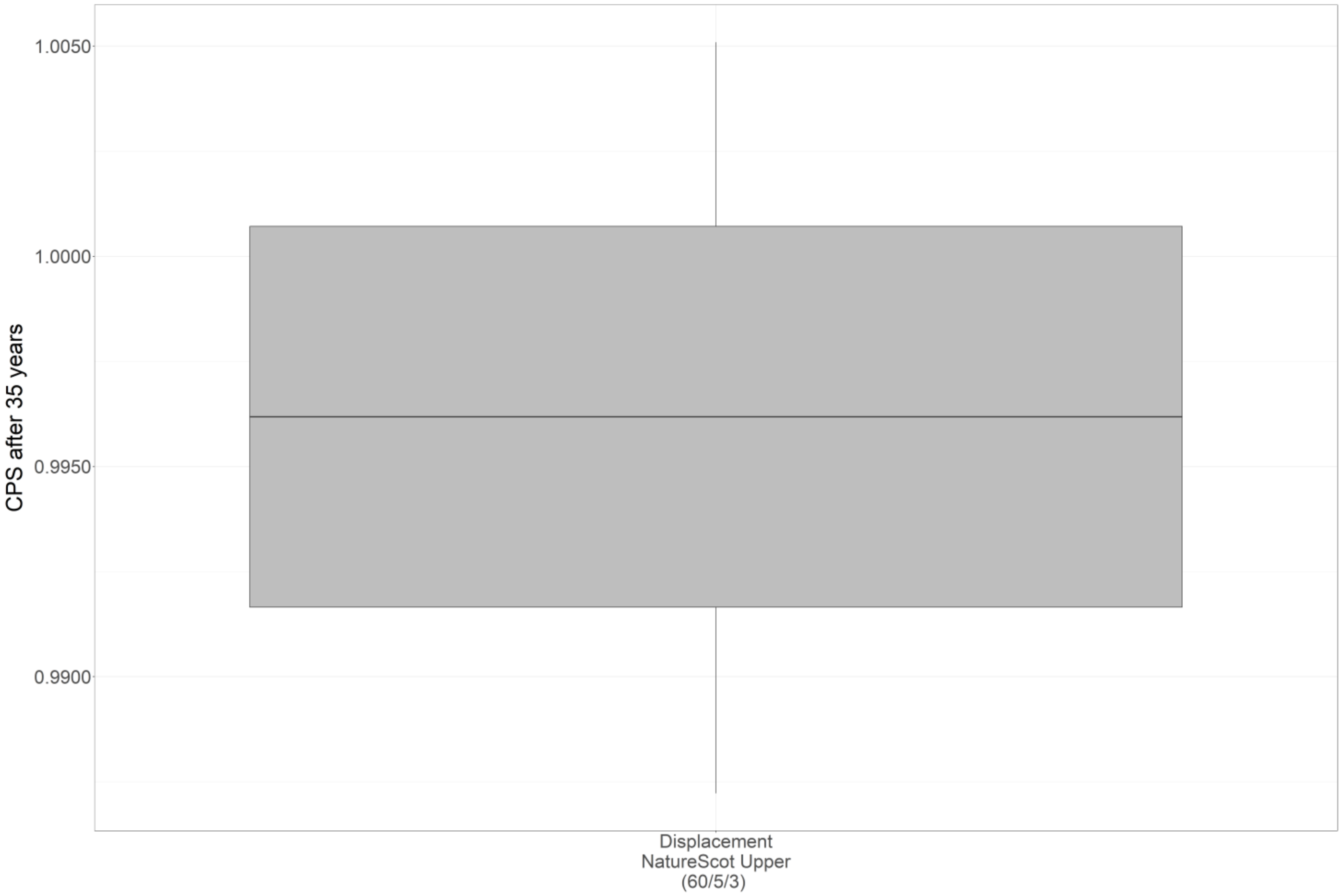
4.2.2.4 Within Plate 4-5 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-5 CGR after 35 Years for the Guillemot Annual Population under the modelled impact scenario(s).



4.2.2.5 Within Plate 4-6 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-6 CPS for the Guillemot Annual Population from the Simulations after 35 Years under the modelled impact scenario(s).



4.2.3 RAZORBILL

4.2.3.1 The results of the PVA runs for impacts from the Offshore Project alone to the razorbill regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 4-3.

4.2.3.2 As part of NatureScot guidance (2023c), 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 Plate 4-7 for the breeding season. Plate 4-8 show the CGR values for the breeding season and Plate 4-9 show the CPS values for the breeding season. Plate 4-7 presents the impact up to 50 years post commencement.

Table 4-3 Razorbill 35 Year PVA Offshore Project Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.977	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/5)	12.30	0.9768	0.9998	0.9911	0.0200	0.8900	49.24	50.80

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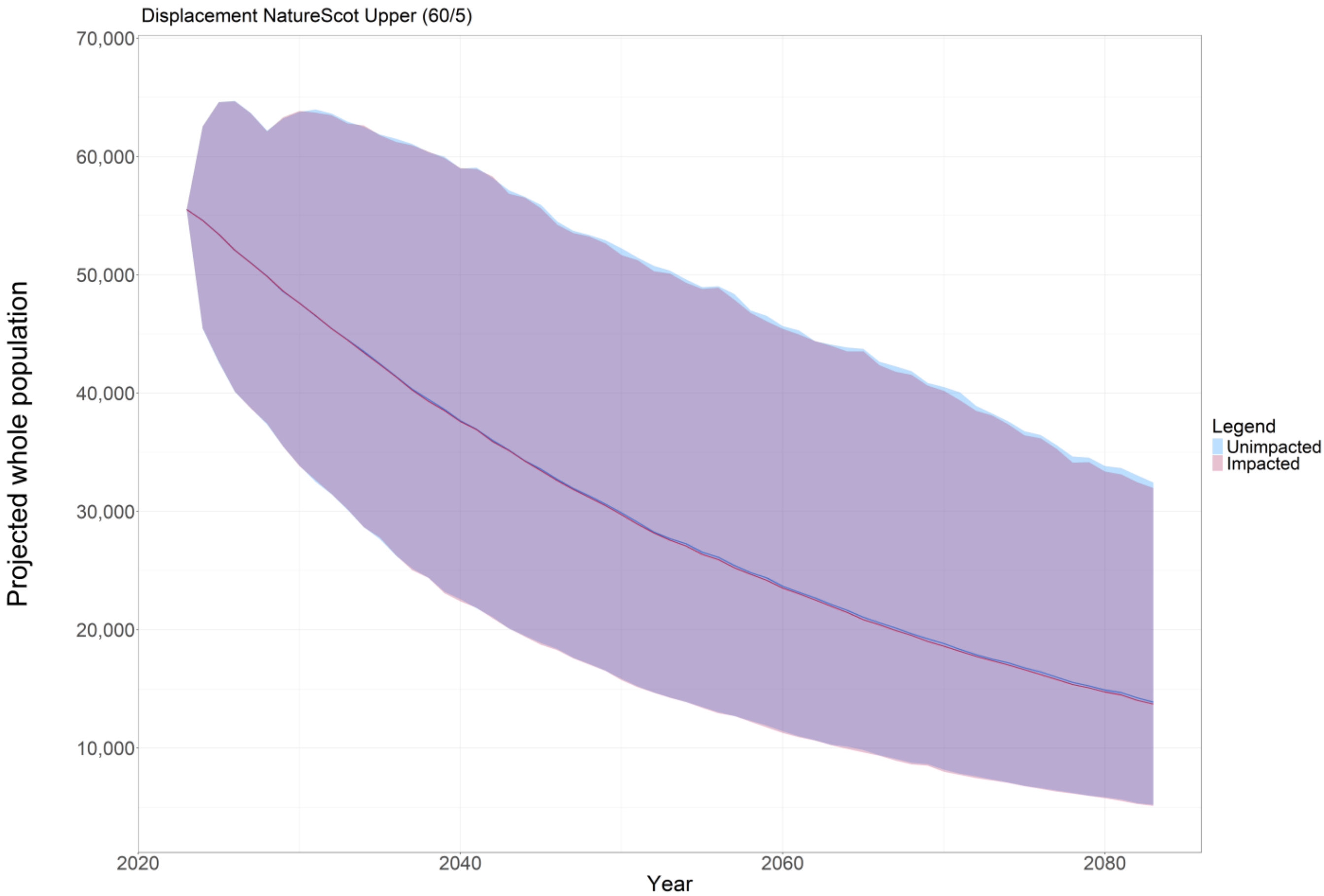
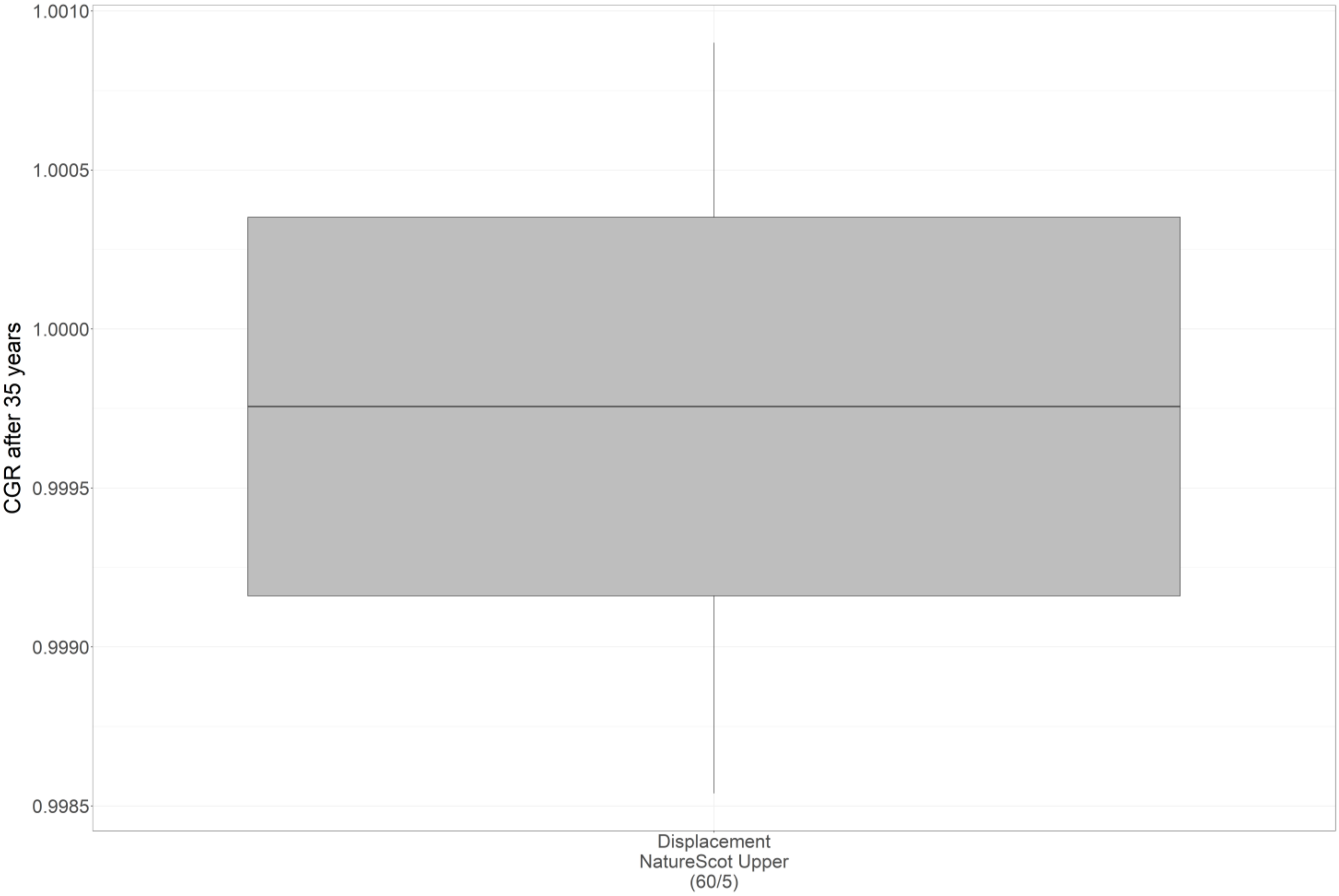
4.2.3.3 Within Plate 4-7 the unimpacted population is shown in blue, with the impacted population overlaid in red. The blue shading represents the 95% confidence interval for the unimpacted population, while the red shading represents the 95% confidence interval for the impacted population. Where the red and blue overlap, the combined colour (purple) indicates a similar population projection.

Plate 4-7 Razorbill Population Projection over 35-50 years during the Breeding Season under the modelled impact scenario.



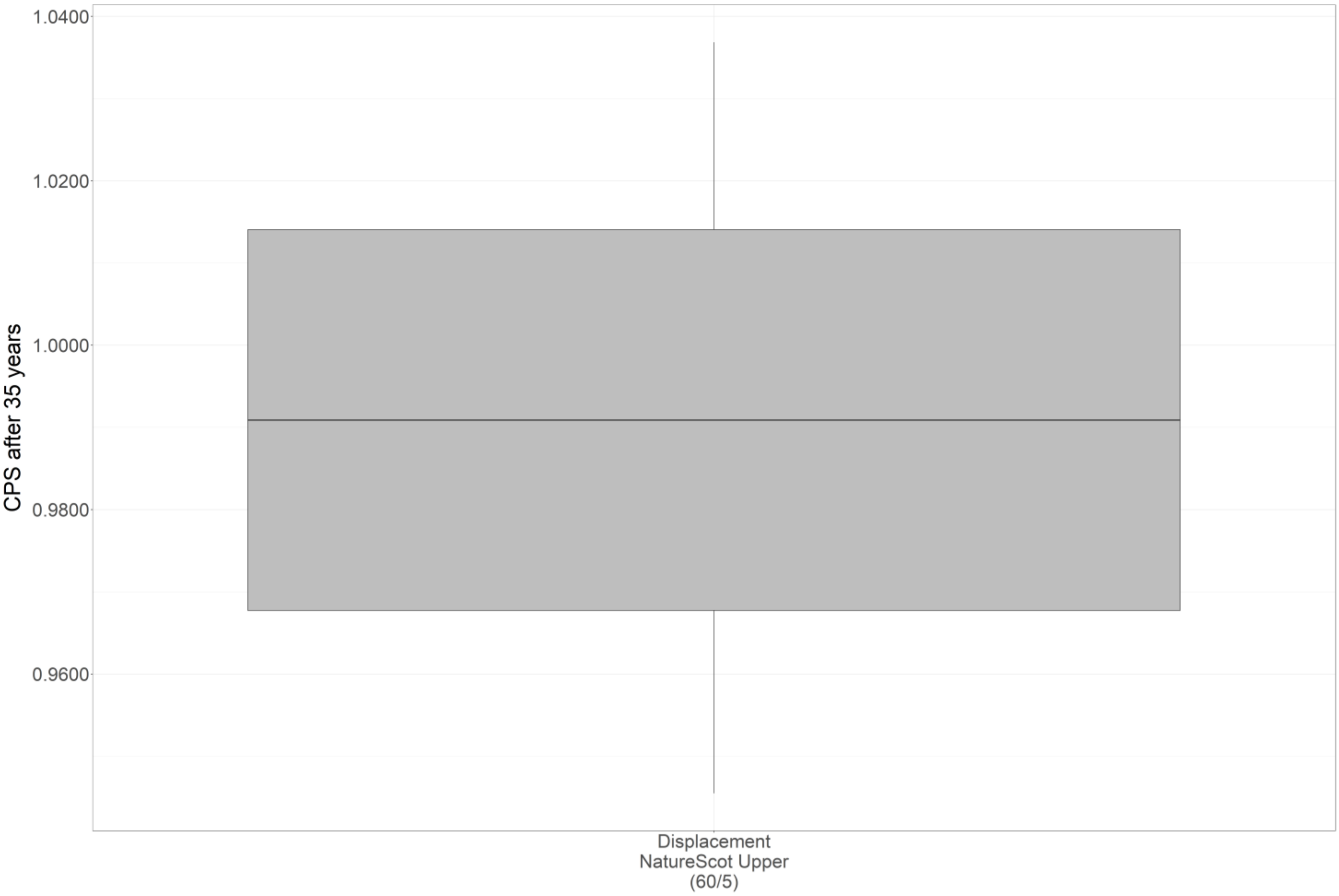
4.2.3.4 Within Plate 4-8 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-8 CGR after 35 Years for the Razorbill Population during the Breeding Season under the modelled impact scenario.



4.2.3.5 Within Plate 4-9 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-9 CPS for the Razorbill Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenario.



4.2.4 RED-THROATED DIVER

4.2.4.1 The results of the PVA runs for impacts from the Offshore Project alone to the red-throated diver regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 4-4.

4.2.4.2 As part of NatureScot guidance (2023c), 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 Plate 4-10 for the breeding season and in Plate 4-13 for the annual projection. Plate 4-11 show the CGR values for the breeding season and Plate 4-14 for annually. Plate 4-12 shows the CPS values for the non-breeding season while Plate 4-15 shows the CPS values annually. Plate 4-10 and Plate 4-13 present the impact up to 50 years post commencement

Table 4-4 Red-throated Diver 35 Year PVA Offshore Project Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9733	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot and Applicant (100/10)	0.40	0.9713	0.9979	0.9341	0.21	6.59	45.62	55.16
Annual	Baseline	0	0.9745	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot and Applicant (100/10)	1.20	0.9740	0.9996	0.9852	0.04	1.48	49.24	50.88

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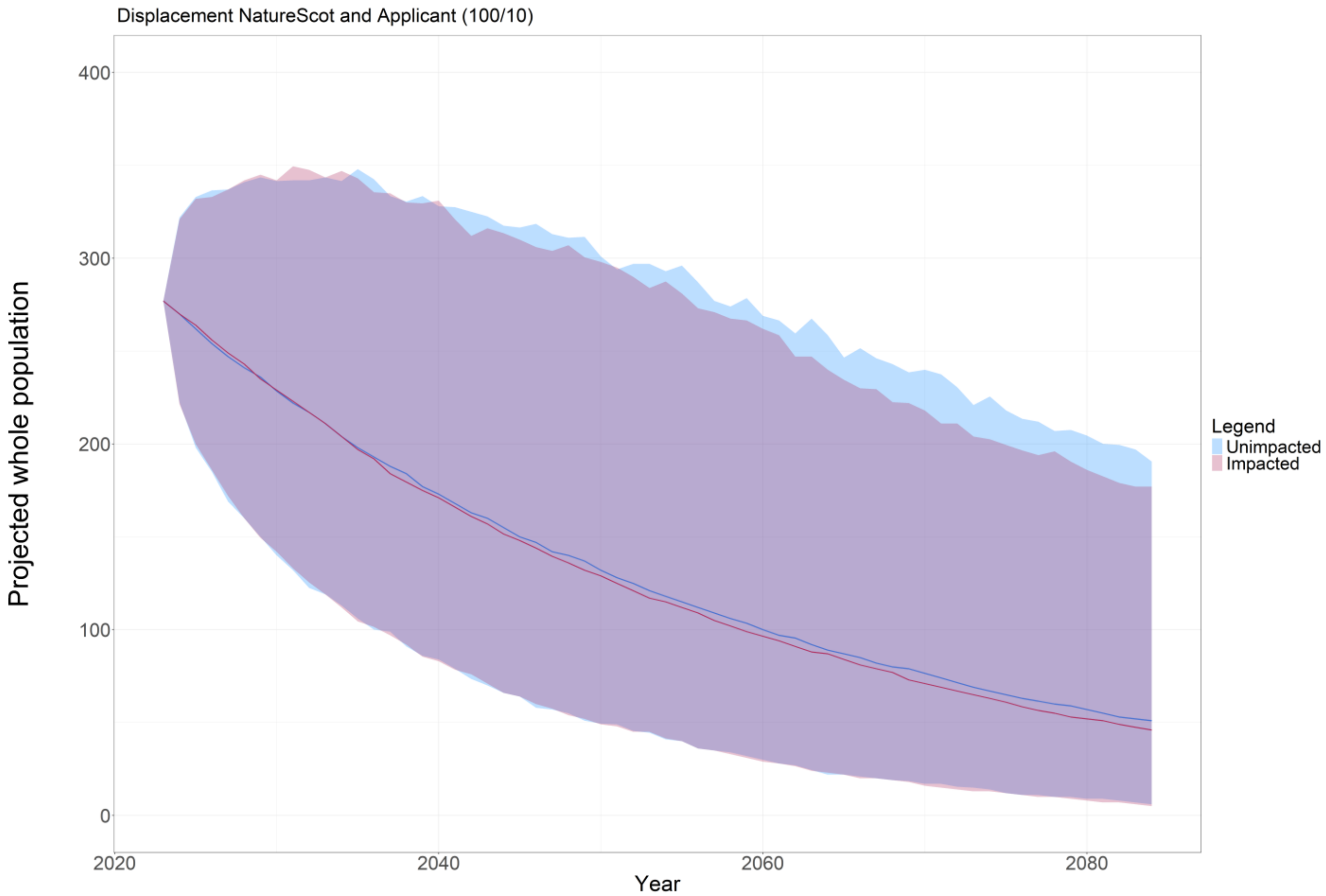
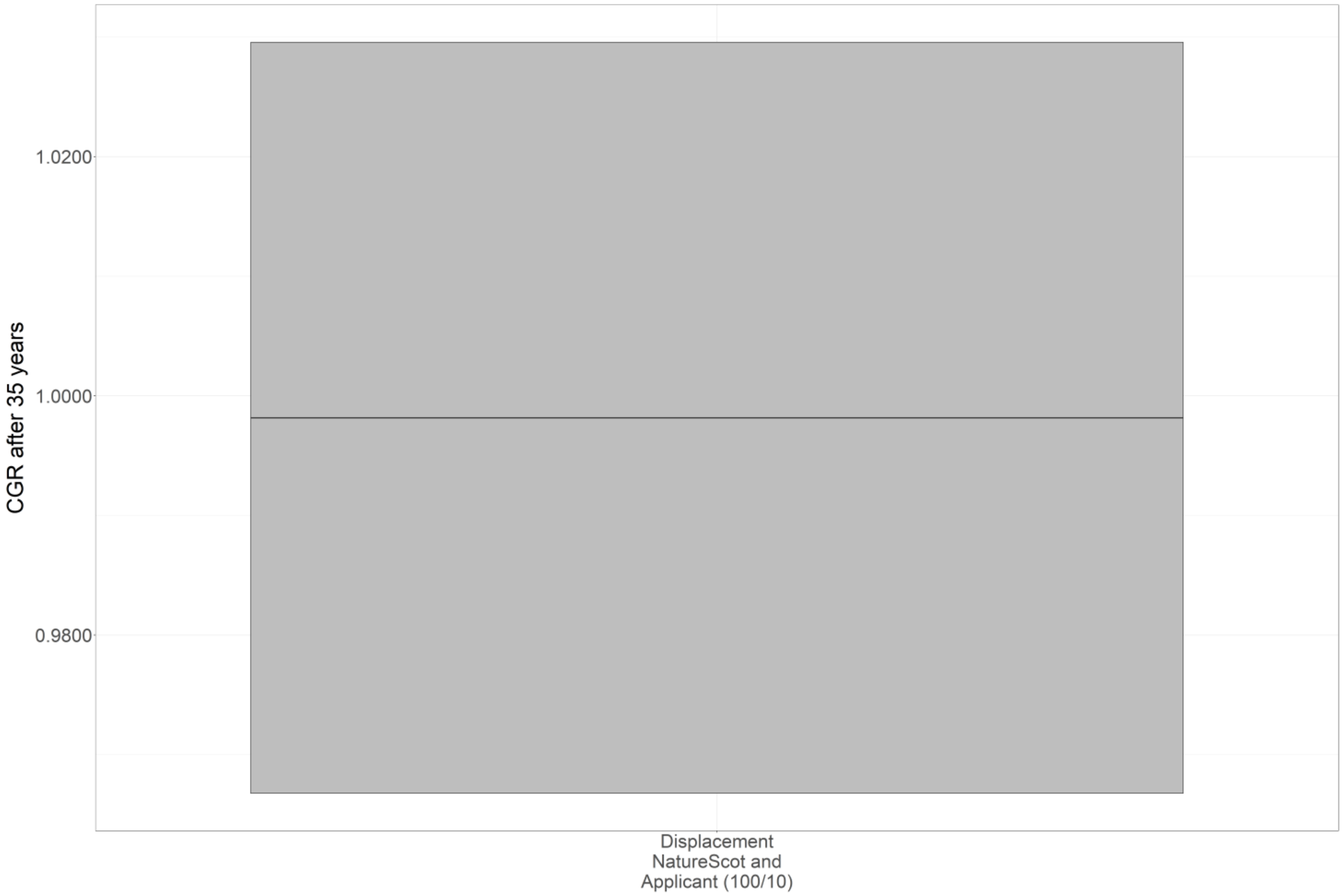
4.2.4.3 Within Plate 4-10 the unimpacted population is shown in blue, with the impacted population overlaid in red. The blue shading represents the 95% confidence interval for the unimpacted population, while the red shading represents the 95% confidence interval for the impacted population. Where the red and blue overlap, the combined colour (purple) indicates a similar population projection.

Plate 4-10 Red-throated Diver Population Projection over 35-50 years during the Breeding Season under the modelled impact scenarios.



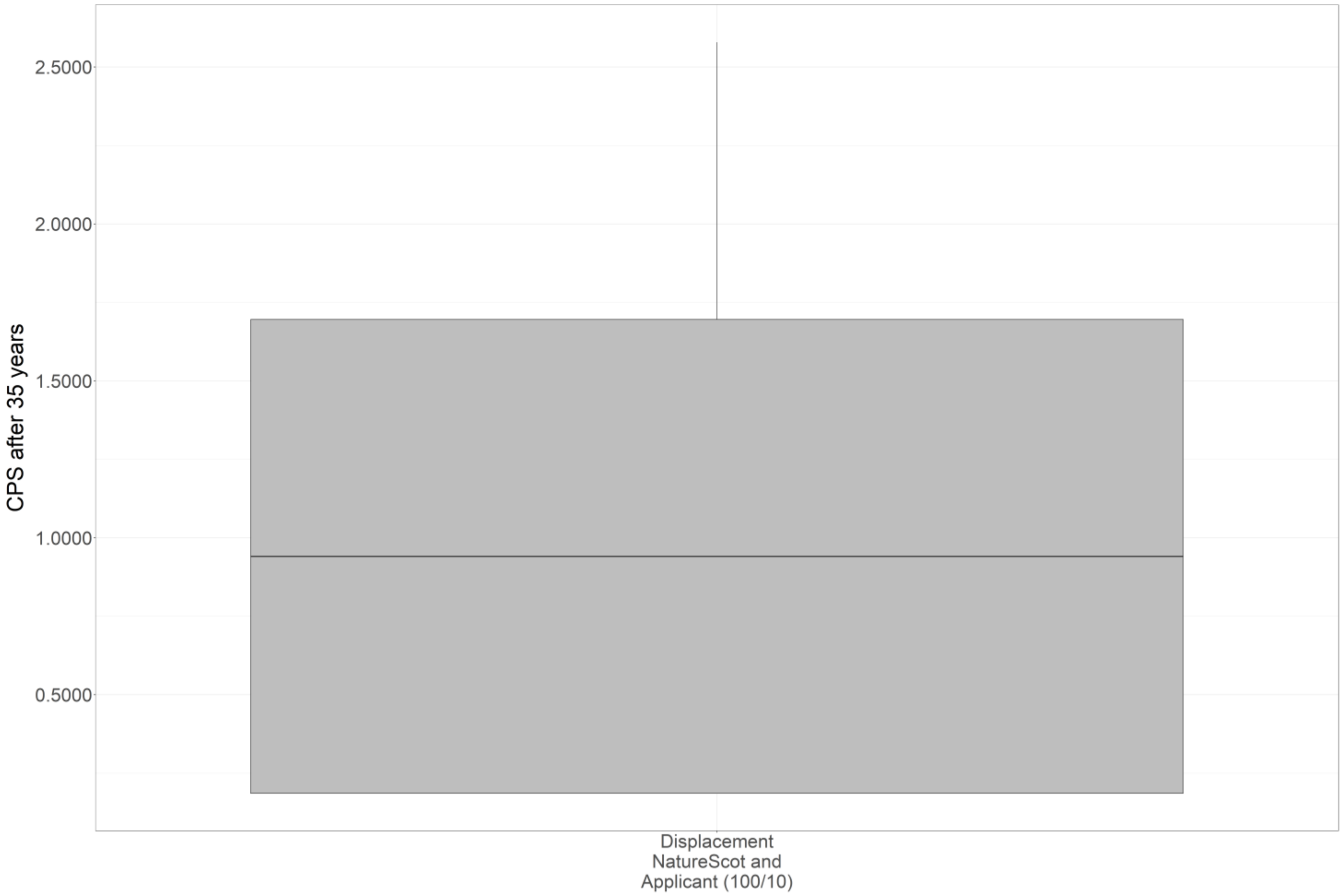
4.2.4.4 Within Plate 4-11 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-11 CGR after 35 Years for the Red-throated Diver Population during the Breeding Season under the modelled impact scenarios.



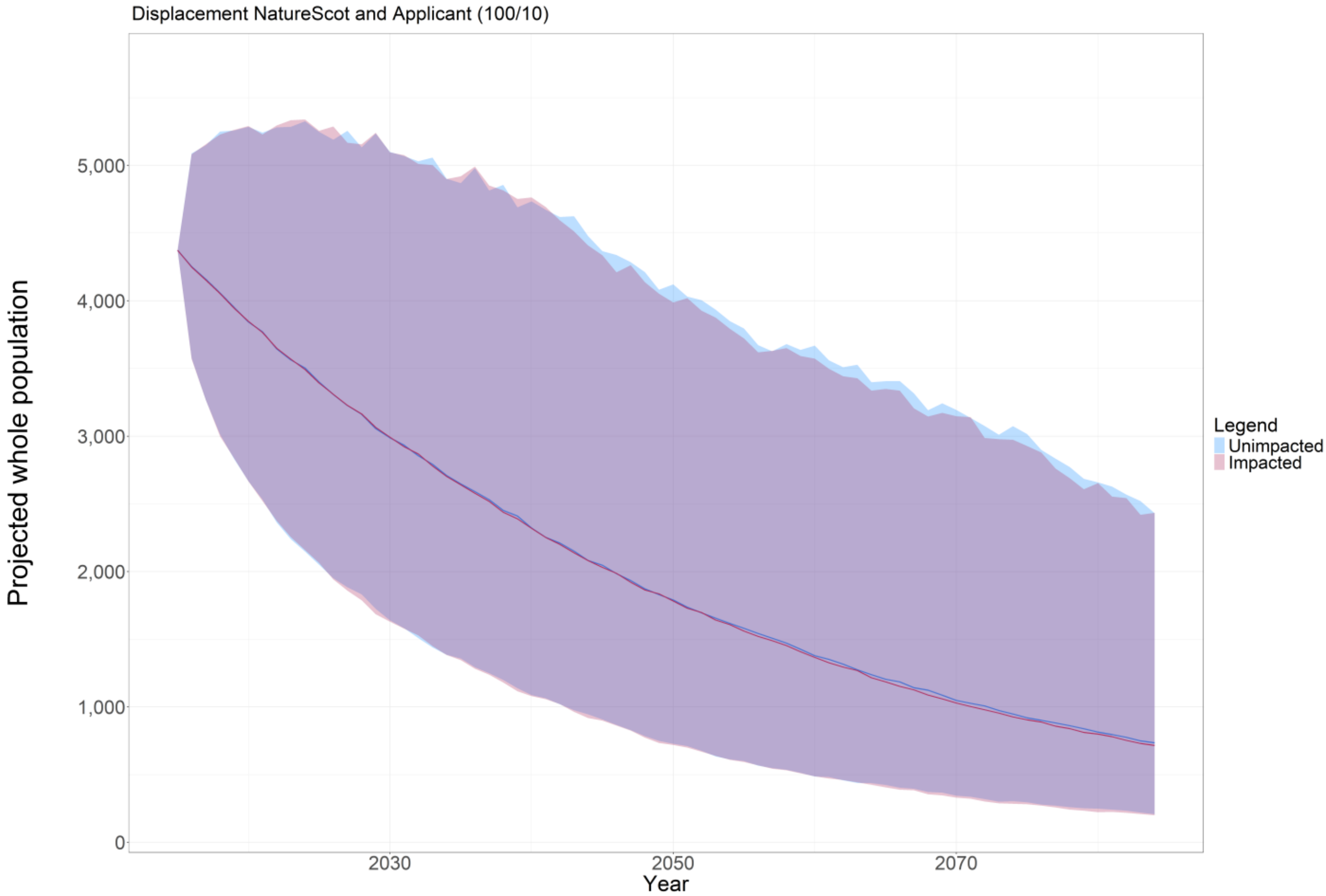
4.2.4.5 Within Plate 4-12 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-12 CPS for the Red-throated Diver Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenarios.



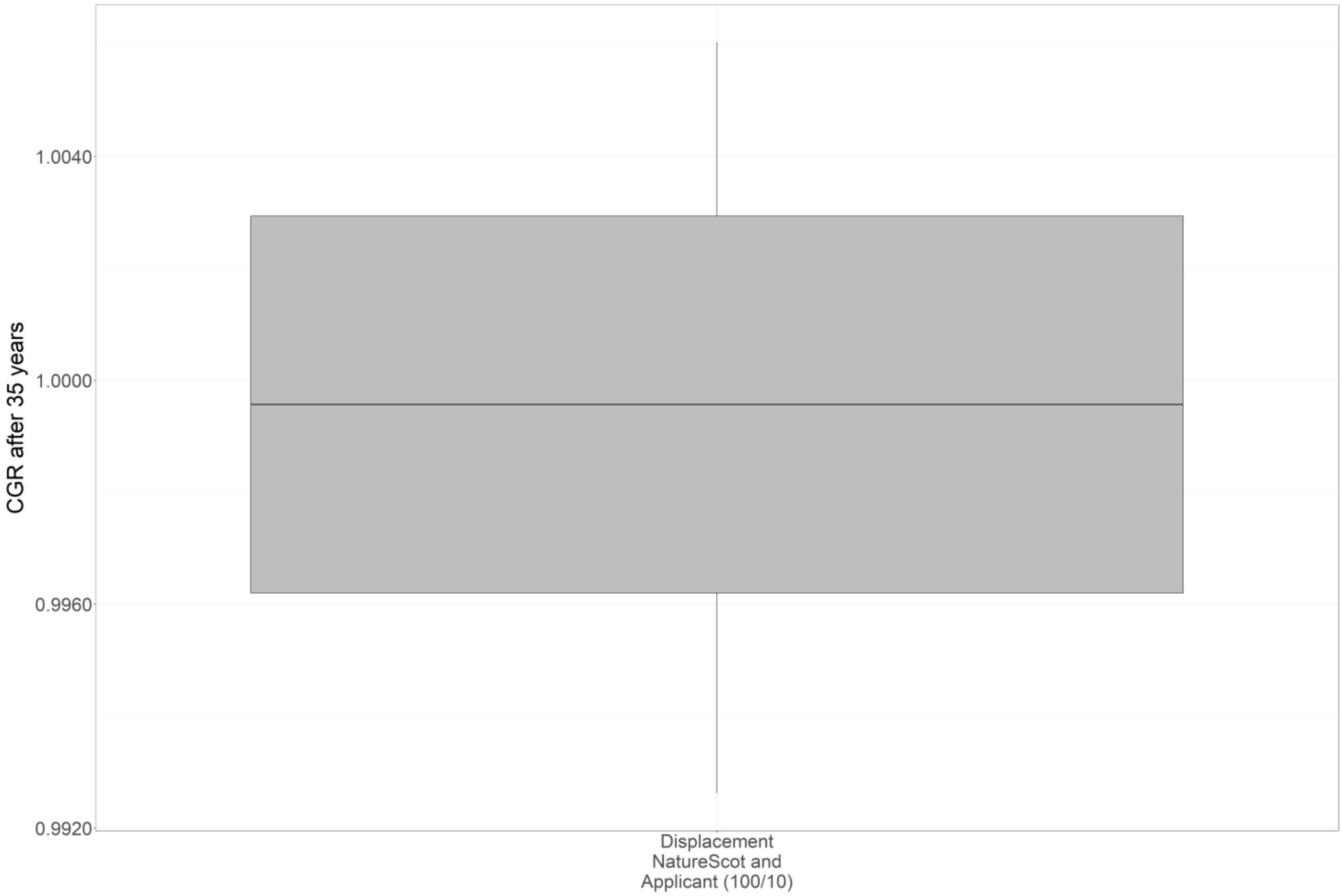
4.2.4.6 Within Plate 4-13 the unimpacted population is shown in blue, with the impacted population overlaid in red. The blue shading represents the 95% confidence interval for the unimpacted population, while the red shading represents the 95% confidence interval for the impacted population. Where the red and blue overlap, the combined colour (purple) indicates a similar population projection.

Plate 4-13 Annual Red-throated Diver Population Projection over 35 years under the modelled impact scenarios.



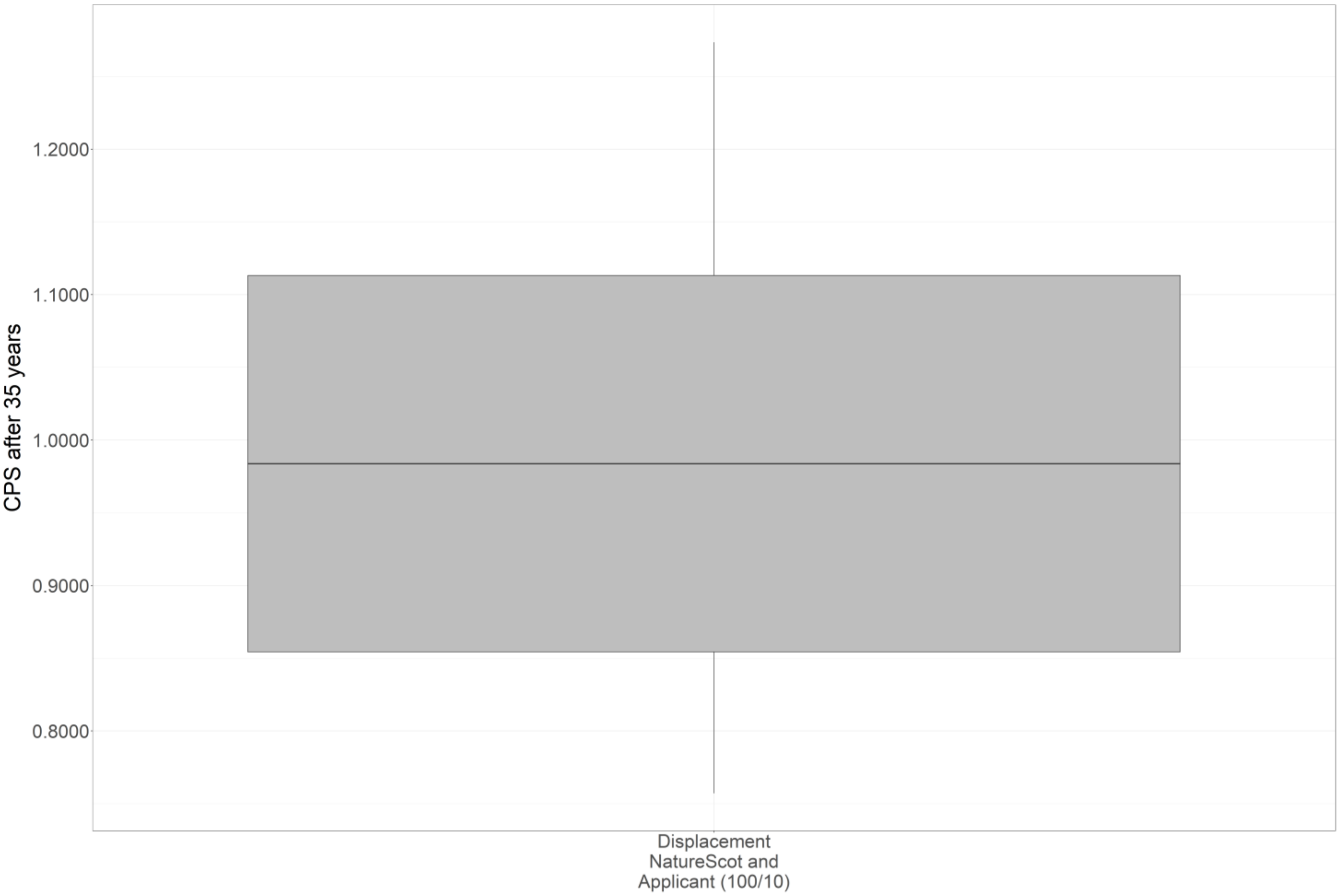
4.2.4.7 Within Plate 4-14 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-14 CGR after 35 Years for the Red-throated Diver Annual Population under the modelled impact scenarios.



4.2.4.8 Within Plate 4-15 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-15 CPS for the Red-throated Diver Annual Population from the Simulations after 35 Years under the modelled impact scenarios.



4.2.5 GREAT NORTHERN DIVER

4.2.5.1 The results of the PVA runs for impacts from the Offshore Project alone to the great northern diver regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 4-5.

4.2.5.2 As part of NatureScot guidance (2023c), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. Only one set of graphs is presented as the non-breeding season and annual impact are the same on the same population. As such, the population size graphs are shown in Plate 4-16 for the non-breeding season and for the annual projection. Plate 4-17 show the CGR values for the non-breeding season for annually. Plate 4-18 shows the CPS values for the non-breeding season and annually. Plate 4-16 presents the impact up to 50 years post commencement.

Table 4-5 Great Northern Diver 35 Year PVA Offshore Project Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Non-breeding	Baseline	0	0.9664	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot (100/10)	2.70	0.9647	0.9981	0.9368	0.1900	6.3200	31.34	70.92
	Displacement Applicant Upper (100/5)	1.35	0.9660	0.9994	0.9787	0.0600	2.1300	43.40	57.24
Annual	Baseline	0	0.9664	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot (100/10)	2.70	0.9647	0.9981	0.9368	0.1900	6.3200	31.34	70.92
	Displacement Applicant Upper (100/5)	1.35	0.9660	0.9994	0.9787	0.0600	2.1300	43.40	57.24

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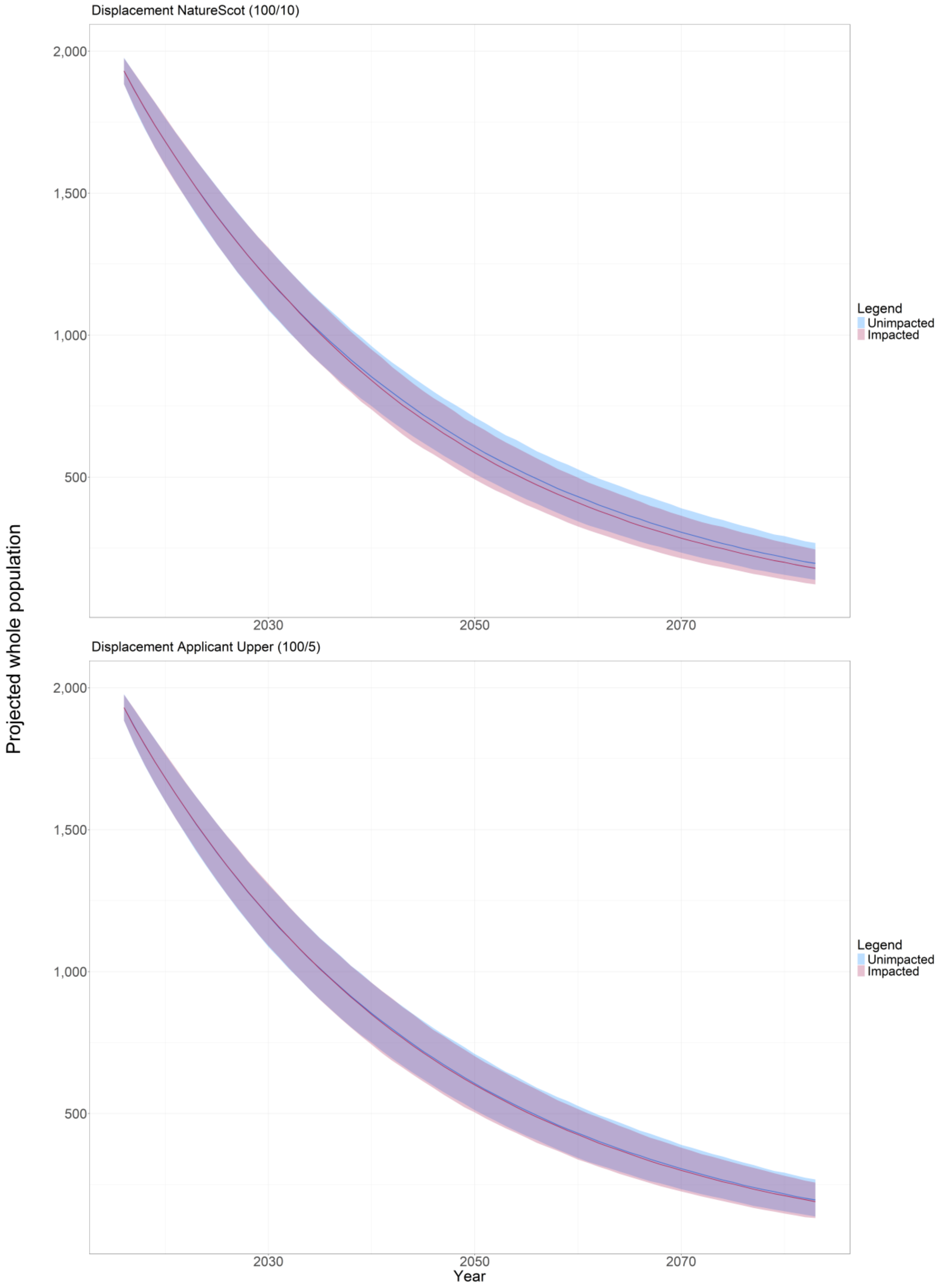
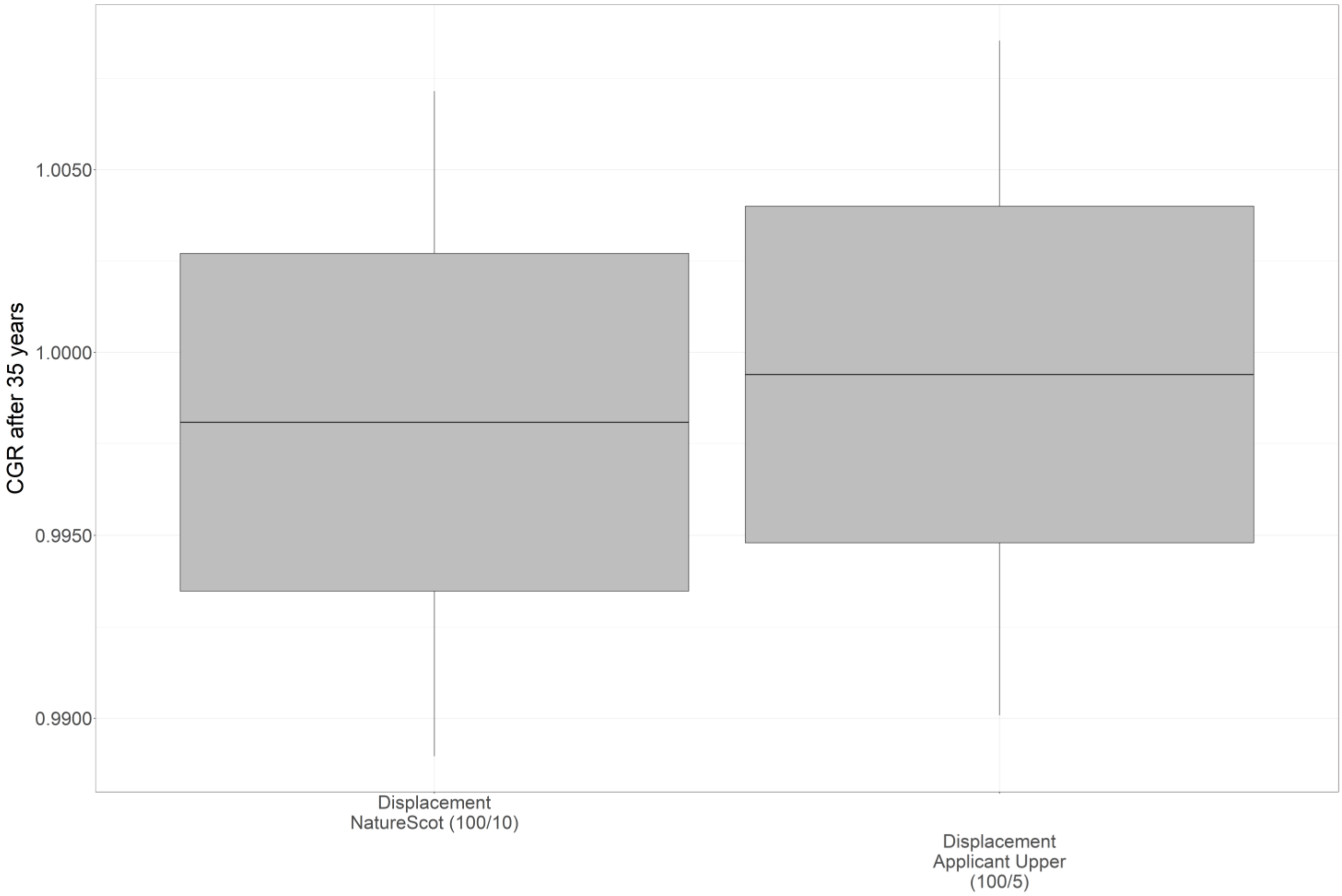
4.2.5.3 Within Plate 4-16 the unimpacted population is shown in blue, with the impacted population overlaid in red. The blue shading represents the 95% confidence interval for the unimpacted population, while the red shading represents the 95% confidence interval for the impacted population. Where the red and blue overlap, the combined colour (purple) indicates a similar population projection.

Plate 4-16 Great Northern Diver Population Projection over 35-50 years during the Non-breeding Season and Annually under the modelled impact scenarios.



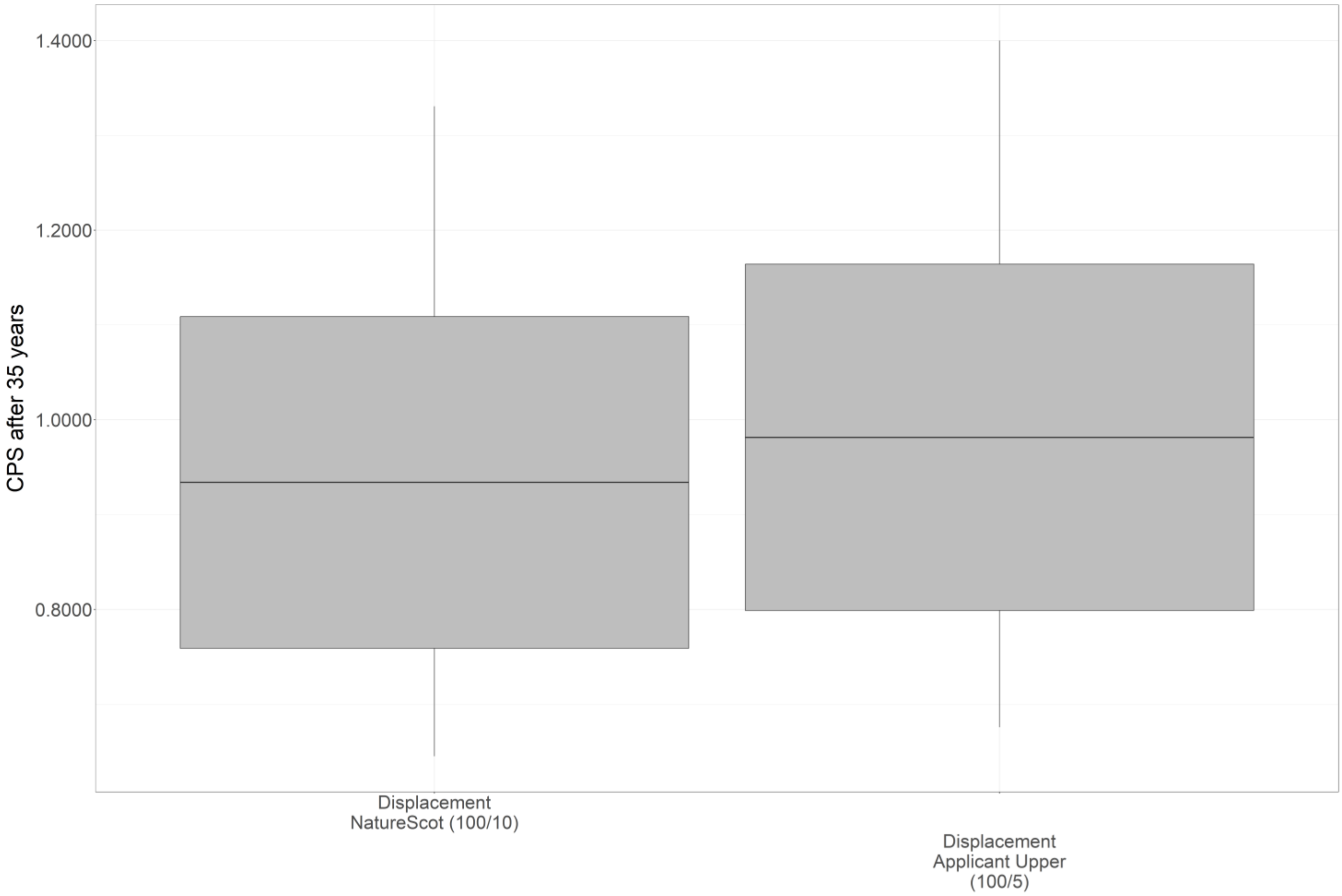
4.2.5.4 Within Plate 4-17 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-17 CGR after 35 Years for the Great Northern Diver Population during the Non-breeding Season and Annually under the modelled impact scenarios.



4.2.5.5 Within Plate 4-18 the central line represents the median, the shaded box represents 1 SD above and below the median and the whiskers show the lower and upper confidence intervals.

Plate 4-18 CPS for the Great Northern Diver Population during the Non-Breeding Season and Annually from the Simulations after 35 Years under the modelled impact scenarios.



4.3 RESULTS: AFTER 50 YEARS

4.3.1 ARCTIC TERN

4.3.1.1 The results of the PVA runs for impacts from the Offshore Project to the Arctic tern regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 4-6. The baseline 'unimpacted' scenario is also shown for comparison purposes. Plate 4-1 presents the impact up to 50 years post commencement.

Table 4-6 Arctic tern 50 Year PVA Offshore Project Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.8963	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	1.75	0.8952	0.9939	0.7500	0.6100	25.000	58.02	60.84

4.3.2 GUILLEMOT

4.3.2.1 The results of the PVA runs for impacts from the Offshore Project to the guillemot regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 4-7. The baseline 'unimpacted' scenario is also shown for comparison purposes. Plate 4-4 presents the impact up to 50 years post commencement.

Table 4-7 Guillemot 50 Year PVA Offshore Project Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Annual	Baseline	0	1.0252	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/5/3)	62.43	1.0249	0.9997	0.9872	0.0300	1.2800	47.96	52.20

4.3.3 RAZORBILL

4.3.3.1 The results of the PVA runs for impacts from the Offshore Project to the razorbill regional from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 4-8. The baseline 'unimpacted' scenario is also shown for comparison purposes. Plate 4-7 presents the impact up to 50 years post commencement.

Table 4-8 Razorbill 50 Year PVA Offshore Project Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9771	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/5)	12.30	0.9768	0.9998	0.9872	0.0200	1.2800	48.88	51.22

4.3.4 RED-THROATED DIVER

4.3.4.1 The results of the PVA runs for impacts from the Offshore Project to the red-throated diver regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 4-9. The baseline 'unimpacted' scenario is also shown for comparison purposes. Plate 4-10 and Plate 4-13 present the impact up to 50 years post commencement.

Table 4-9 Red-throated Diver 50 Year PVA Offshore Project Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9727	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot and Applicant (100/10)	0.40	0.9707	0.9980	0.9091	0.20	9.09	44.94	55.54
Annual	Baseline	0	0.9741	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot and Applicant (100/10)	1.20	0.9739	0.9997	0.9809	0.03	1.91	48.38	51.60

4.3.5 GREAT NORTHERN DIVER

4.3.5.1 The results of the PVA runs for impacts from the Offshore Project to the great northern diver regional from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 4-10. The baseline 'unimpacted' scenario is also shown for comparison purposes. Plate 4-16 present the impact up to 50 years post commencement.

Table 4-10 Great Northern Diver 50 Year PVA Offshore Project Results

Season	Impact Scenario	Predicted Mortality (no. of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Non-breeding	Baseline	0	0.9664	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot (100/10)	2.70	0.9647	0.9981	0.9365	0.1900	6.3500	30.04	70.36
	Displacement Applicant Upper (100/5)	1.35	0.9658	0.9994	0.9720	0.0600	2.8000	43.84	58.42
Annual	Baseline	0	0.9664	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot (100/10)	2.70	0.9647	0.9982	0.9104	0.1800	8.9600	30.86	71.64
	Displacement Applicant Upper (100/5)	1.35	0.9658	0.9994	0.9720	0.0600	2.8000	43.84	58.42

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5 CUMULATIVE ASSESSMENT OUTPUTS

5.1 Cumulative Assessment Outputs Overview

5.1.1.1 The results of the PVA runs for cumulative impacts from the Offshore Project in-combination with impacts from other projects, are presented for each species listed in Section 3.3 (Cumulative). These results reflect impacts from the start of the operation and maintenance phase (estimated in 2034) and cover the expected 35-year operational lifespan of the Offshore Project, which forms the basis for the assessment conclusions. In accordance with NatureScot guidance (NatureScot, 2023c), results for 50 year time periods are also provided for context, although they are not used to inform the conclusions of the assessment.

5.1.1.2 The baseline 'unimpacted' scenarios (i.e. assuming no additional mortality other than baseline mortality exists) are also shown for comparison purposes. Graphs relating to population size, CPS, and CGR for each impact scenario for the lifetime of the Offshore Project are also presented for the 35-year period in line with guidance (NatureScot, 2023c).

5.1.1.3 As set out in Section 2.4.3, several scenarios have been requested by the statutory consultees, one of which considers 'with Berwick Bank' and 'without Berwick Bank' options. Due to Berwick Bank's location, only gannet (Sections 5.2.5 and 0) have the potential to be impacted by both the Offshore Project and Berwick Bank, therefore all other species do not present a 'with' and 'without' option.

5.1.1.4 All plates which depict the population projection have been modelled from 2024 (before the impact starts) to 50 years from the first year of full operation (estimated in 2034). These plates are only presented in Section 5.2 (35-year results) and are not repeated in Section 5.3 (50 year results).

5.2 RESULTS: AFTER 35 YEARS

5.2.1 KITTIWAKE

5.2.1.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the kittiwake regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-1. The specific avoidance rates used for kittiwake within the collision scenarios are presented in Table 2-4.

5.2.1.2 As part of NatureScot guidance (2023c), 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 Plate 5-1 for the breeding season, Plate 5-2 for the post-breeding season, Plate 5-3 for the pre-breeding season, and in Plate 5-4 for the annual projection. Plate 5-5 shows the CGR values for the breeding season, Plate 5-6 for the post-breeding season, Plate 5-7 for the pre-breeding season, and Plate 5-8 for annually. Plate 5-9 shows the CPS values for the breeding season, Plate 5-10 for the post-breeding season, Plate 5-11 for pre-breeding season, while Plate 5-12 shows the CPS values annually.

Table 5-1 Kittiwake 35 Year cumulative PVA results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	1.0028	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	215.55	1.0017	0.9989	0.9593	0.11	4.07	45.66	54.34
	Displacement NatureScot Upper (30/3)	124.38	1.0022	0.9993	0.9763	0.07	2.37	47.42	52.36
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	255.78	1.0015	0.9986	0.9521	0.14	4.79	44.94	55.18
	Combined Collisions and Displacement NatureScot Upper (30/3)	339.94	1.0010	0.9982	0.9366	0.18	6.34	43.66	56.98
Post-breeding	Baseline	0	1.0023	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	250.63	1.0020	0.9997	0.9884	0.03	1.16	48.78	51.04
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	282.44	1.0019	0.9996	0.9869	0.04	1.31	48.64	51.32
	Combined Collisions and Displacement NatureScot Upper (30/3)	346.82	1.0018	0.9995	0.9840	0.05	1.60	48.36	51.62
Pre-breeding	Baseline	0	1.0027	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	256.79	1.0019	0.9996	0.9843	0.04	1.57	48.52	51.54

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	277.98	1.0008	0.9985	0.9480	0.15	5.20	45.48	54.82
	Combined Collisions and Displacement NatureScot Upper (30/3)	321.99	1.0006	0.9983	0.9398	0.17	6.02	44.60	55.48
Annual	Baseline	0	1.0027	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	722.96	1.0014	0.9991	0.9667	0.09	3.33	46.74	53.16
	Displacement NatureScot Upper (30/3)	285.79	1.0019	0.9996	0.9866	0.04	1.34	48.66	51.14
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	816.20	1.0012	0.9989	0.9625	0.11	3.75	46.38	53.60
	Combined Collisions and Displacement NatureScot Upper (30/3)	1008.75	1.0010	0.9987	0.9539	0.13	4.61	45.78	54.28

Plate 5-1 Kittiwake population projection over 35-50 years during the breeding season under the modelled impact scenarios.

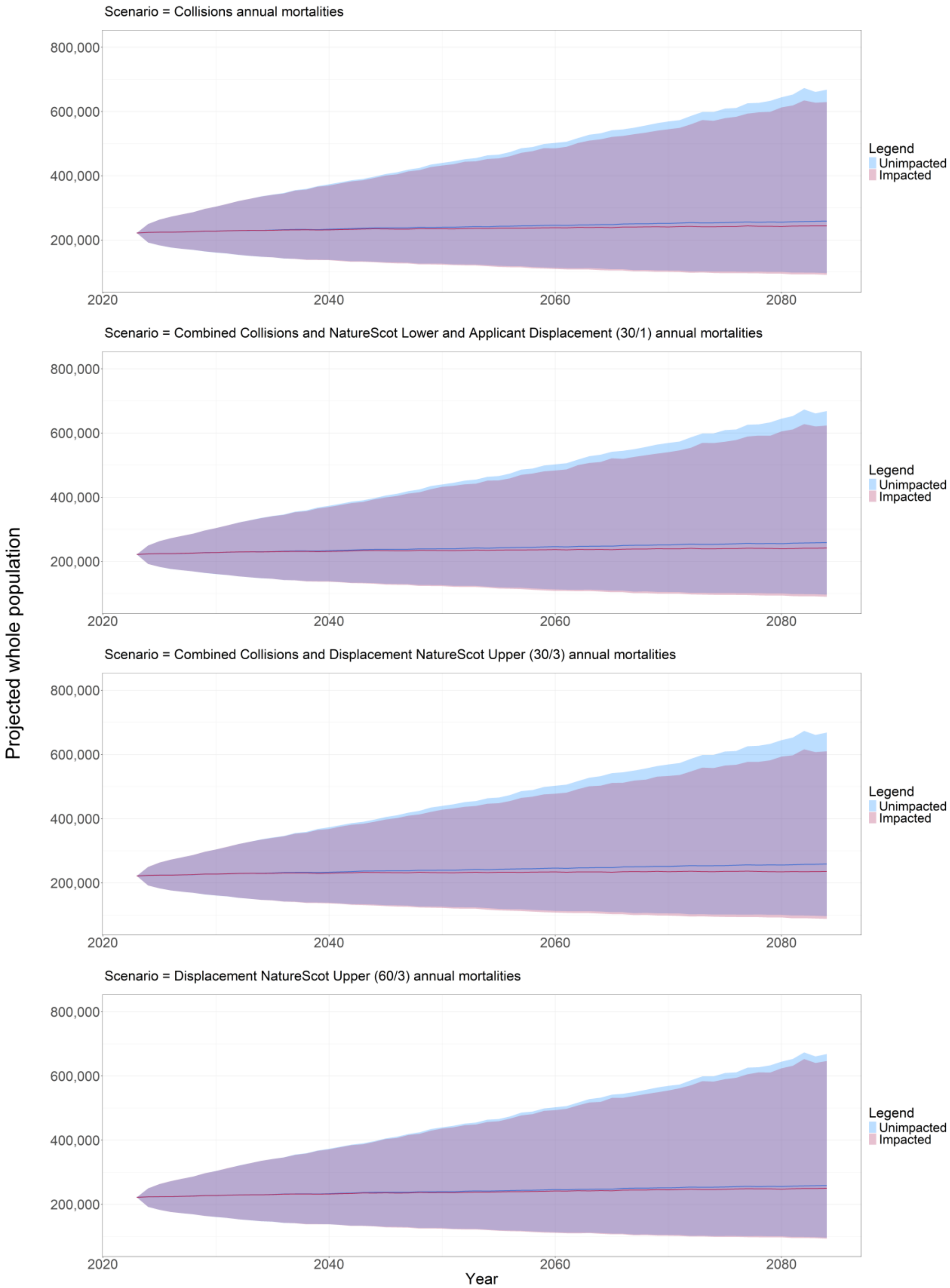


Plate 5-2 Kittiwake population projection over 35-50 years during the post-breeding season under the modelled impact scenarios.

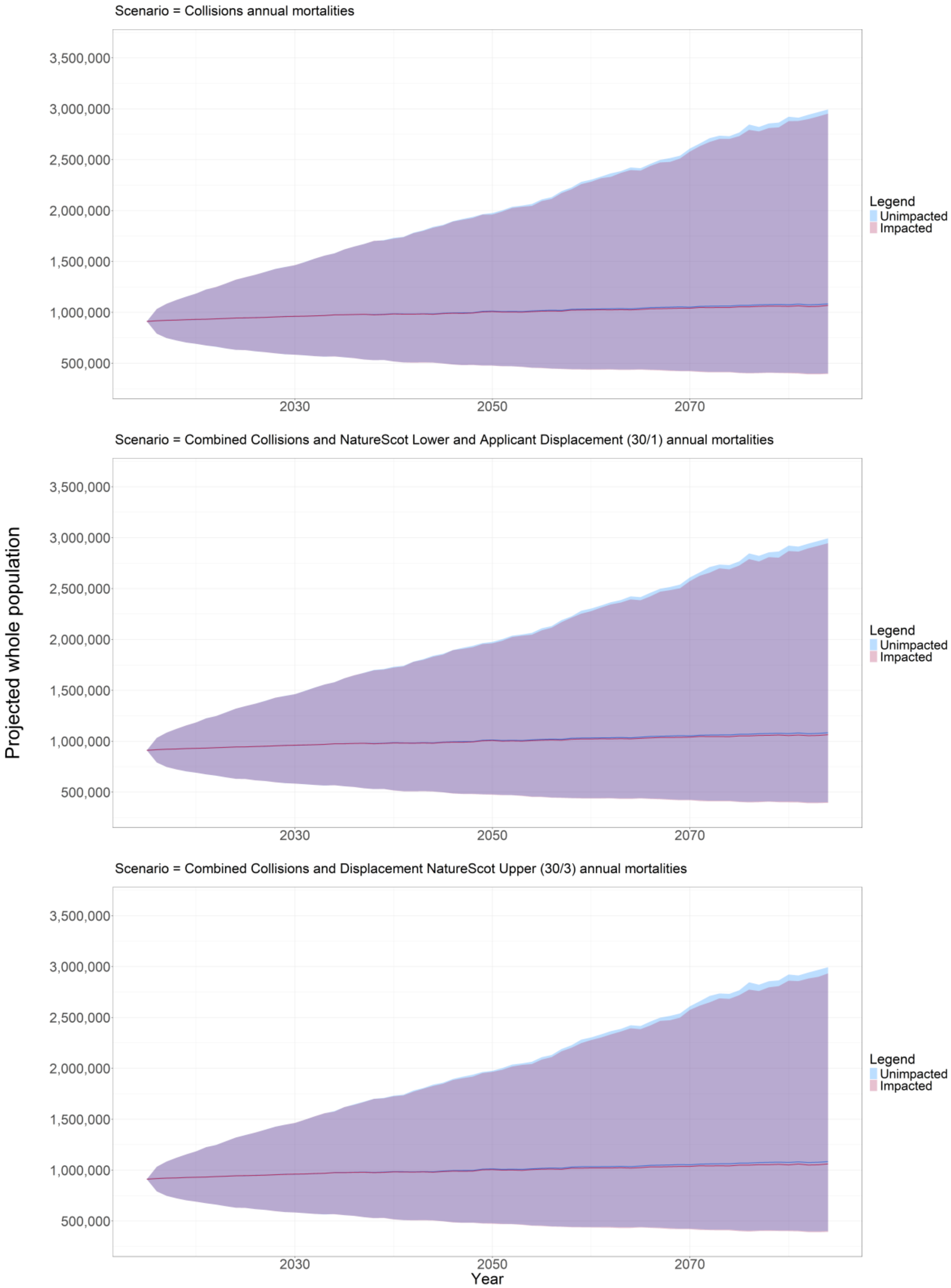


Plate 5-3 Kittiwake Population Projection over 35-50 years during the pre-breeding Season under the modelled impact scenarios.

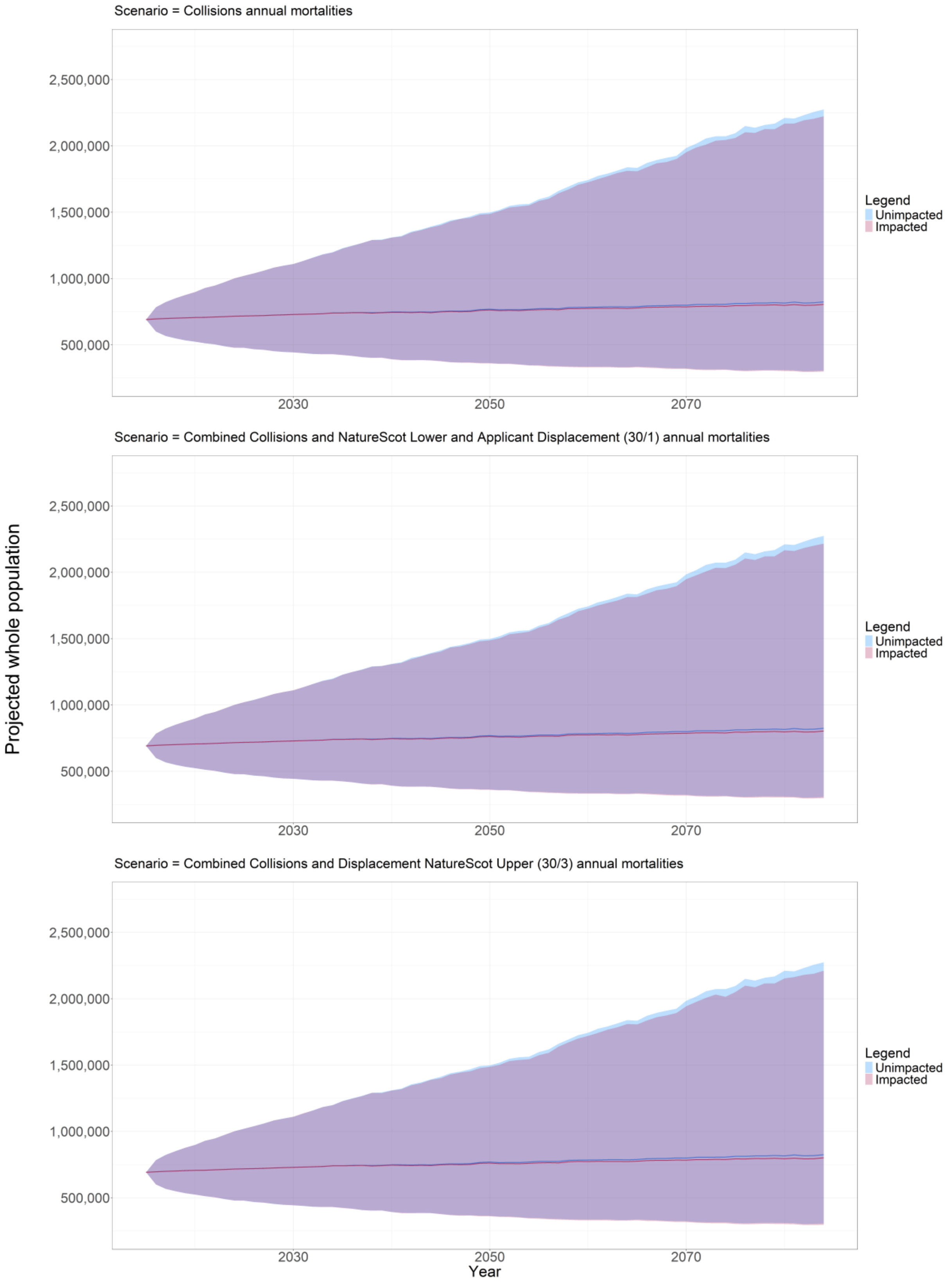


Plate 5-4 Kittiwake Annual Population Projection over 35-50 years under the modelled impact scenarios.

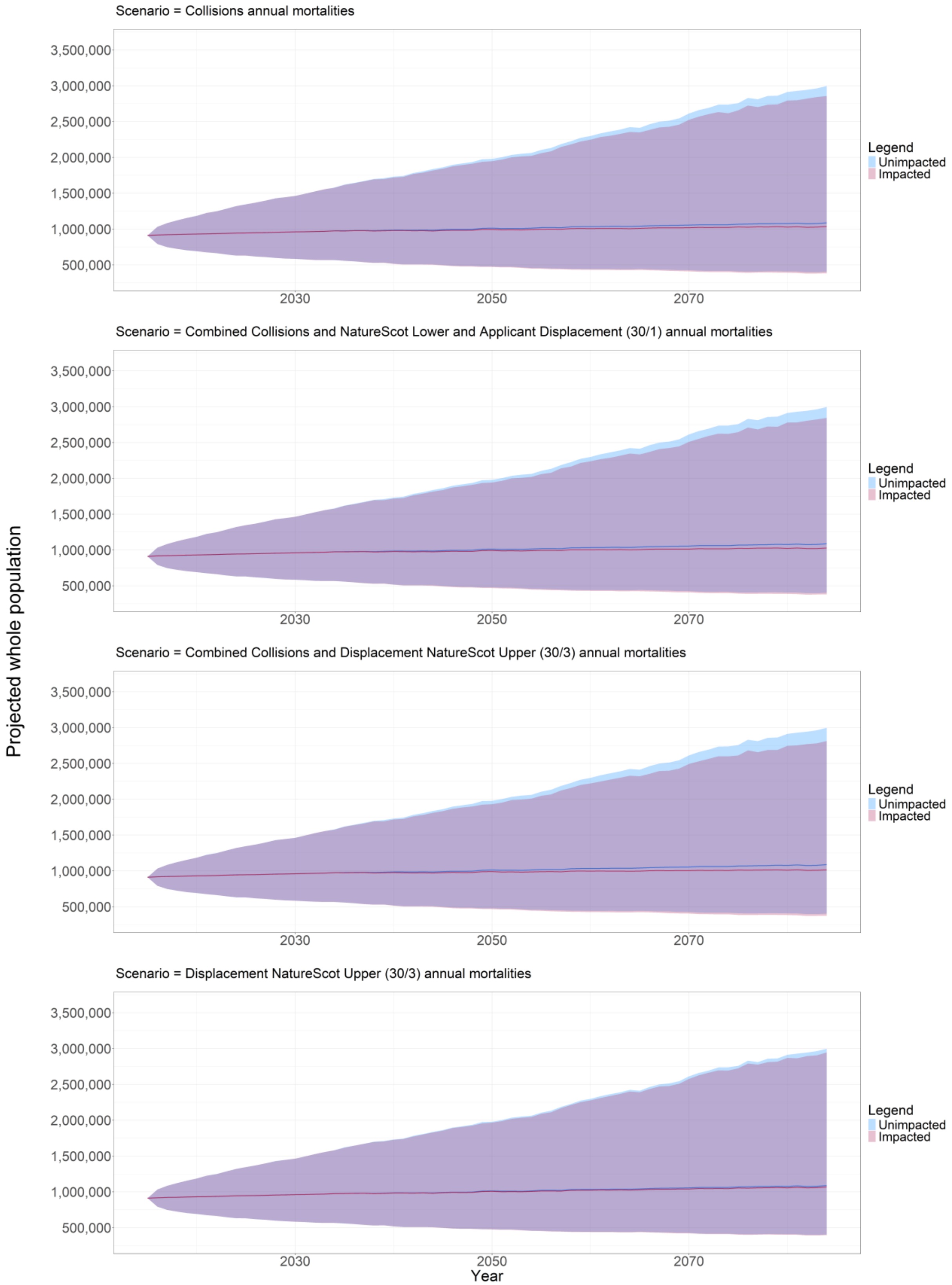


Plate 5-5 CGR after 35 Years for the Kittiwake Population during the Breeding Season under the modelled impact scenarios.

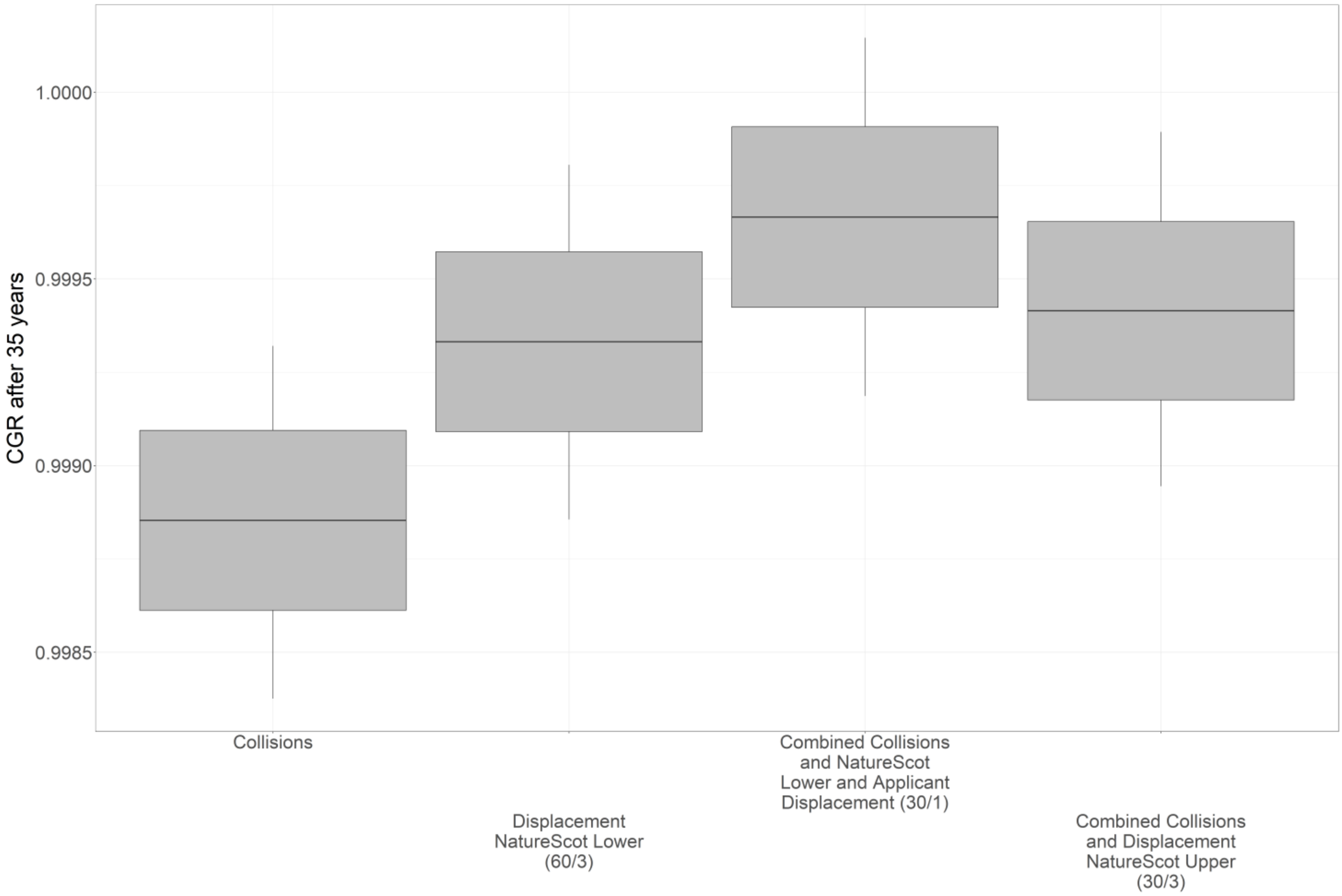


Plate 5-6 CGR after 35 Years for the Kittiwake Population during the Post-breeding Season under the modelled impact scenarios.

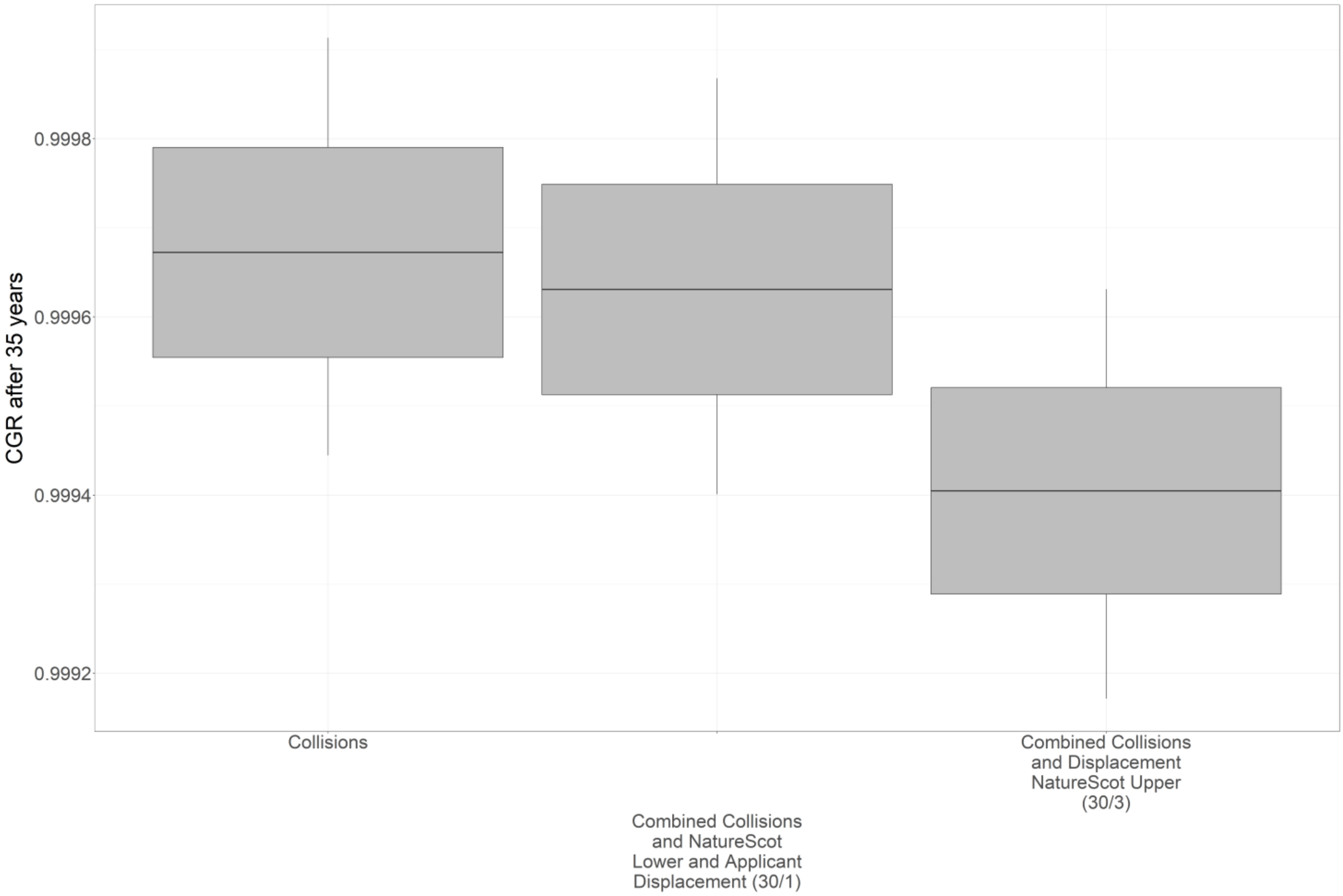


Plate 5-7 CGR after 35 Years for the Kittiwake Population during the Pre-breeding Season under the modelled impact scenarios.

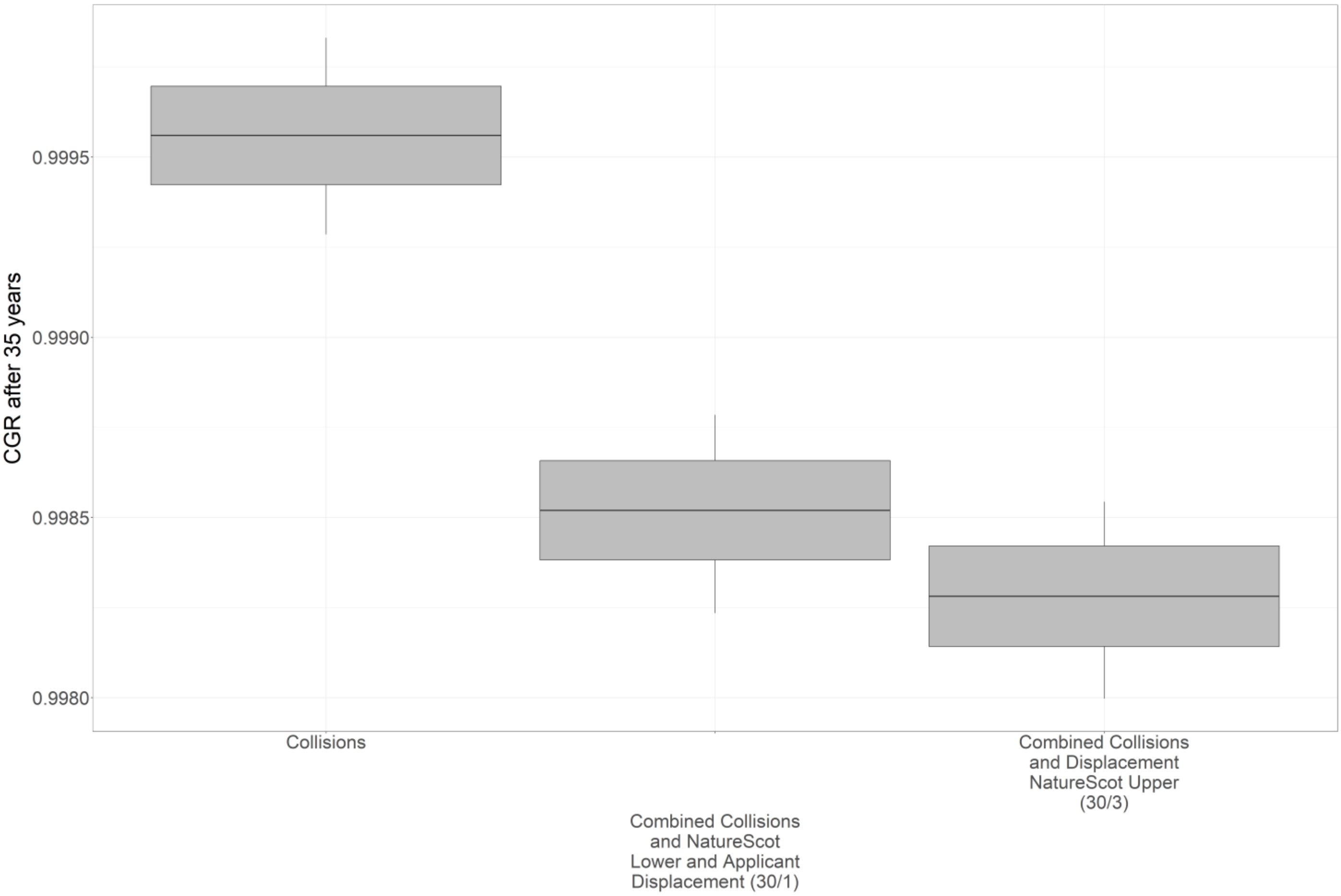


Plate 5-8 CGR after 35 Years for the Kittiwake Annual Population under the modelled impact scenarios.

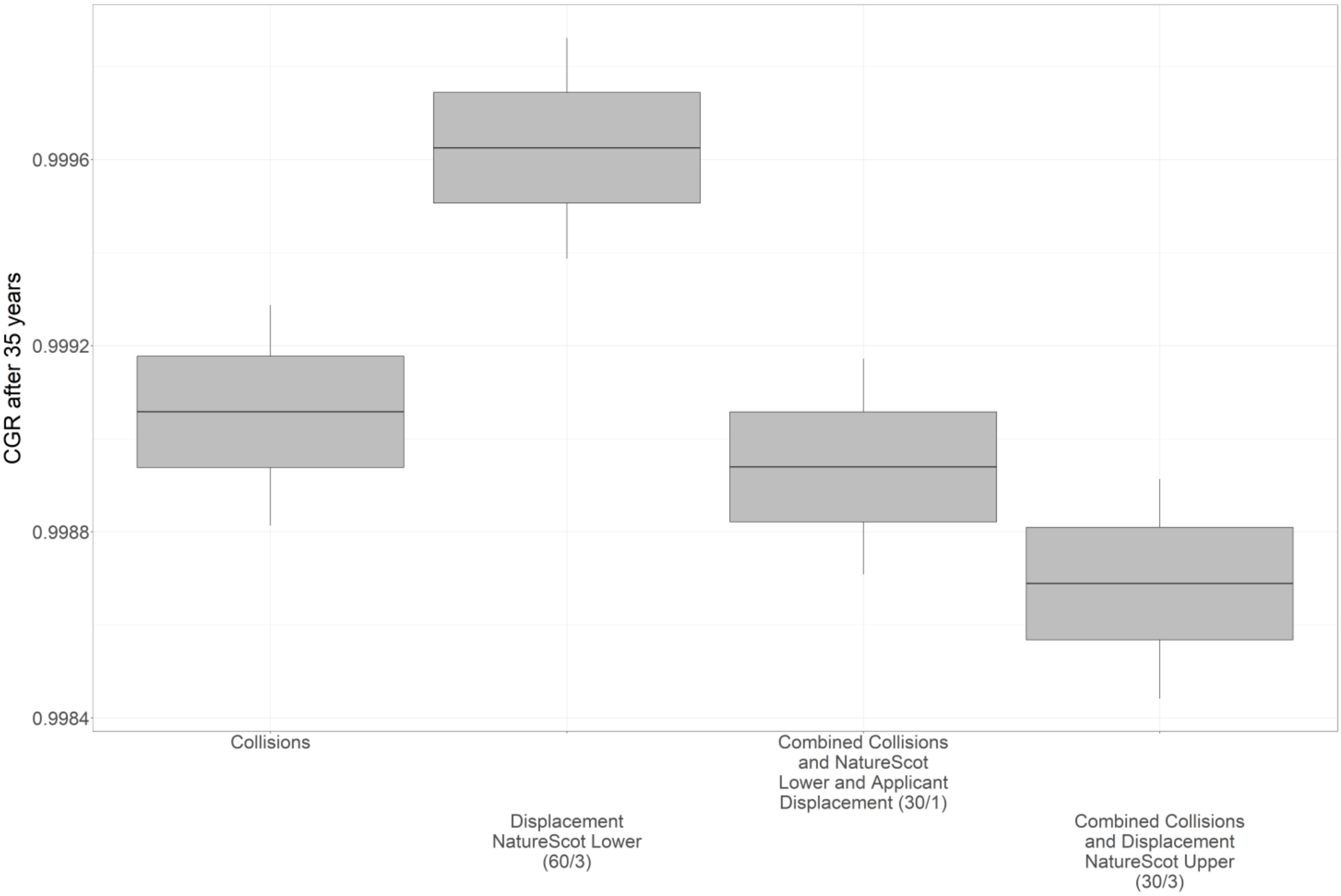


Plate 5-9 CPS for the Kittiwake Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenarios.

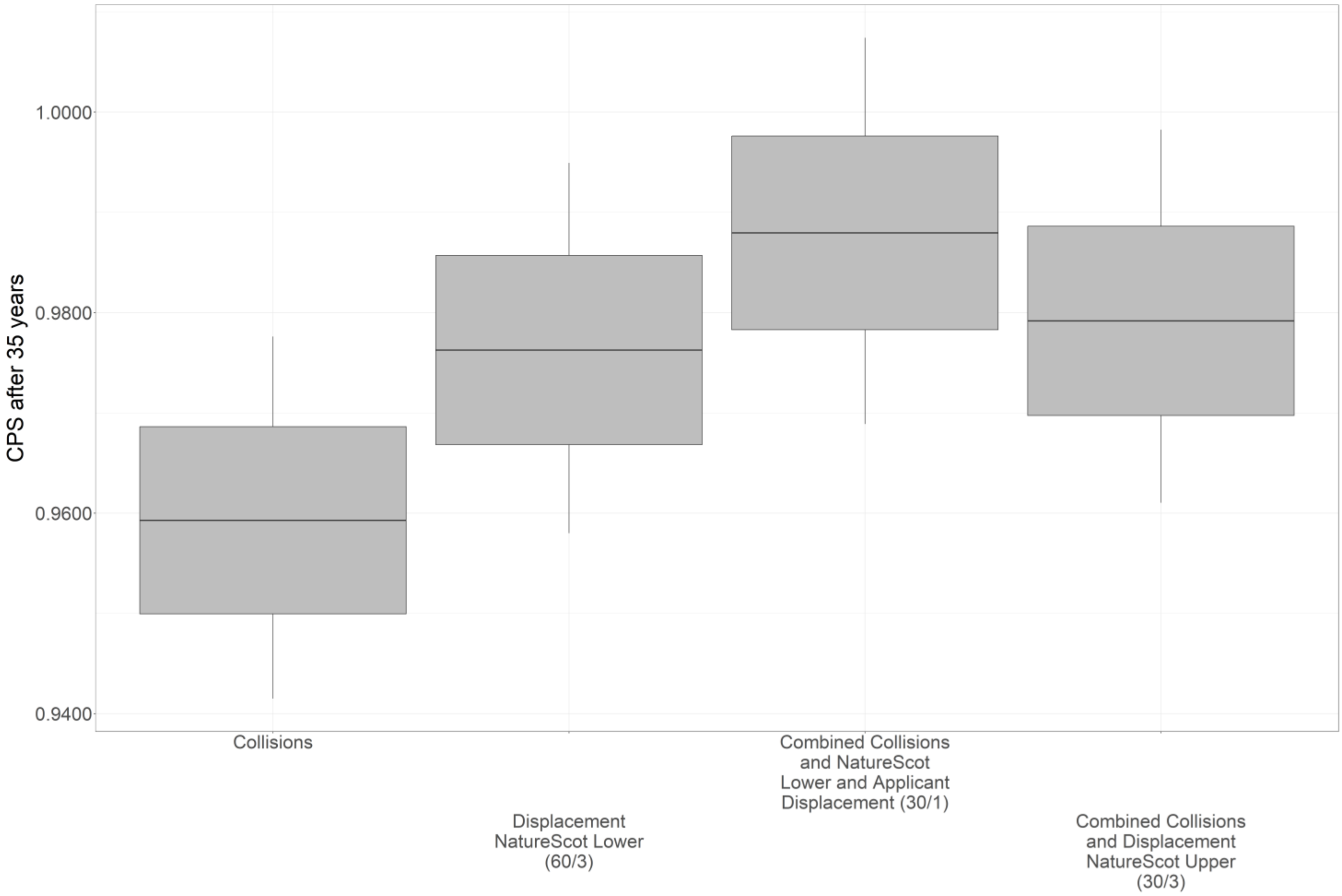


Plate 5-10 CPS for the Kittiwake Population during the Post-breeding Season from the Simulations after 35 Years under the modelled impact scenarios.

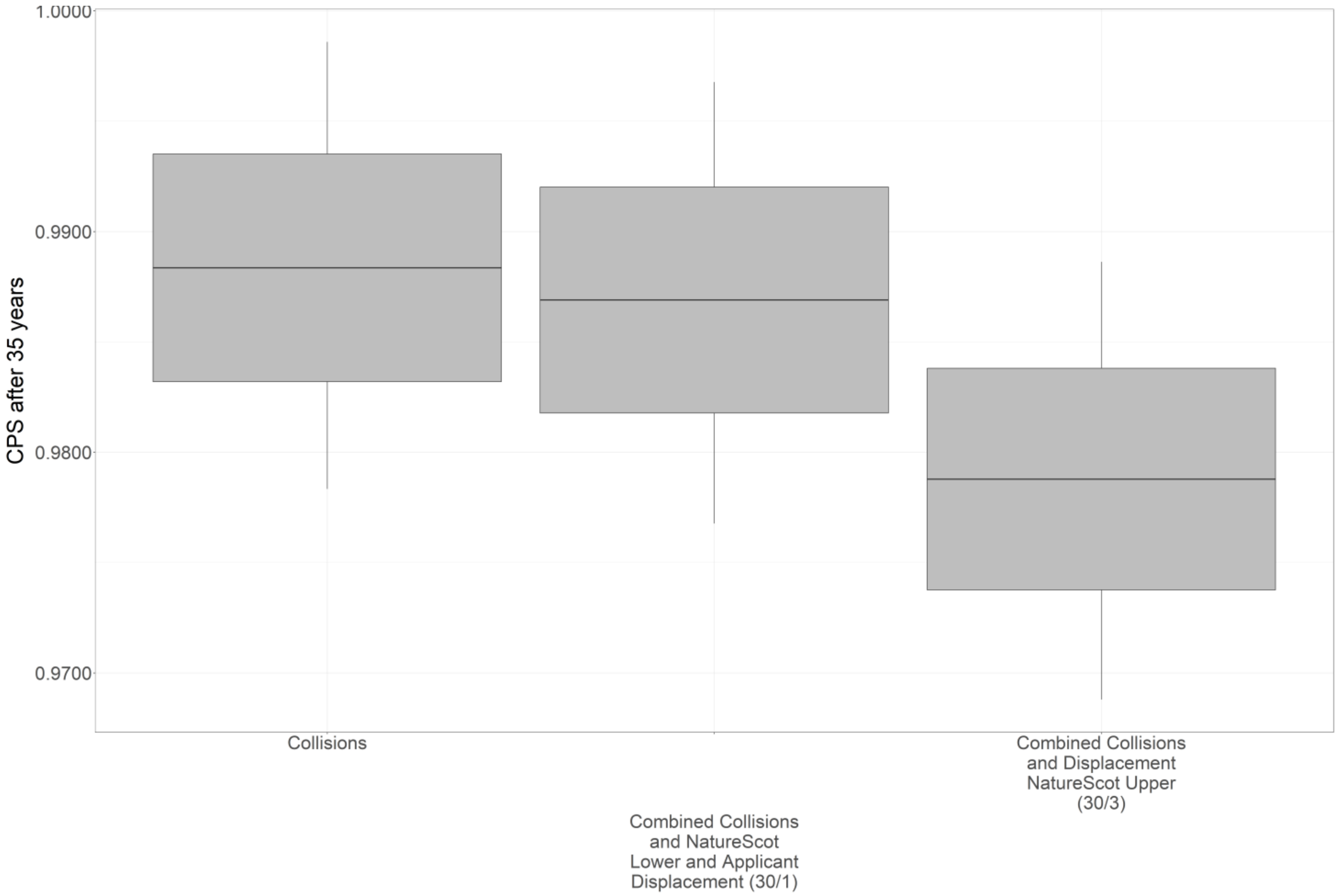


Plate 5-11 CPS for the Kittiwake Population during the Pre-reeding Season from the Simulations after 35 Years under the modelled impact scenarios.

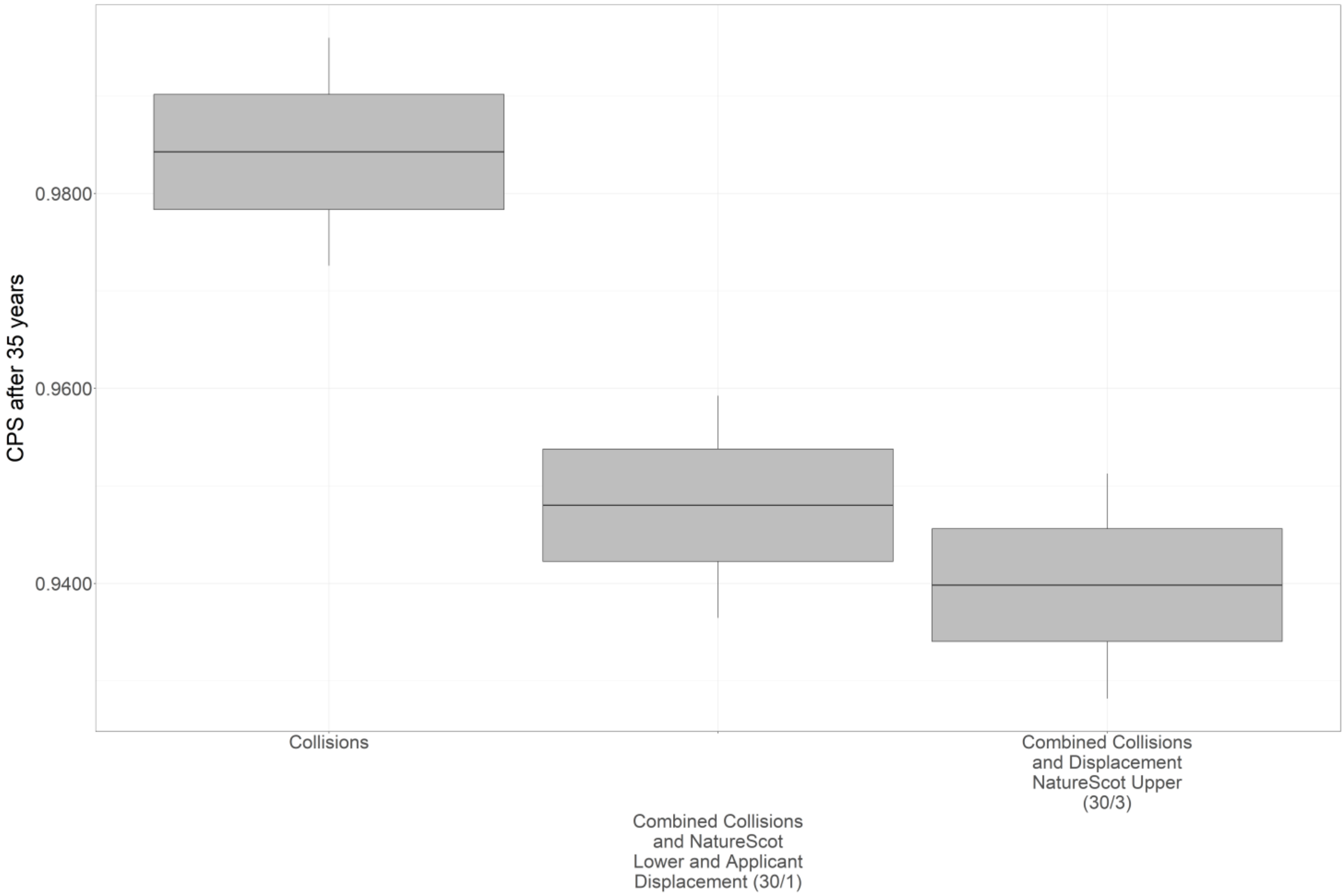
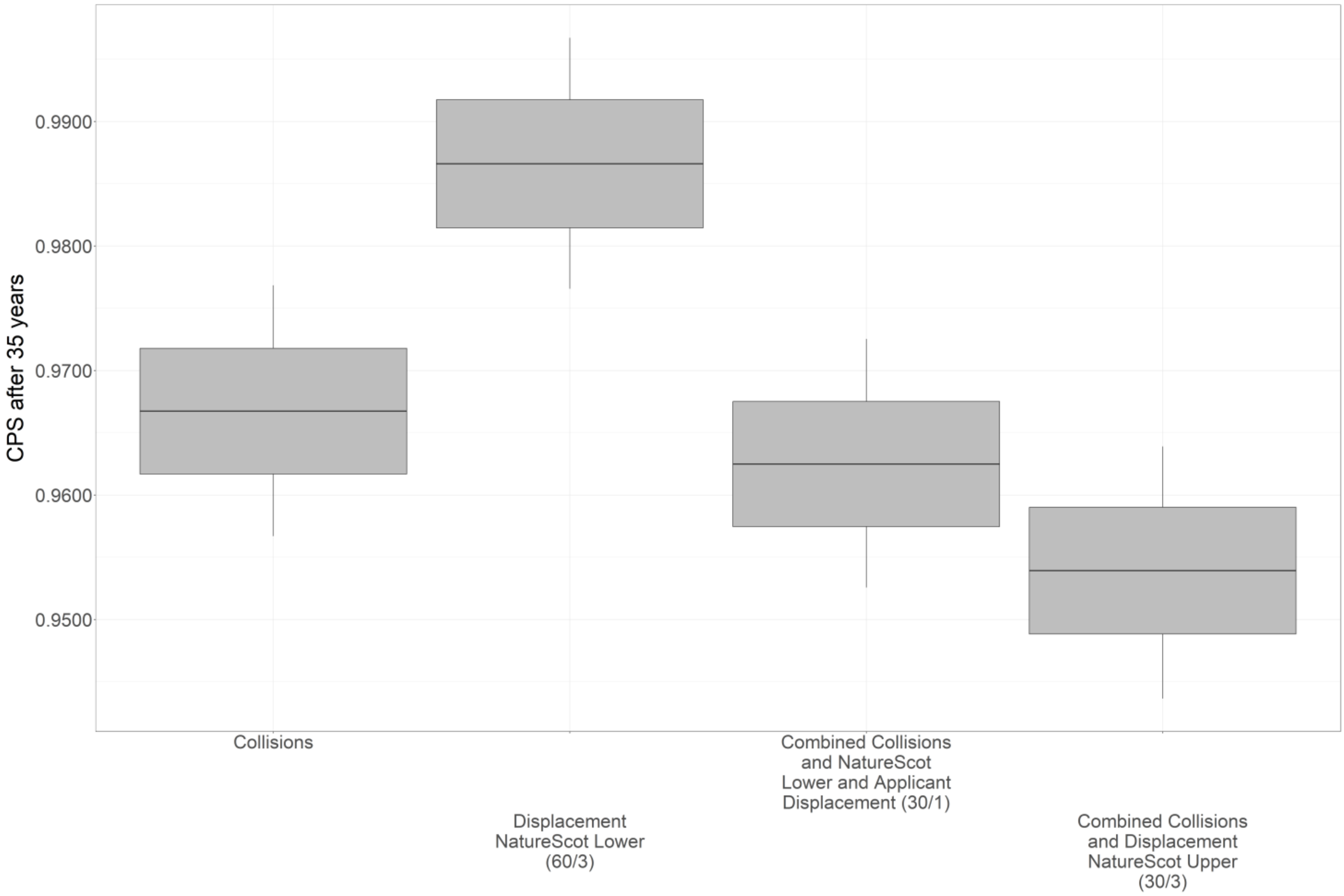


Plate 5-12 CPS for the Kittiwake Annual Population from the Simulations after 35 Years under the modelled impact scenarios.



5.2.2 GREAT BLACK-BACKED GULL

5.2.2.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the great black-backed gull regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-2. The specific avoidance rates used for great black-backed gull within the collision scenarios are presented in Table 2-4.

5.2.2.2 As part of NatureScot guidance (2023c), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such, the population size graph is shown in Plate 5-13 for the non-breeding season. Plate 5-14 shows the CGR values for the non-breeding season and Plate 5-15 shows the CPS values for the non-breeding season.

Table 5-2 Great Black-Backed Gull 35 Year Cumulative PVA Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Non-breeding	Baseline	0	1.1263	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	15.28	1.1257	0.9995	0.9825	0.05	1.75	46.04	53.84

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Plate 5-13 Great Black-Backed Gull Population Projection over 35-50 years for the Non-breeding Season under the modelled impact scenario

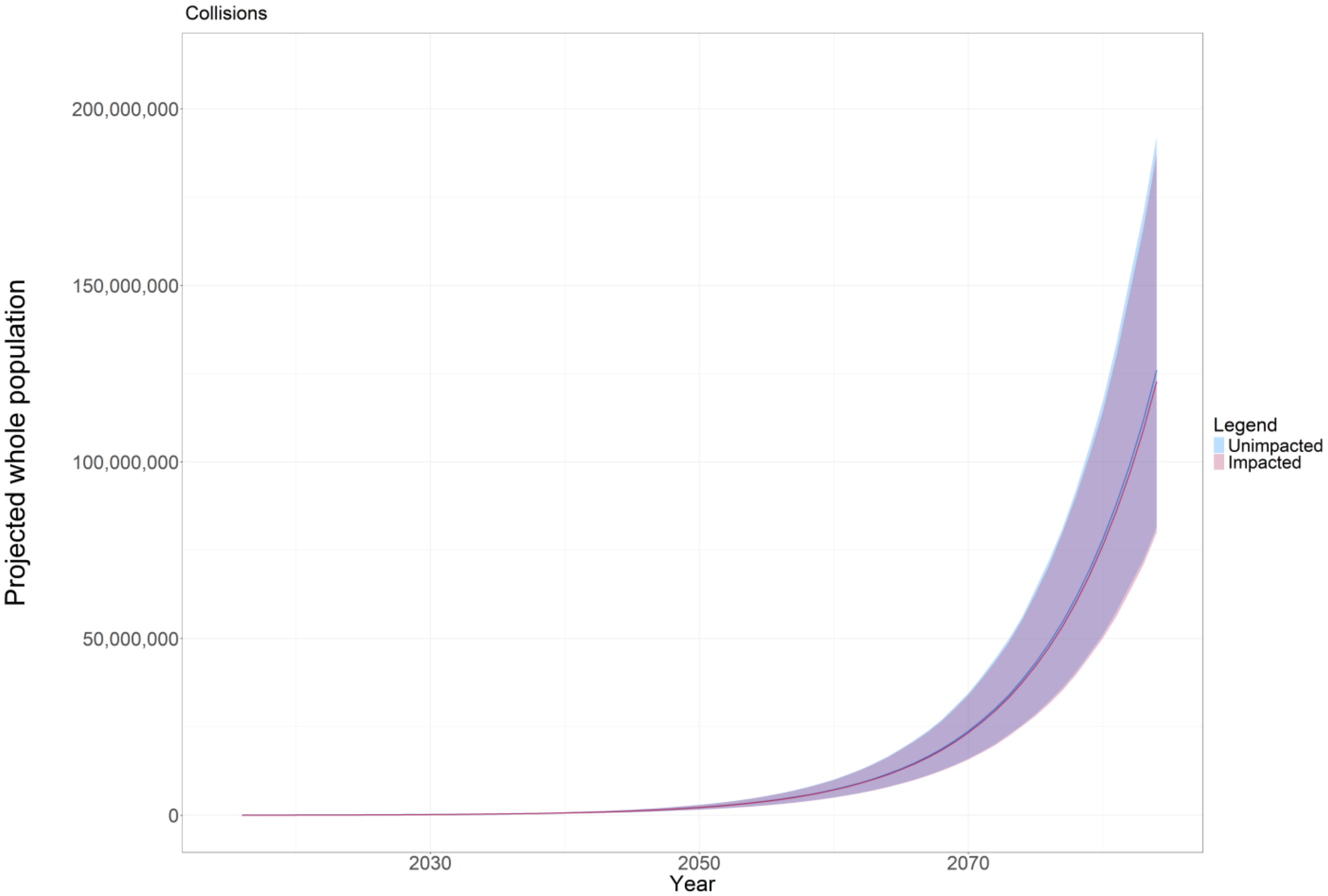


Plate 5-14 CGR after 35 Years for the Great Black-Backed Gull Population Annually for the Non-breeding Season under the modelled impact scenario

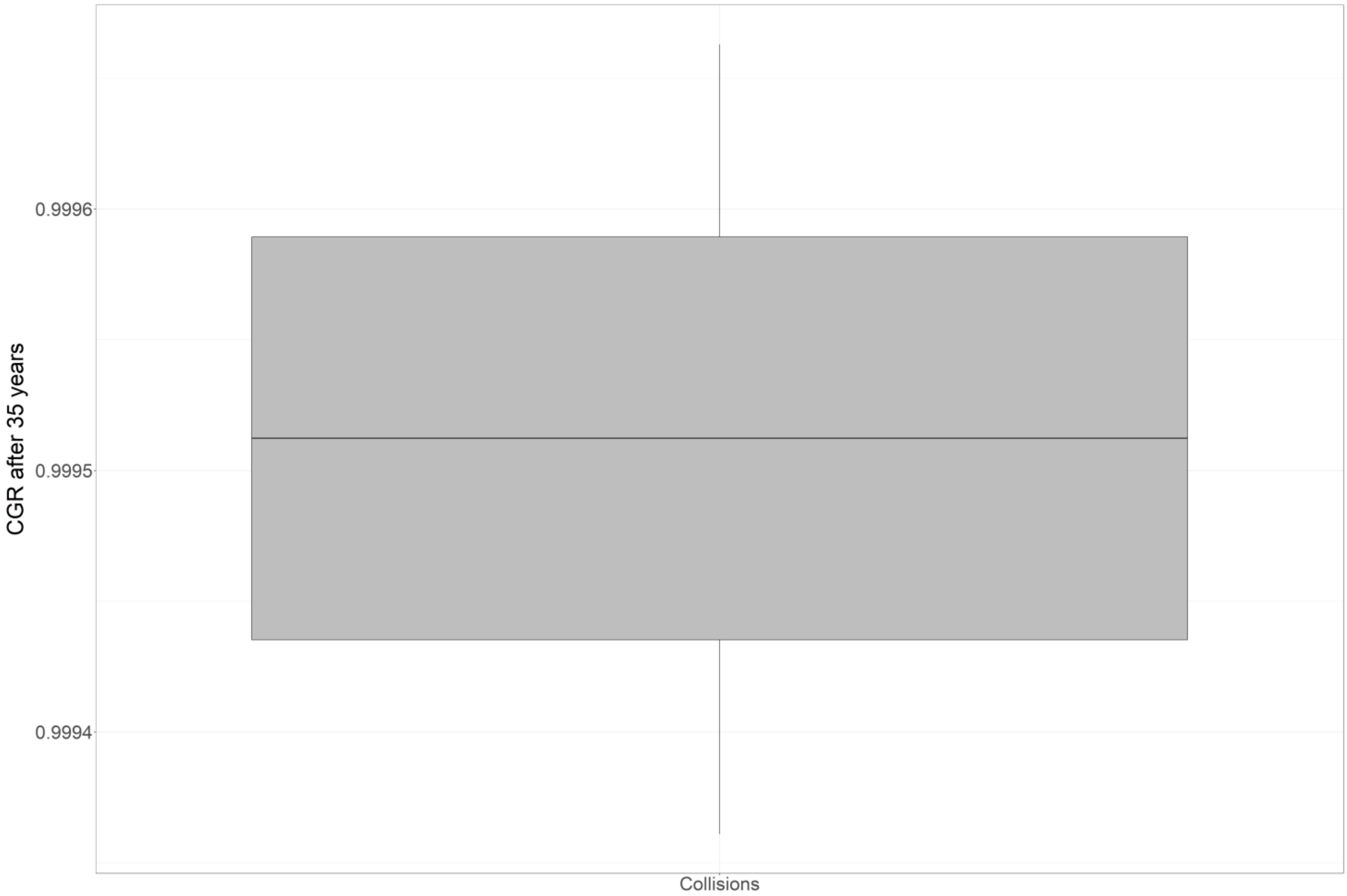
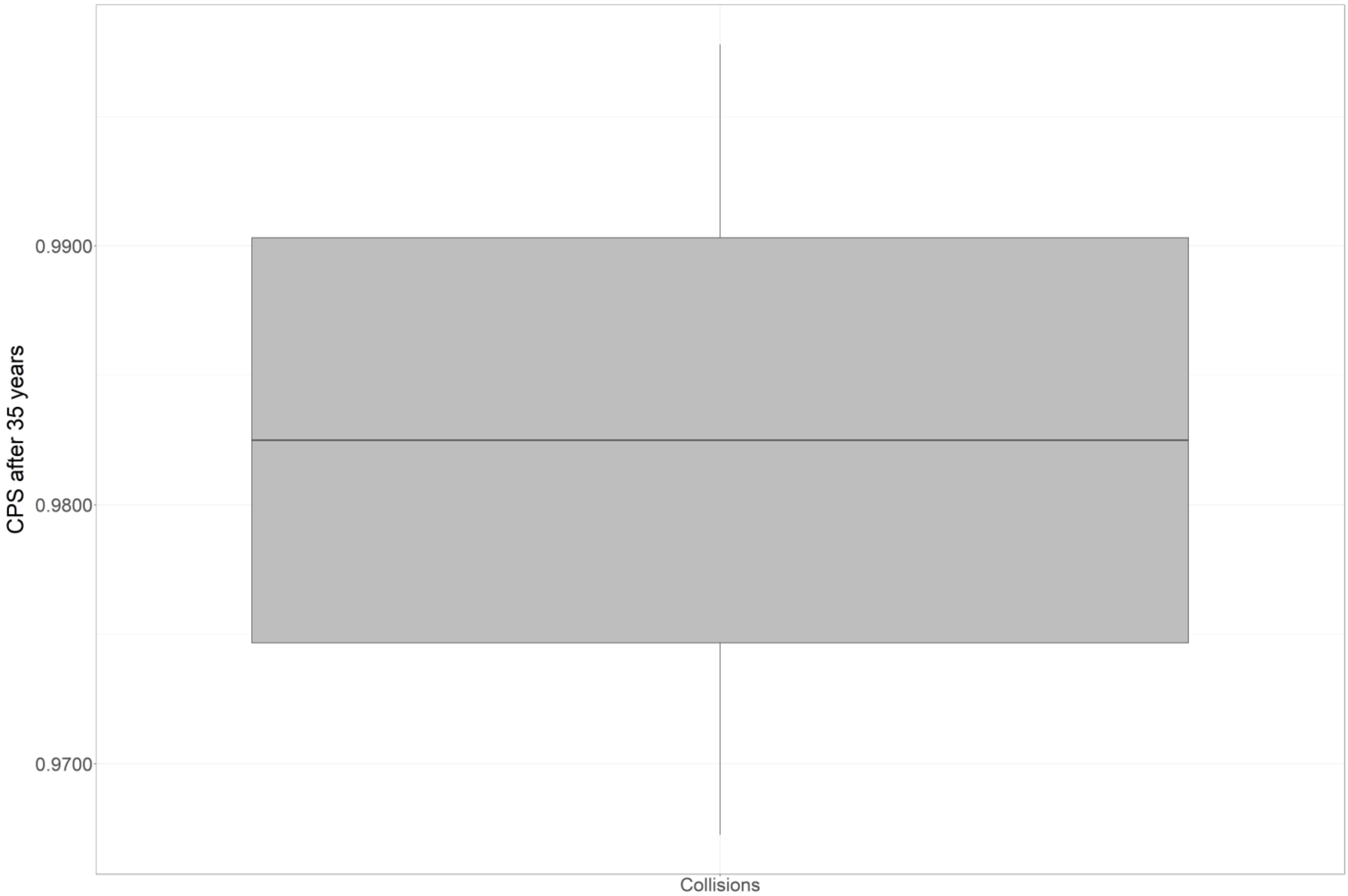


Plate 5-15 CPS for the Great Black-Backed Gull Population for the Non-breeding Season from the Simulations after 35 Years under the modelled impact scenario



5.2.3 HERRING GULL

5.2.3.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the herring gull regional from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-3. The specific avoidance rates used for herring gull within the collision scenarios are presented in Table 2-4.

5.2.3.2 As part of NatureScot guidance (2023c), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such, the population size graph is shown in Plate 5-16 for the non-breeding season. Plate 5-17 shows the CGR values for the non-breeding season and Plate 5-18 shows the CPS values for the non-breeding season.

Table 5-3 Herring Gull 35 Year Cumulative PVA Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Non-breeding	Baseline	0	0.9494	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	169.20	0.9484	0.9989	0.9585	0.12	4.15	46.42	53.34

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Plate 5-16 Herring Gull Population Projection over 35-50 years during the Non-Breeding Season under the modelled impact scenario.

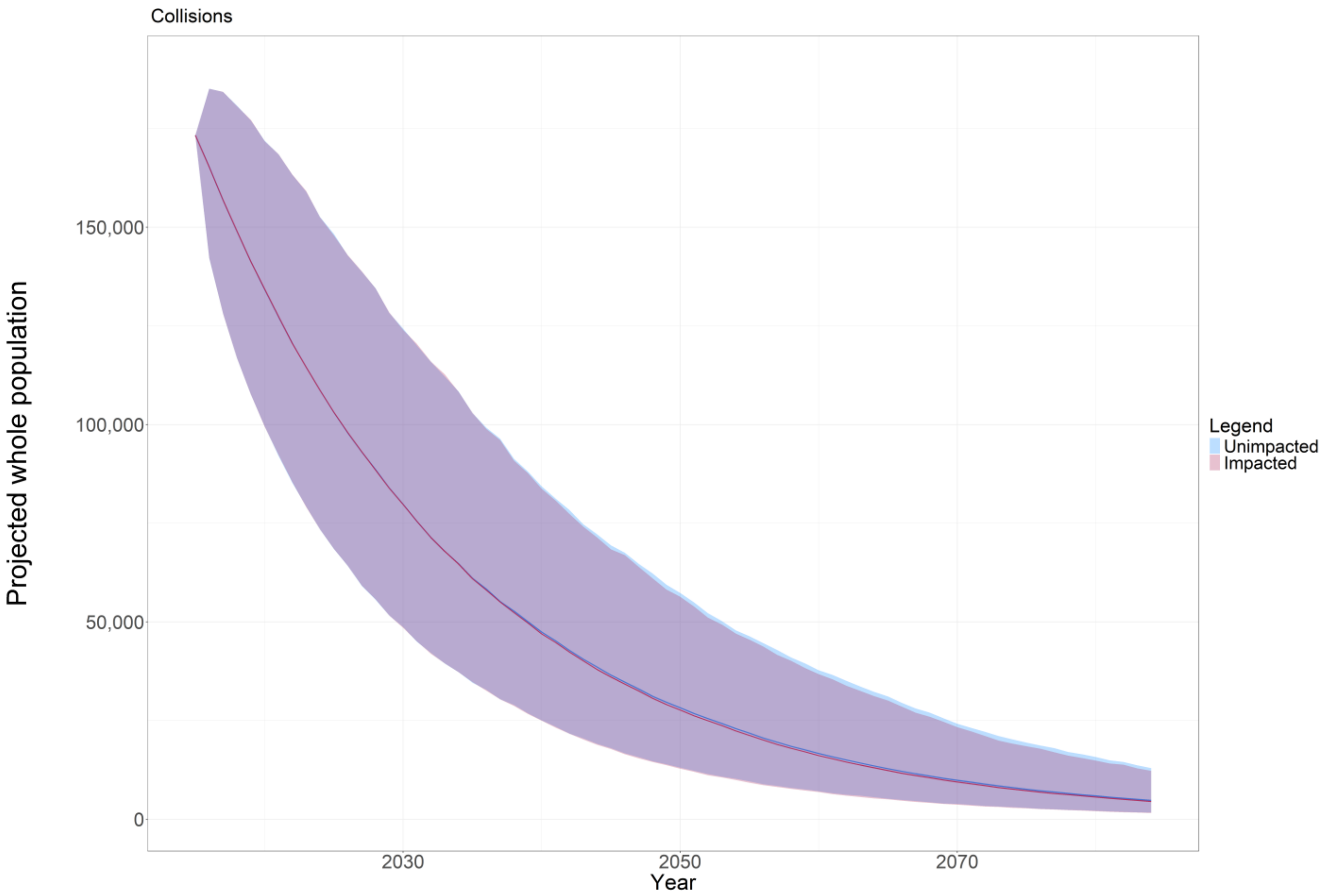


Plate 5-17 CGR after 35 Years for the Herring Gull Population during the Non-breeding Season under the modelled impact scenario

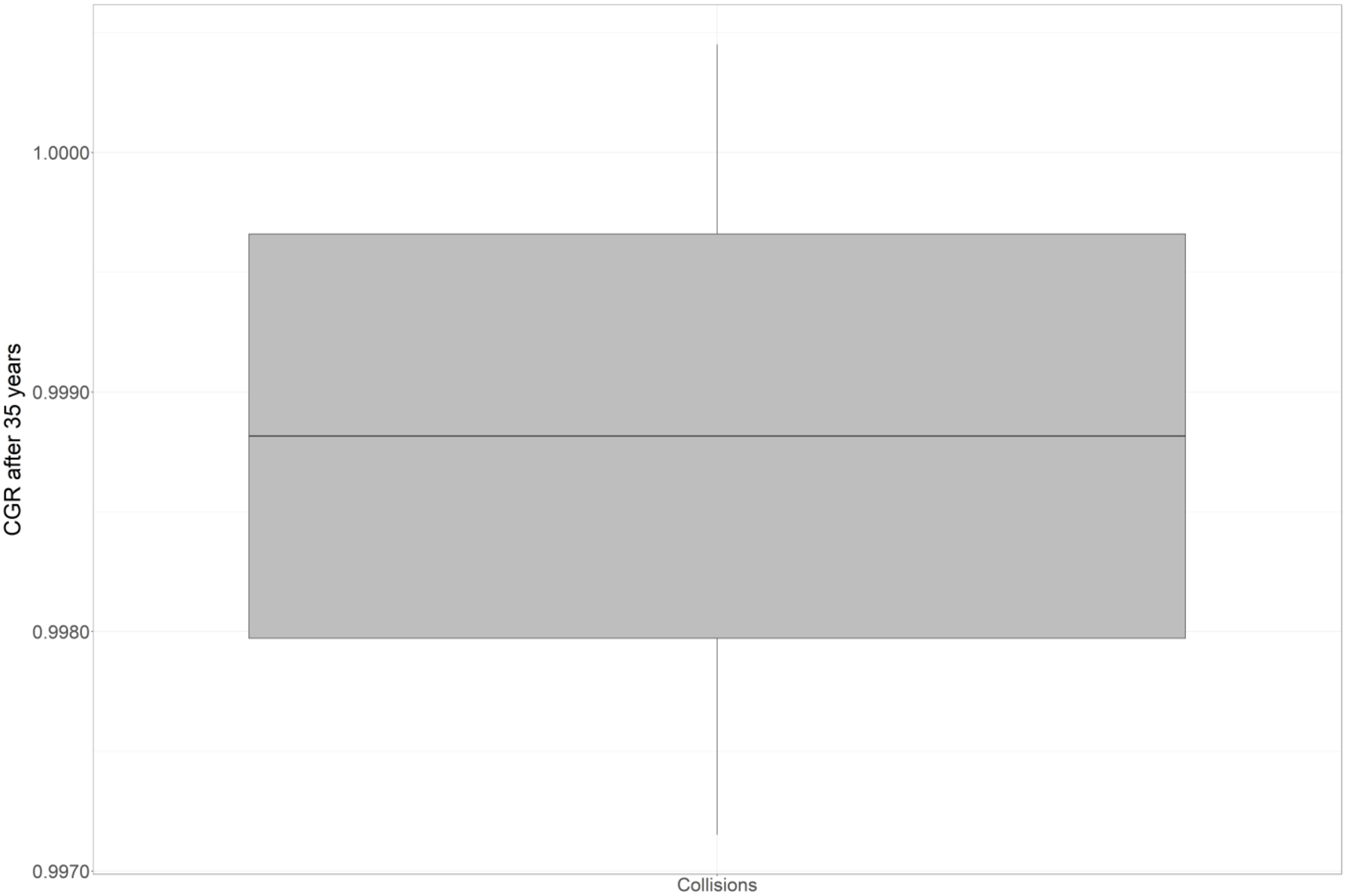
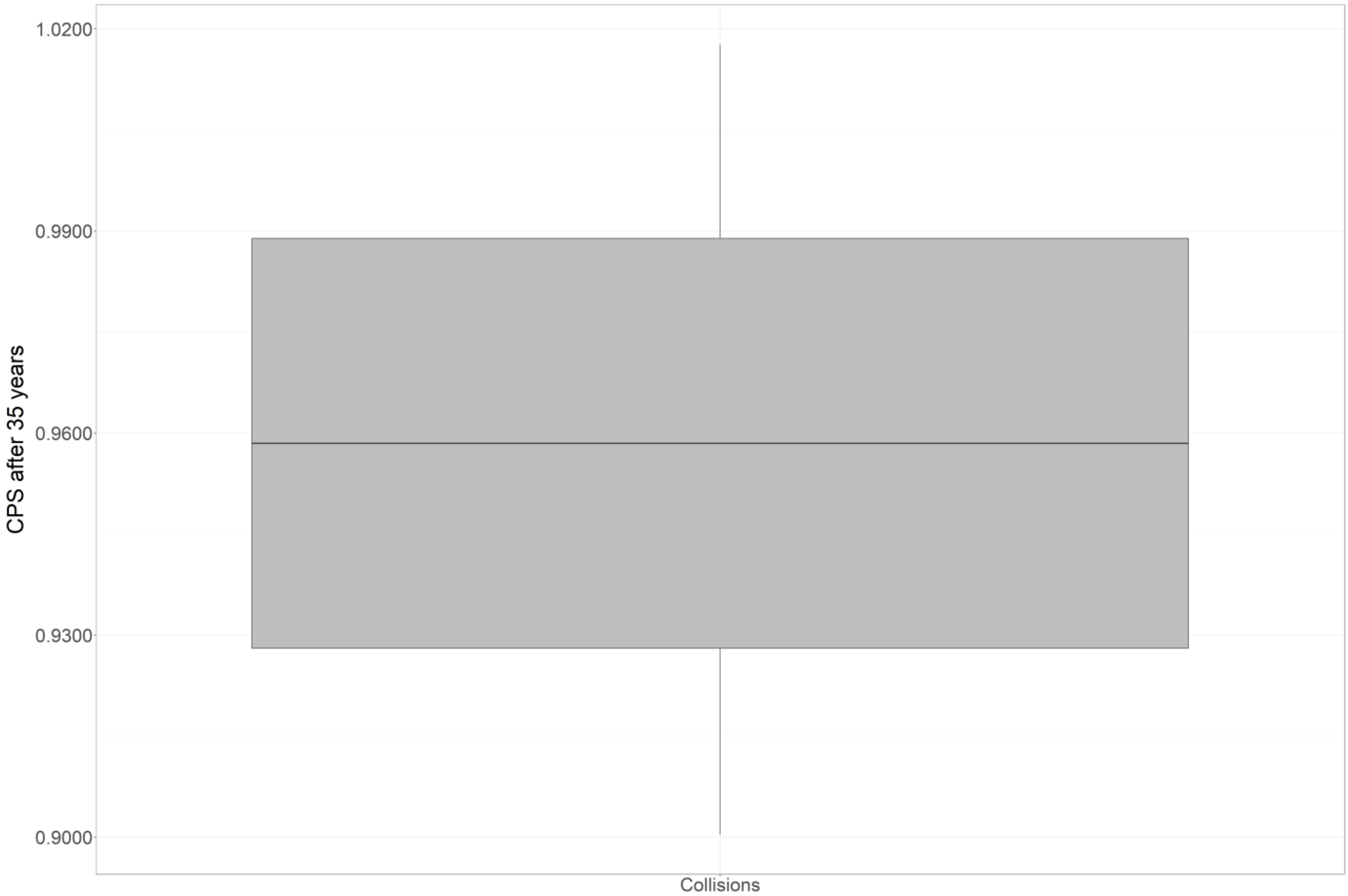


Plate 5-18 CPS for the Herring Gull Population during the Non-breeding Season from the Simulations after 35 Years under the modelled impact scenario.



5.2.4 ARCTIC TERN

5.2.4.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the Arctic tern regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-4. The specific avoidance rates used for Arctic tern within the collision scenarios are presented in Table 2-4.

5.2.4.2 As part of NatureScot guidance (2023c), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such, the population size graph is shown in Plate 5-19 for the breeding season. Plate 5-20 shows the CGR values for the breeding season. Plate 5-21 shows the CPS values for the breeding season.

Table 5-4 Arctic Tern 35 Year Cumulative PVA Results

Season	Impact Scenario	Predicted Mortality (no. of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9004	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	1.75	0.8991	0.9988	0.9545	0.12	4.55	48.78	55.58

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Plate 5-19 Arctic Tern Population Projection over 35-50 years during the Breeding Season under the modelled impact scenario.

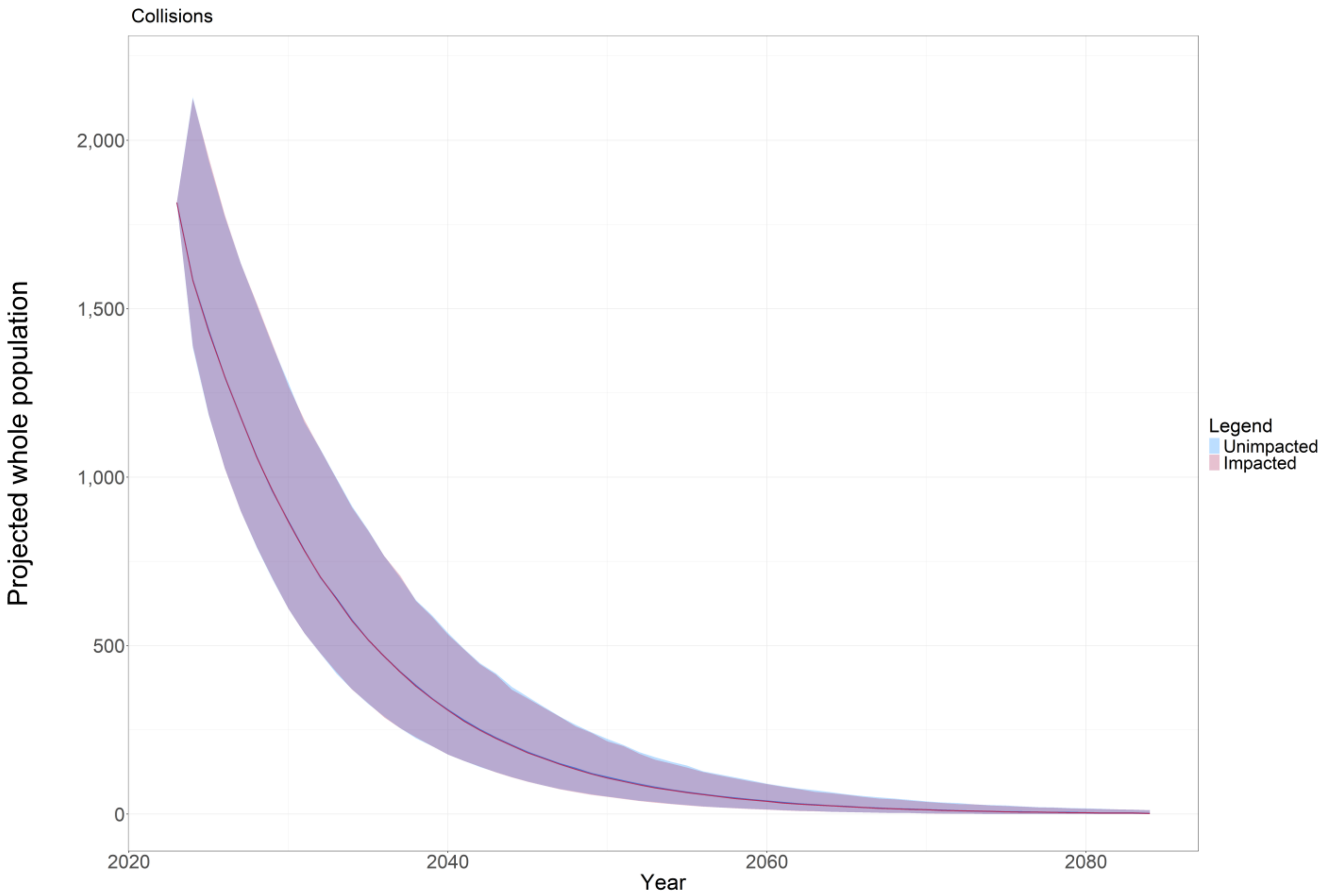


Plate 5-20 CGR after 35 Years for the Arctic Tern Population during the Breeding Season under the modelled impact scenario

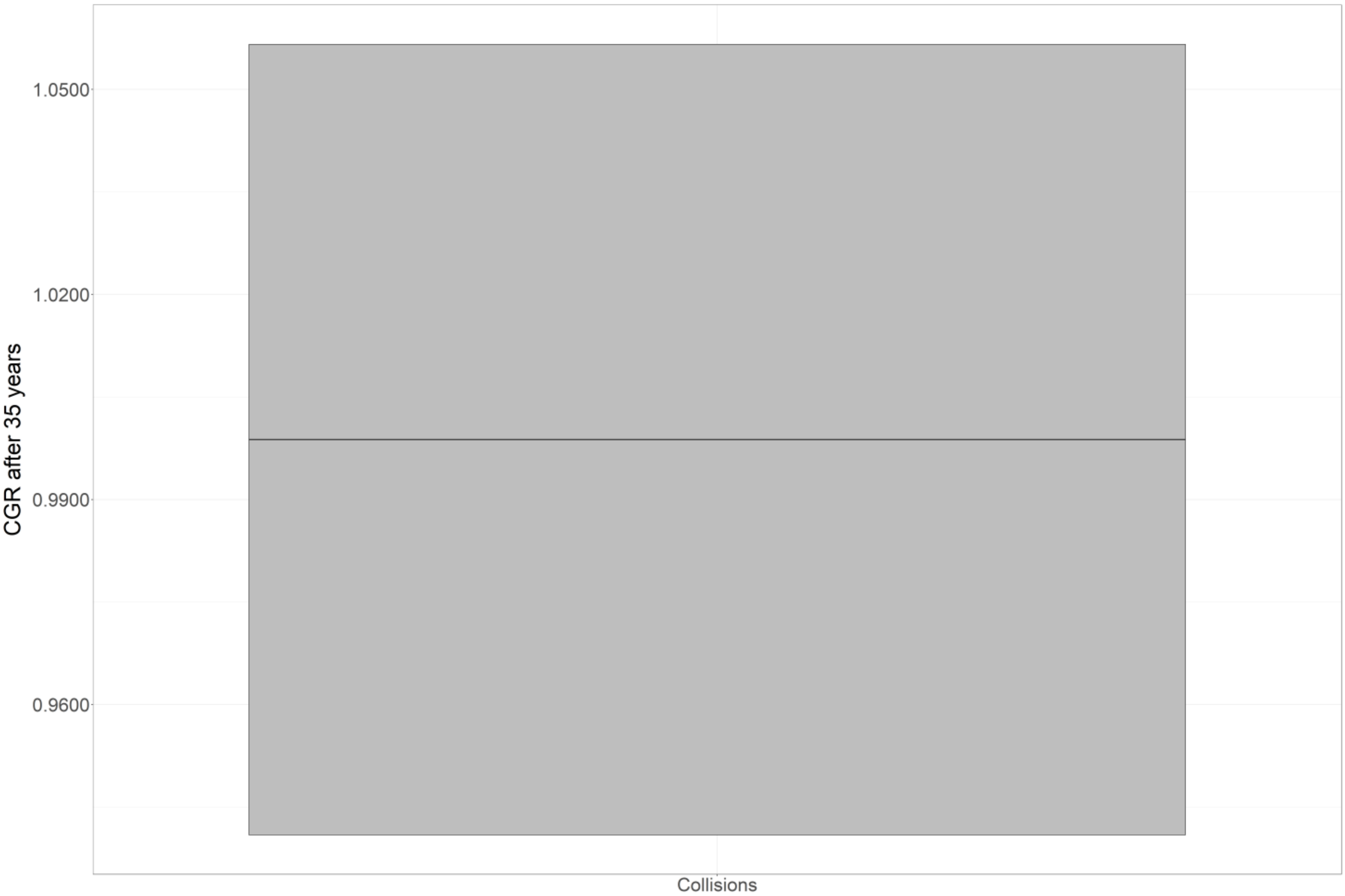
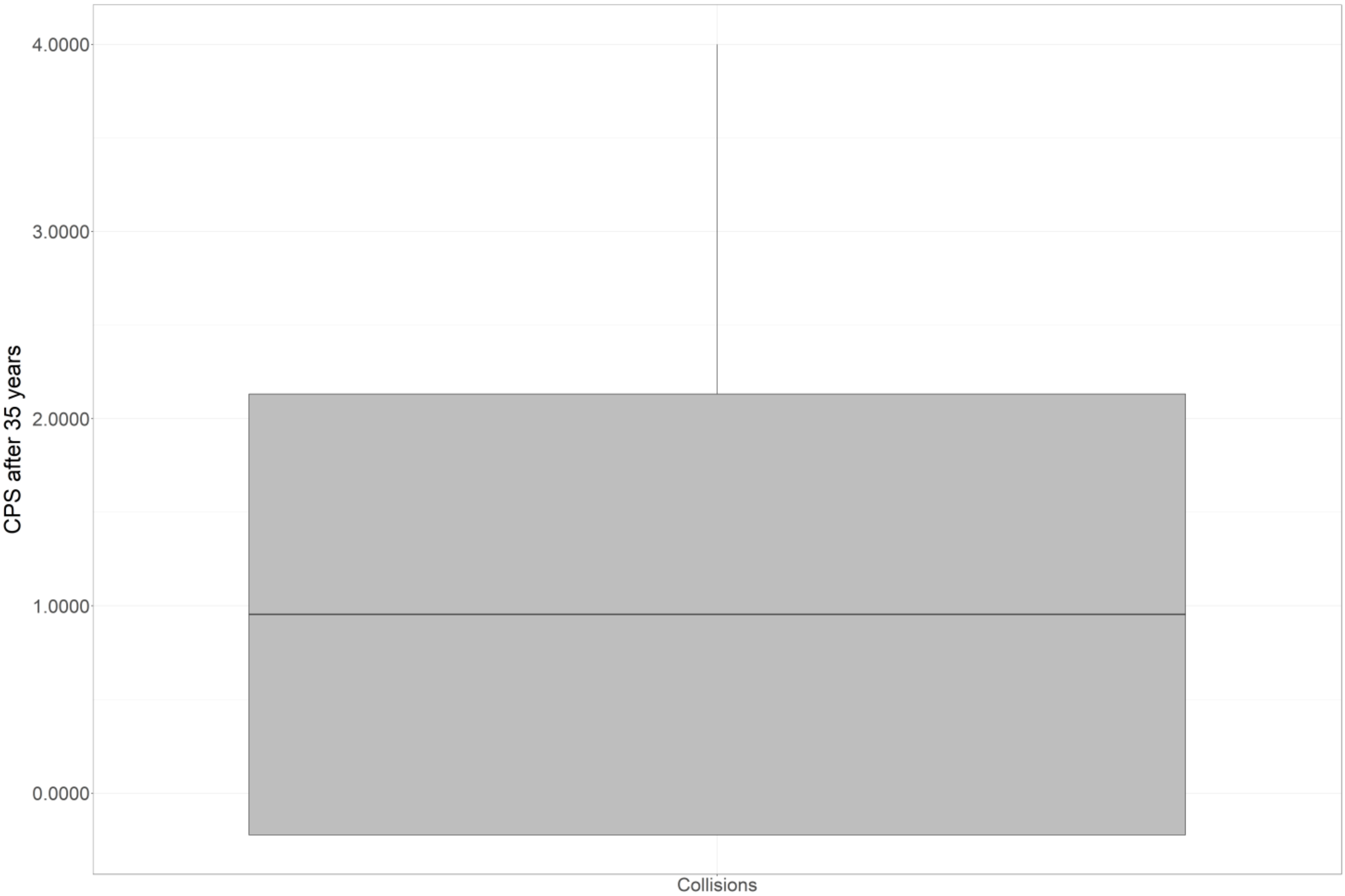


Plate 5-21 CPS for the Arctic Tern Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenario.



5.2.5 GANNET

5.2.5.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the gannet regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-5. The specific avoidance rates used for gannet within the collision scenarios are presented in Table 2-4.

5.2.5.2 As part of NatureScot guidance (2023c), 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 Plate 5-22 for the breeding season, and Plate 5-23 for annually. Plate 5-24 show the CGR values for the breeding season, and Plate 5-25 for annually. Plate 5-26 show the CPS values for the breeding season, and Plate 5-27 for annually.

5.2.5.3 As set out in Section 2.4.3, several scenarios have been requested by the statutory consultees, one of which considers 'with Berwick Bank' and 'without Berwick Bank' options.

Table 5-5 Gannet 35 Year Cumulative PVA Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	1.0124	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions (with Berwick Bank)	580.66	1.0116	0.9993	0.9734	0.07	2.66	45.44	54.08
	Collisions (without Berwick Bank)	620.13	1.0116	0.9992	0.9716	0.08	2.84	45.08	54.56
	Displacement NatureScot Upper (70/3) (with Berwick Bank)	386.94	1.0119	0.9995	0.9822	0.05	1.78	46.92	52.36
	Displacement NatureScot Upper (70/3) (without Berwick Bank)	375.48	1.0119	0.9995	0.9827	0.05	1.73	47.10	52.38
	Combined Collisions and Displacement NatureScot Lower and Applicant (70/1) (with Berwick Bank)	650.07	1.0115	0.9992	0.9702	0.08	2.98	44.78	54.82
	Combined Collisions and Displacement NatureScot Lower and Applicant (70/1) (without Berwick Bank)	744.30	1.0114	0.9990	0.9661	0.10	3.39	44.12	55.90
	Combined Collisions and Displacement NatureScot Upper (70/3) (with Berwick Bank)	967.60	1.0111	0.9988	0.9562	0.12	4.38	42.30	57.60

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Combined Collisions and Displacement NatureScot Upper (70/3) (without Berwick Bank)	995.54	1.0111	0.9987	0.9549	0.13	4.51	42.06	58.04
Annual	Baseline	0	1.0124	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions (with Berwick Bank)	609.17	1.0116	0.9992	0.9721	0.08	2.79	45.28	54.46
	Collisions (without Berwick Bank)	614.56	1.0116	0.9992	0.9719	0.08	2.81	45.18	54.58
	Displacement NatureScot Upper (70/3) (with Berwick Bank)	441.23	1.0118	0.9994	0.9797	0.06	2.03	46.50	52.84
	Displacement NatureScot Upper (70/3) (without Berwick Bank)	460.12	1.0118	0.9994	0.979	0.06	2.10	46.36	52.98
	Combined Collisions and Displacement NatureScot Lower and Applicant (70/1) (with Berwick Bank)	677.36	1.0115	0.9991	0.9690	0.09	3.10	44.62	55.30
	Combined Collisions and Displacement NatureScot Lower and Applicant (70/1) (without Berwick Bank)	752.61	1.0114	0.9990	0.9656	0.10	3.44	44.10	55.94

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Combined Collisions and Displacement NatureScot Upper (70/3) (with Berwick Bank)	1050.40	1.0110	0.9986	0.9524	0.14	4.76	41.44	58.44
	Combined Collisions and Displacement NatureScot Upper (70/3) (without Berwick Bank)	1059.36	1.0110	0.9986	0.9521	0.14	4.79	41.40	58.44

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Plate 5-22 Gannet Population Projection over 35-50 years during the Breeding Season under the modelled impact scenarios.

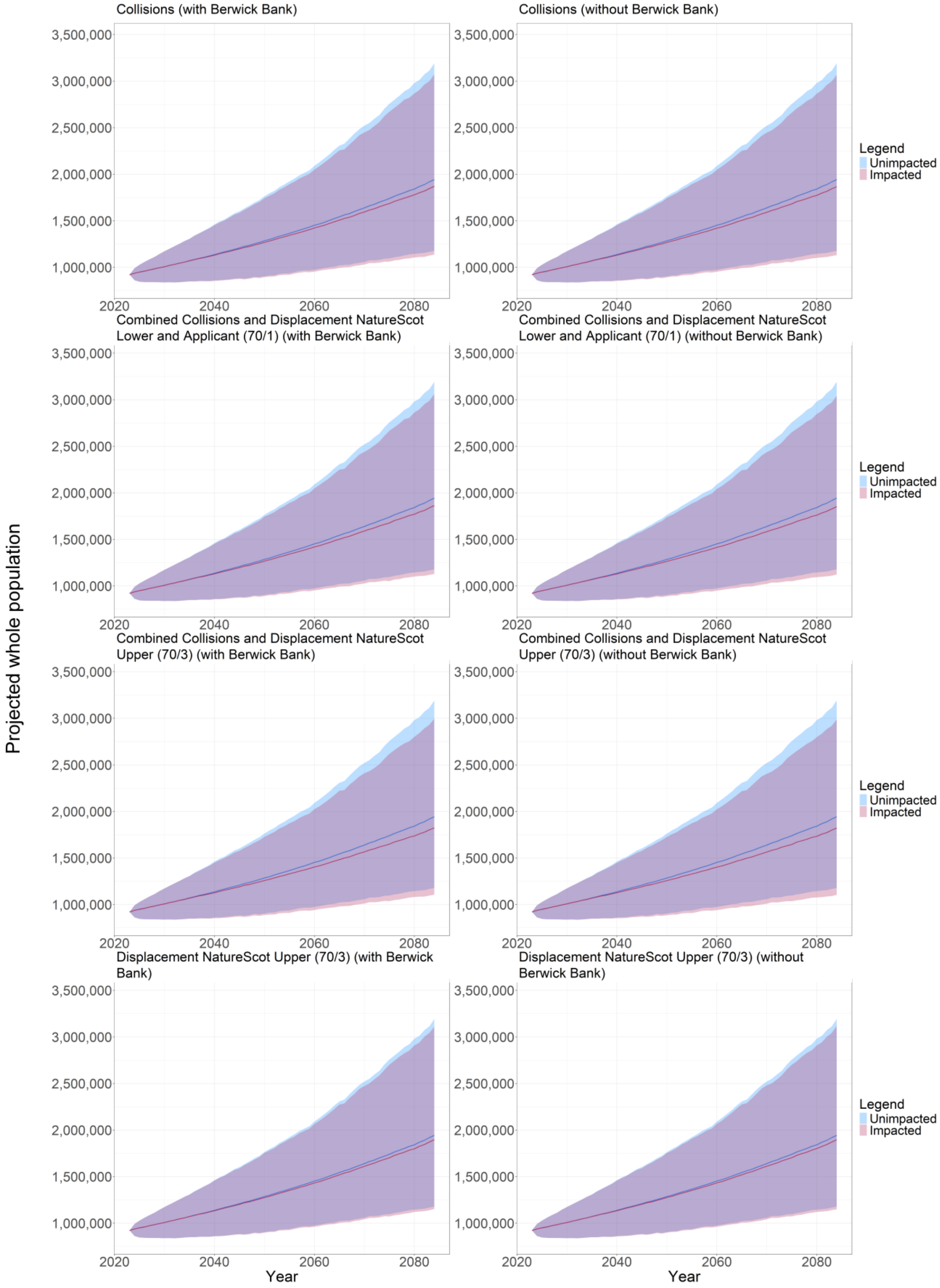


Plate 5-23 Gannet Annual Population Projection over 35-50 years under the modelled impact scenarios.

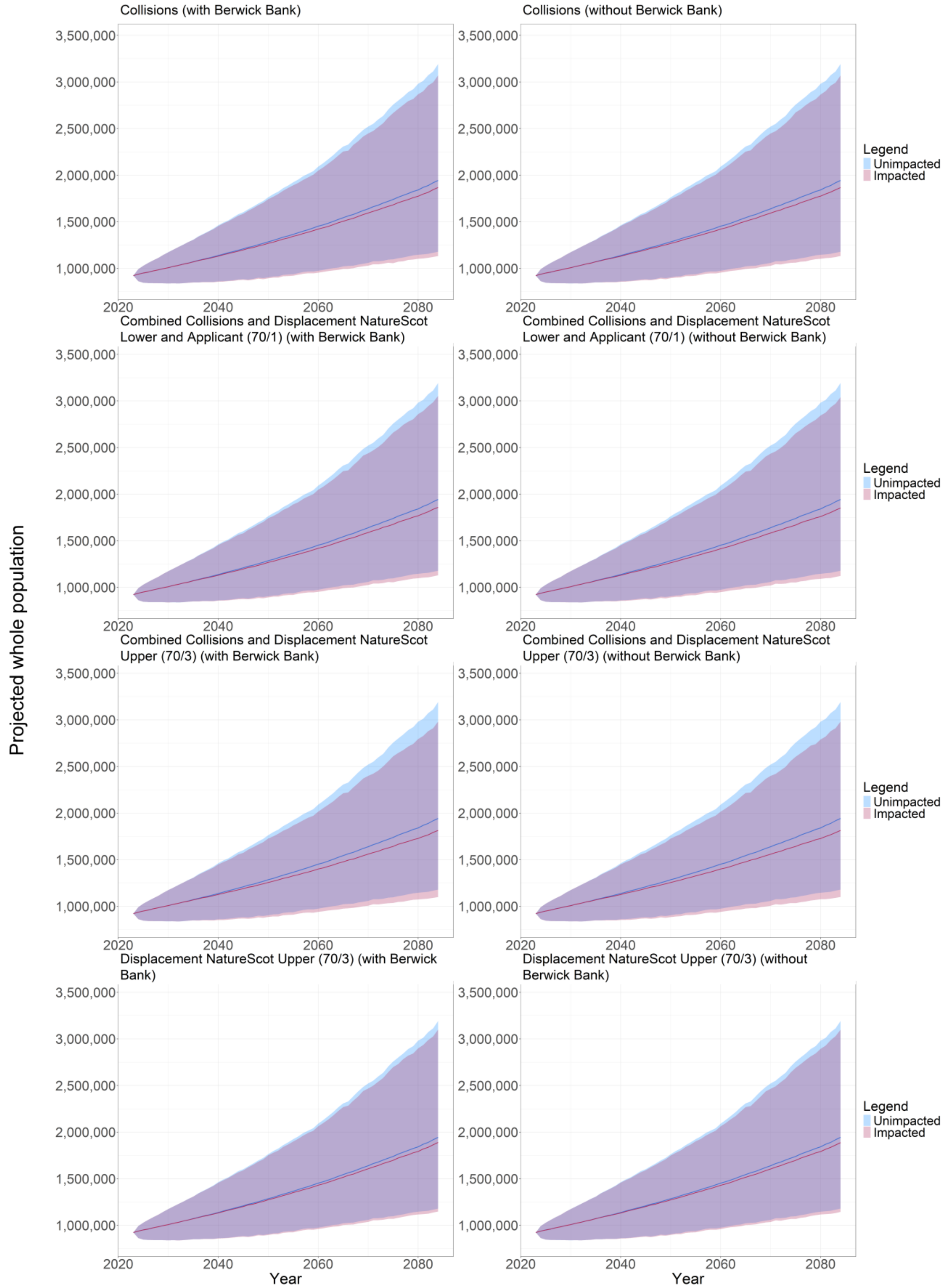


Plate 5-24 CGR for the Gannet Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenarios

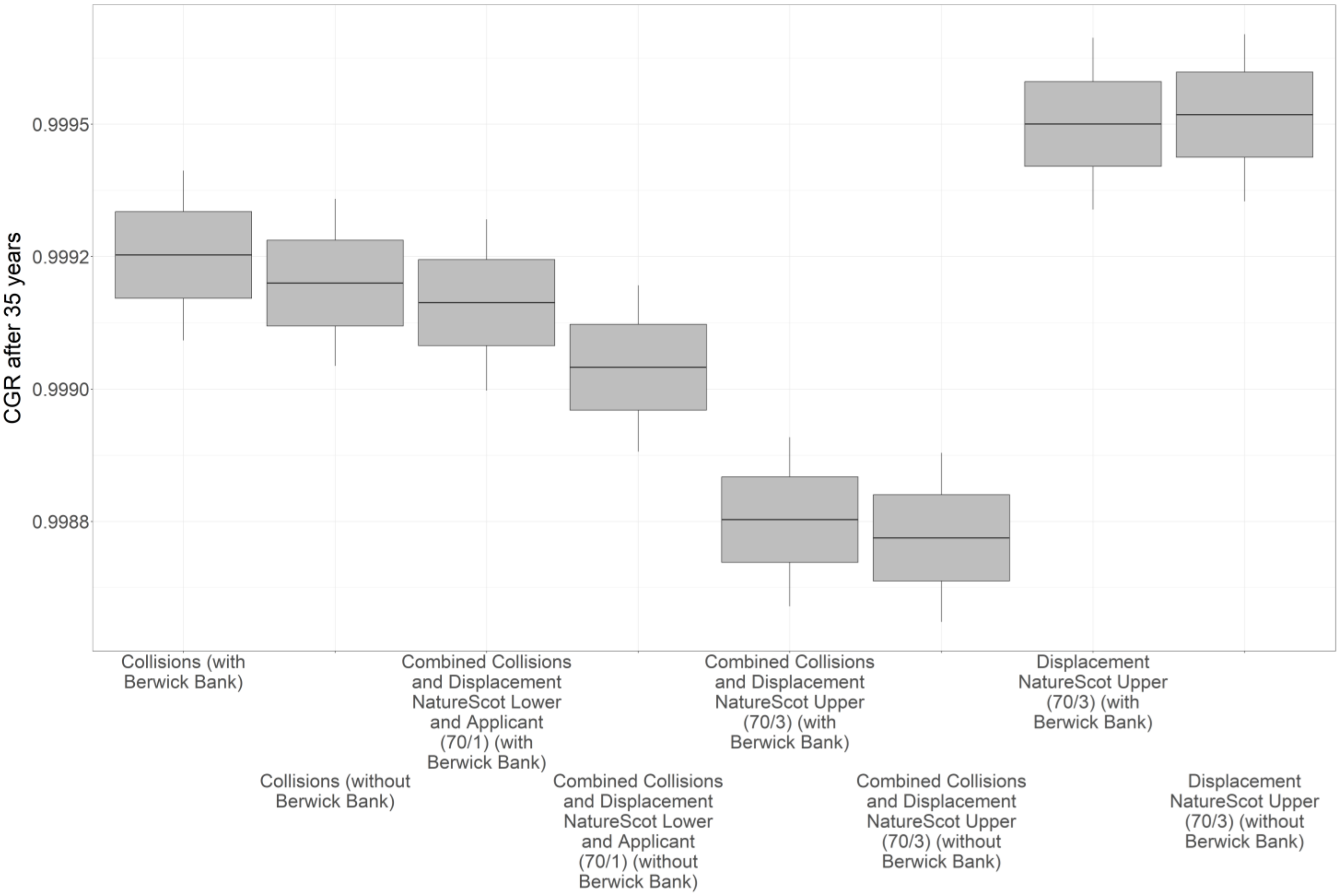


Plate 5-25 CGR for the Gannet Annual Population from the Simulations after 35 Years under the modelled impact scenarios

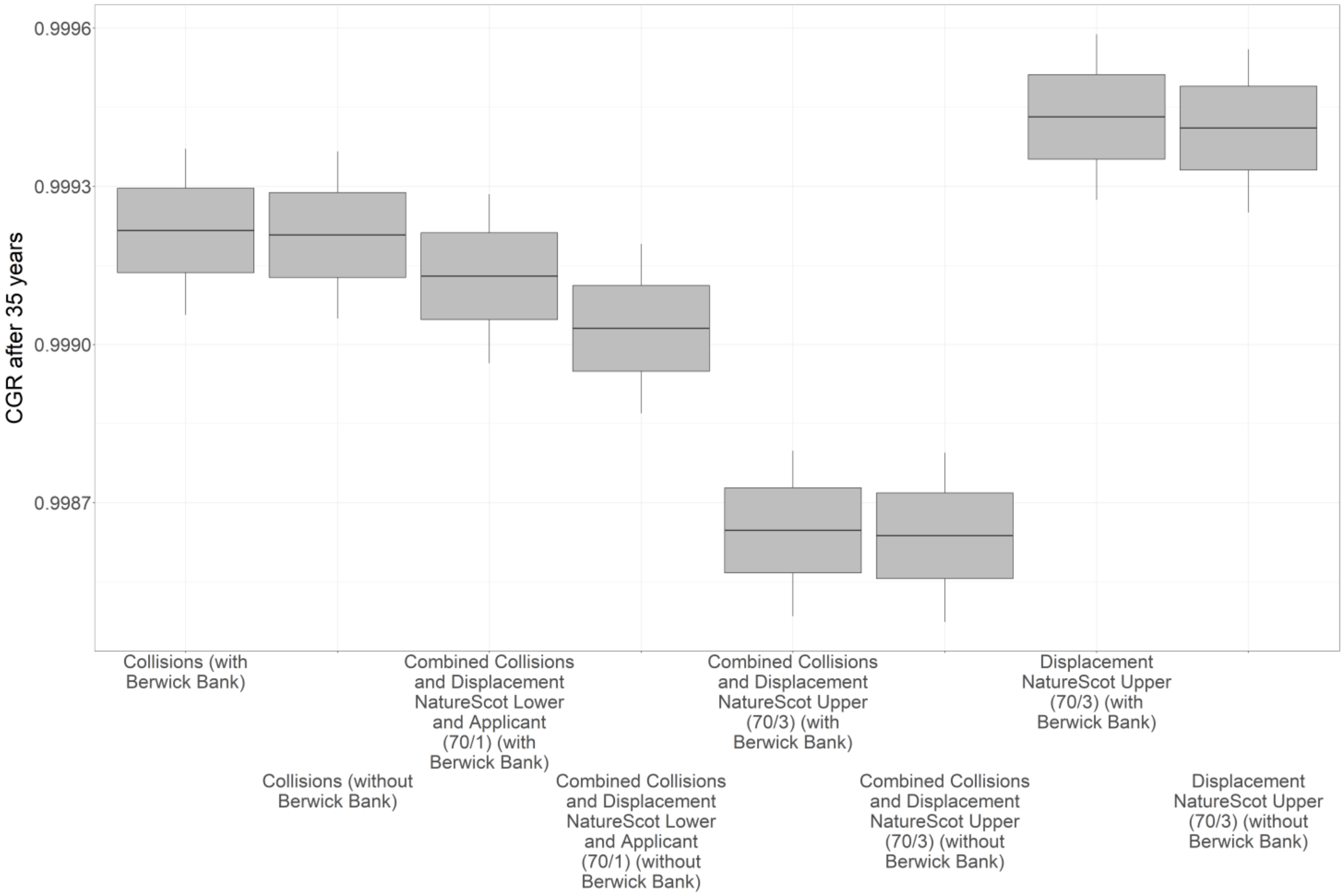


Plate 5-26 CPS for the Gannet Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenarios

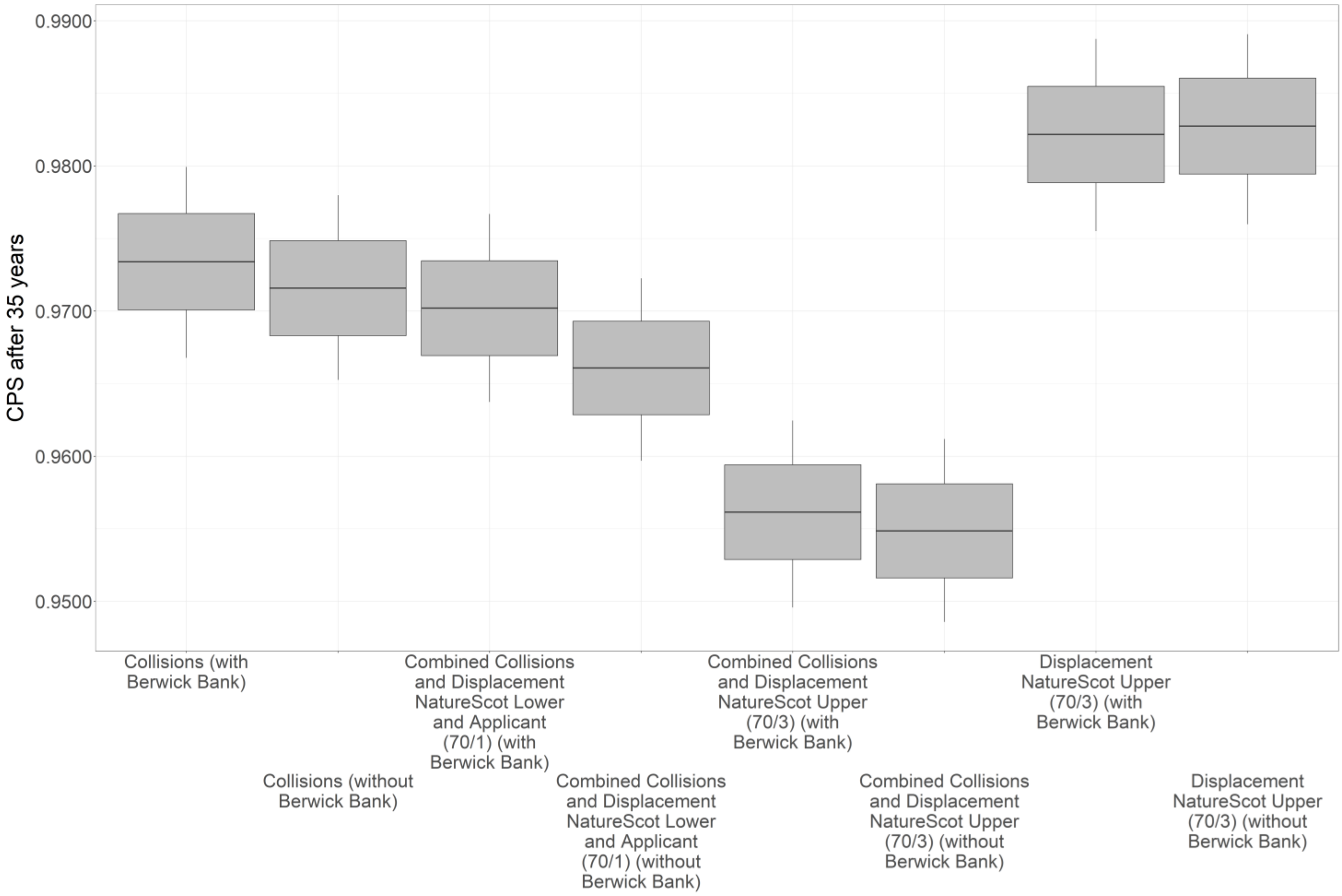
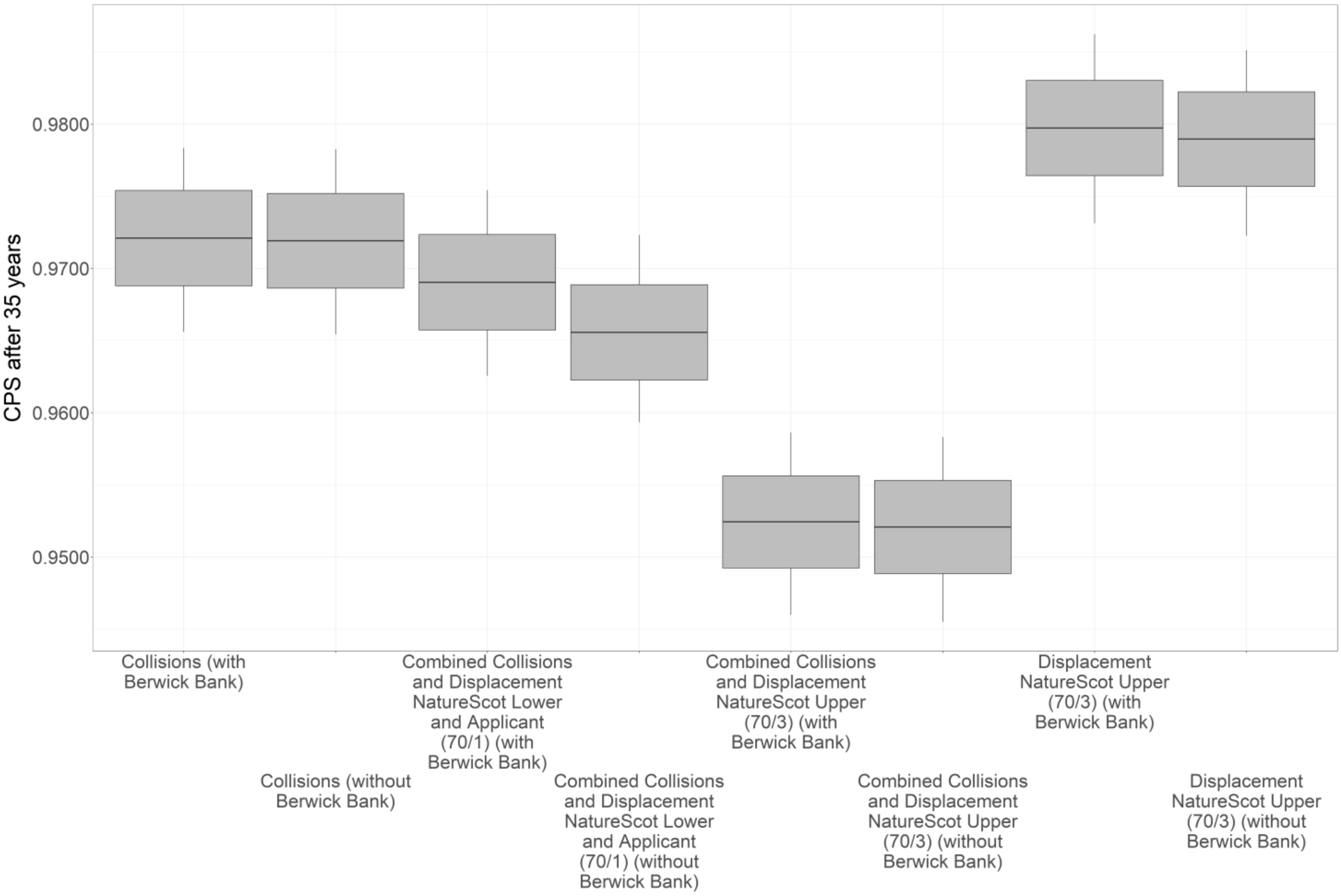


Plate 5-27 CPS for the Gannet Annual Population from the Simulations after 35 Years under the modelled impact scenarios.



5.2.6 GUILLEMOT

5.2.6.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the guillemot regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-6.

5.2.6.2 As part of NatureScot guidance (2023c), impact scenario graphs for the expected lifespan of the project (35 years) are to be presented. As such, the population size graph is shown in Plate 5-28 for annual results. Plate 5-29 shows the CGR values and Plate 5-30 shows the CPS values.

Table 5-6 Guillemot 35 Year Cumulative PVA Results

Season	Impact Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Annual	Baseline	0	1.0254	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/5/3)	62.43	1.0251	0.9997	0.9911	0.03	0.89	48.14	52.38

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Plate 5-28 Guillemot Annual Population Projection over 35-50 years under the modelled impact scenario..

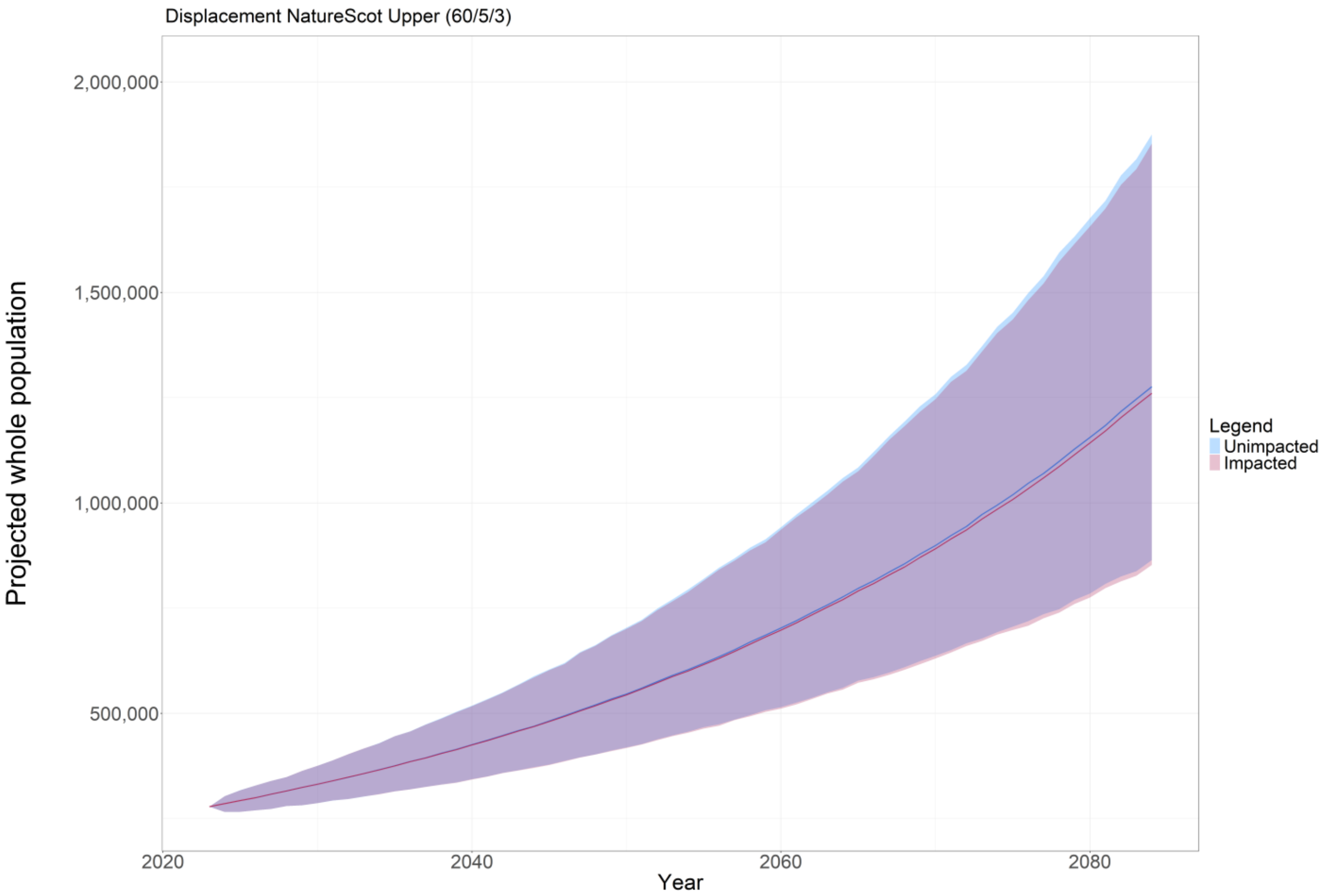


Plate 5-29 CGR after 35 Years for the Guillemot Annual Population under the modelled impact scenario.

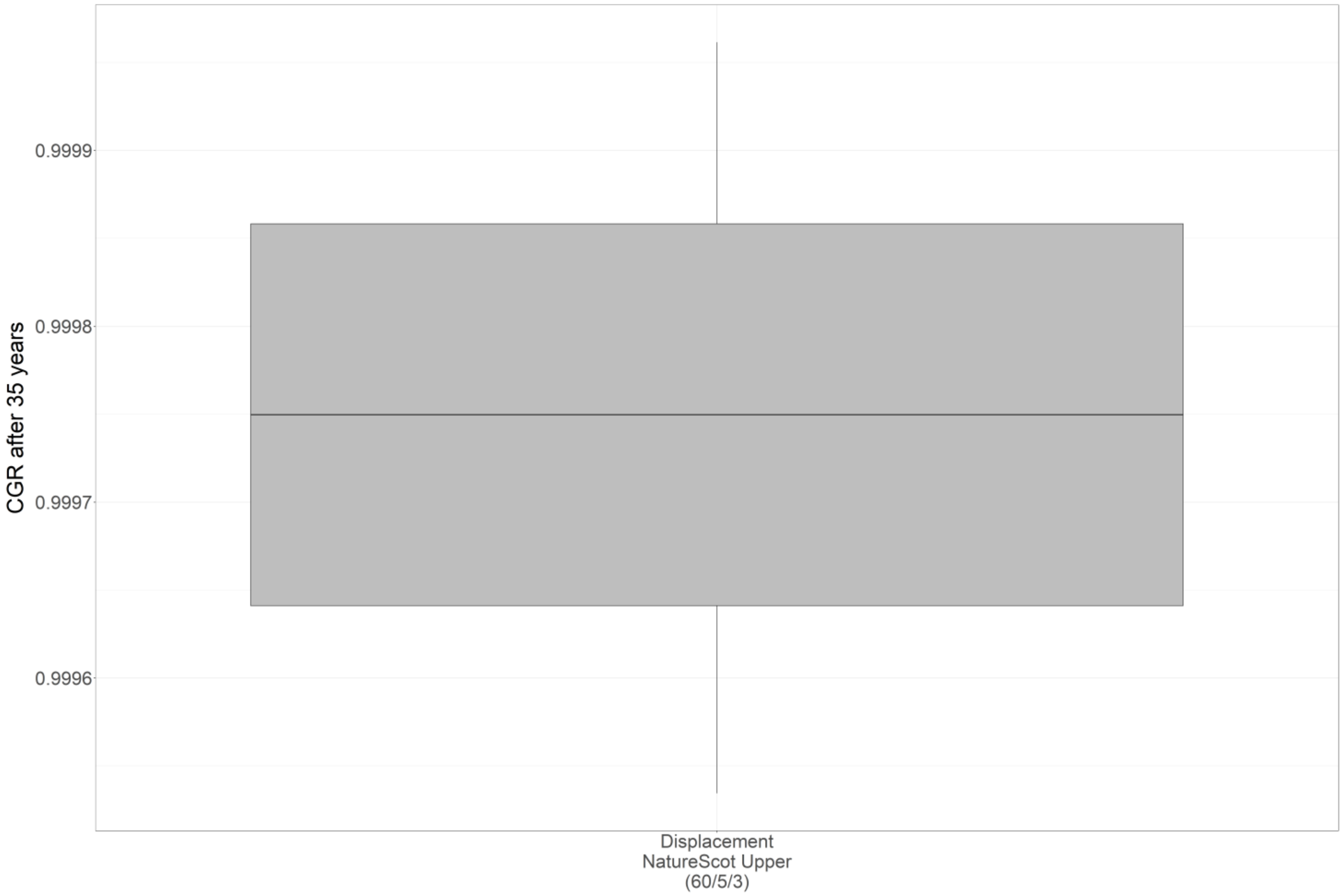
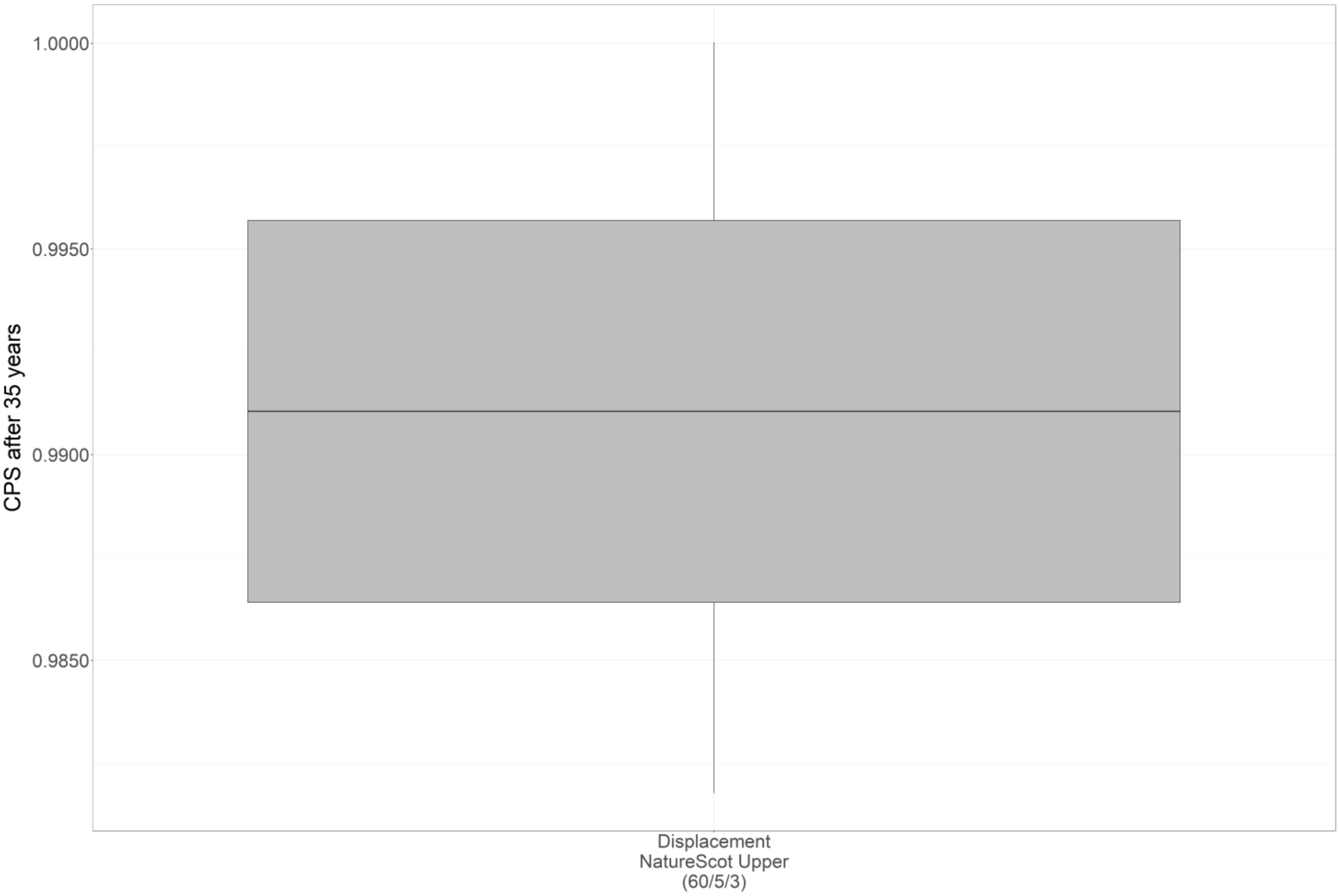


Plate 5-30 CPS for the Guillemot Annual Population from the Simulations after 35 Years under the modelled impact scenario.



5.2.7 RAZORBILL

5.2.7.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the razorbill regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-7.

5.2.7.2 As part of NatureScot guidance (2023c), 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 Plate 5-31 for the breeding season, Plate 5-32 for the non-breeding season, Plate 5-33 for the post-breeding season and Plate 5-34 for annually. Plate 5-35 shows the CGR values for the breeding season, Plate 5-36 for the non-breeding season, Plate 5-37 for the post-breeding season and Plate 5-38 for annually. Plate 5-39 shows the CPS values for the breeding season, Plate 5-40 for the non-breeding season, Plate 5-41 for the post-breeding season and Plate 5-42 for annually.

Table 5-7 Razorbill 35 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9765	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/5)	12.30	0.9763	0.9997	0.9905	0.03	0.95	49.08	50.86
Non-breeding	Baseline	0	0.9765	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/3)	152.35	0.9760	0.9995	0.9812	0.05	1.88	48.06	51.94
Post-breeding	Baseline	0	0.9763	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/3)	125.45	0.9763	0.9998	0.9914	0.02	0.86	49.28	50.84
Annual	Baseline	0	0.9765	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Lower (60/3/1)	145.03	0.9763	0.9997	0.9898	0.03	1.02	49.18	50.88
	Displacement NatureScot Upper (60/5/3)	409.60	0.9758	0.9992	0.9717	0.08	2.83	47.24	52.44

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Plate 5-31 Razorbill Population Projection over 35-50 years during the Breeding Season under the modelled impact scenario.

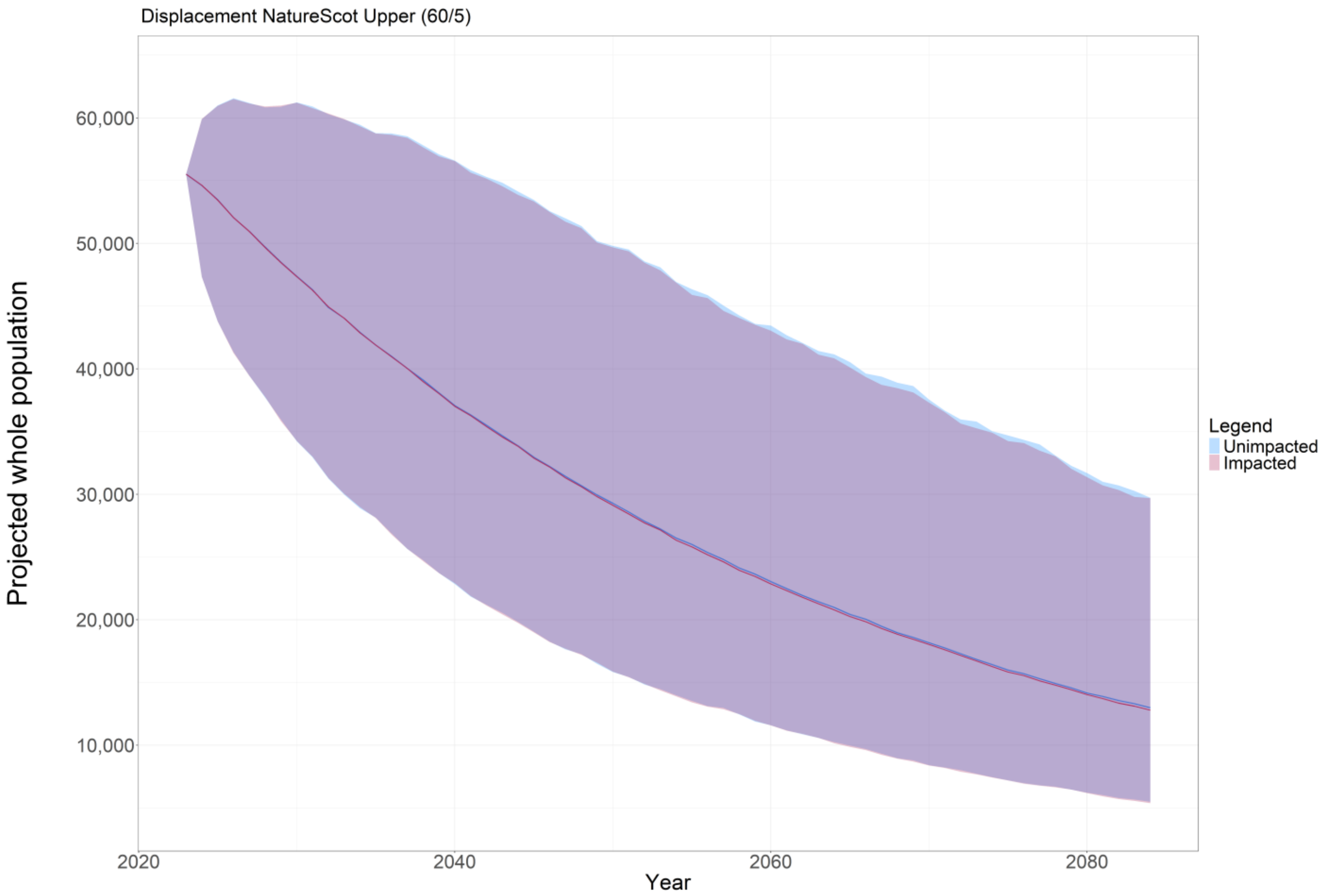


Plate 5-32 Razorbill Population Projection over 35-50 years during the Non-Breeding Season under the modelled impact scenario.

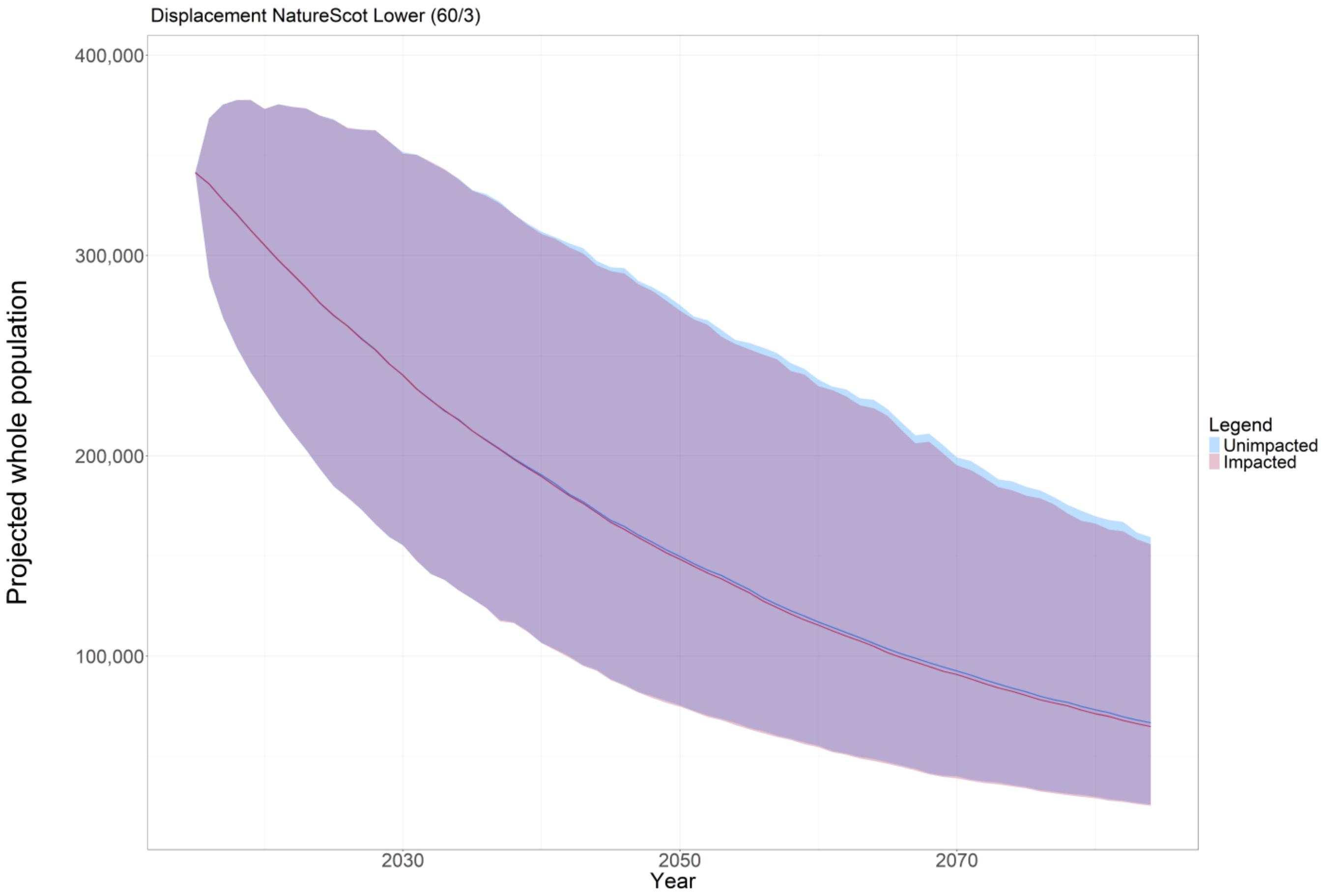


Plate 5-33 Razorbill Population Projection over 35-50 years during the Post-Breeding Season under the modelled impact scenario

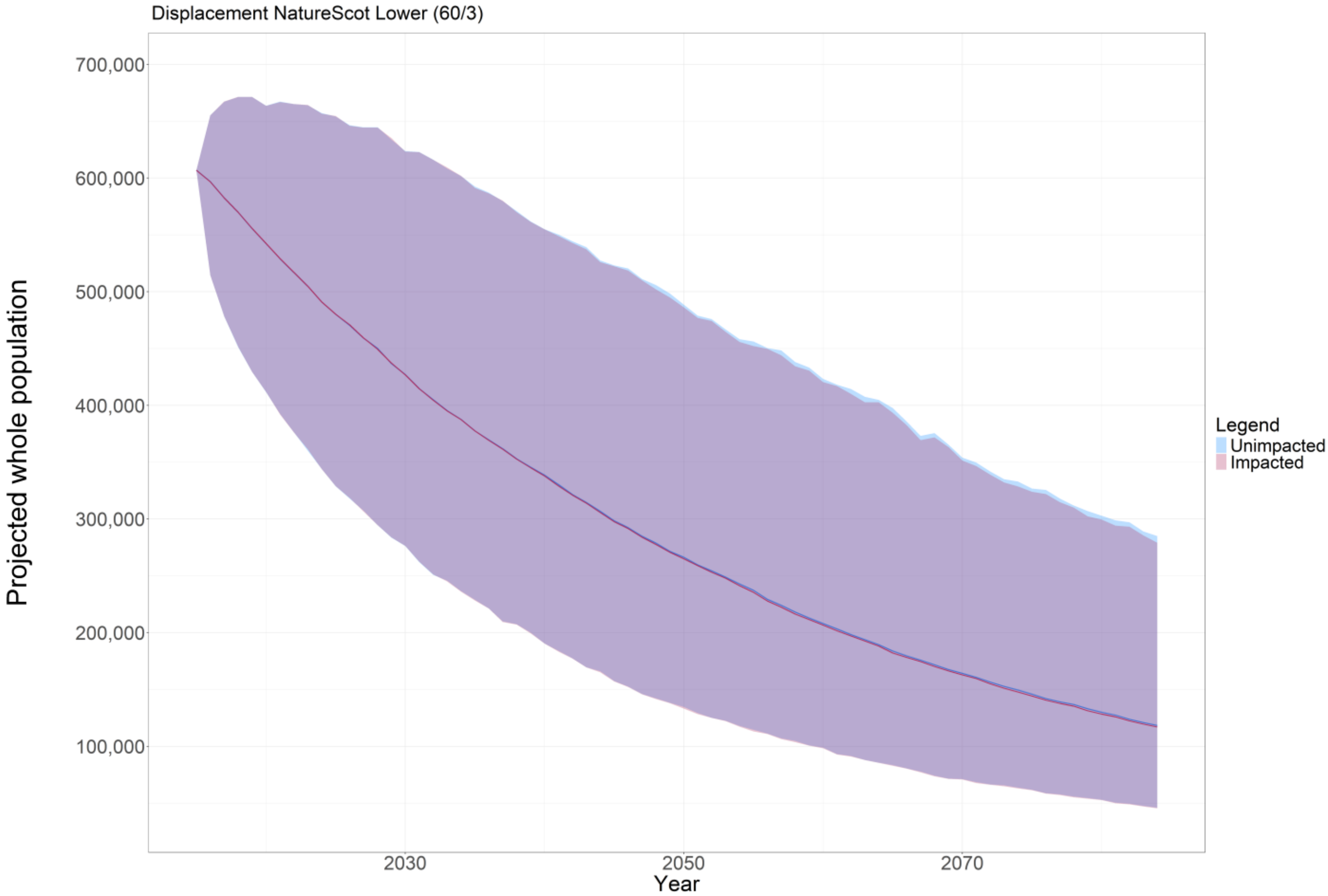


Plate 5-34 Razorbill Annual Population Projection over 35-50 years under the modelled impact scenarios

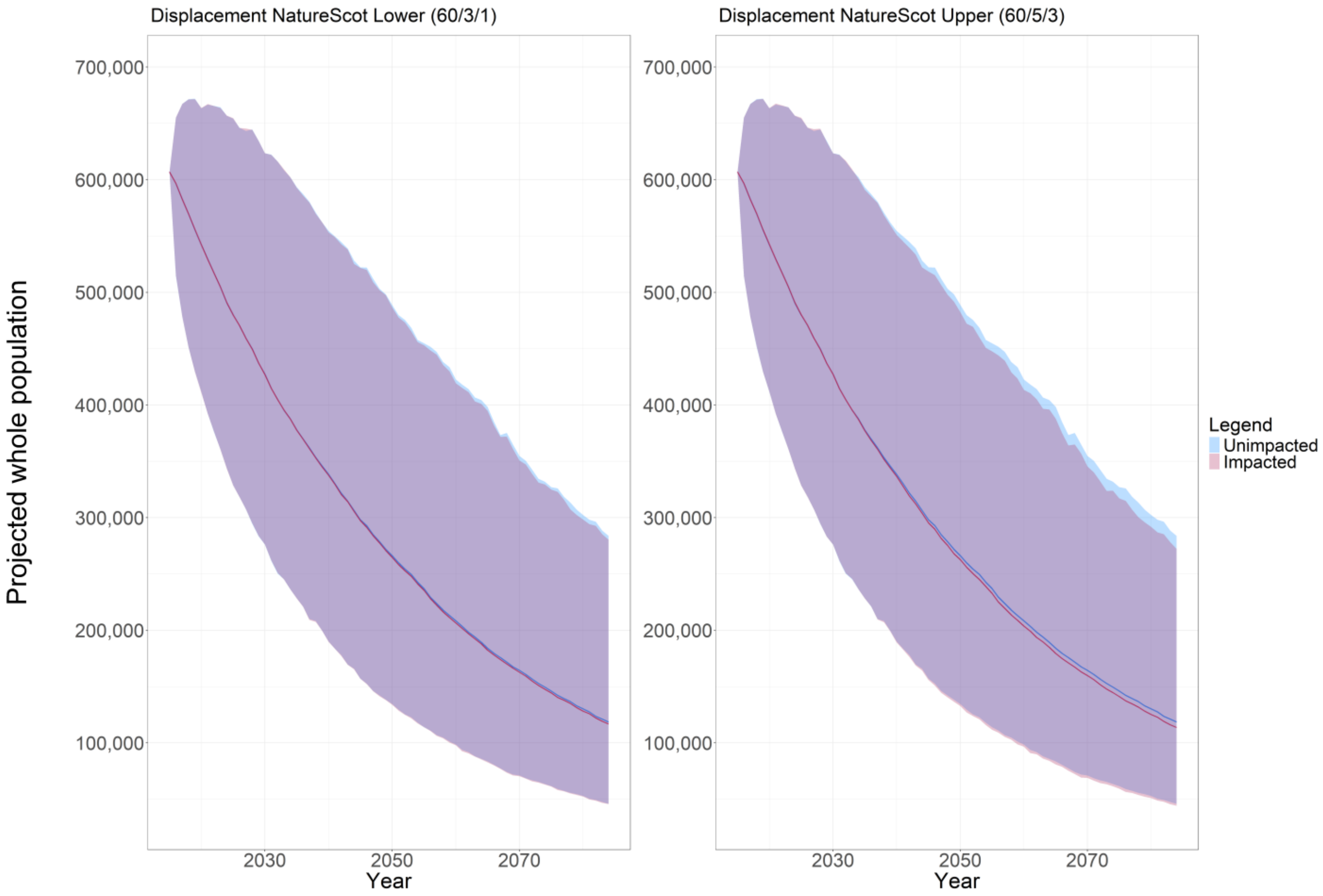


Plate 5-35 CGR after 35 Years for the Razorbill Population during the Breeding Season under the modelled impact scenario

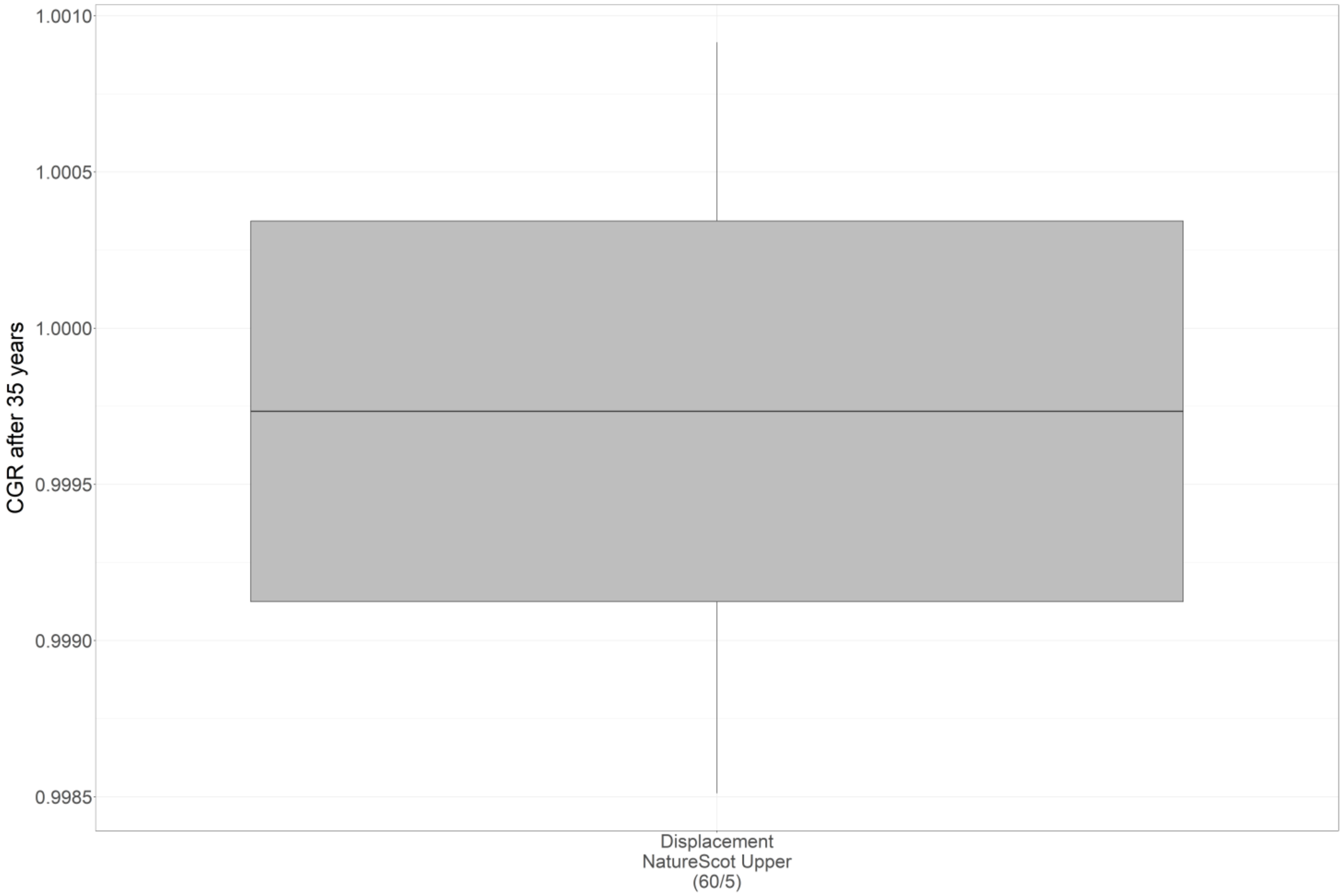


Plate 5-36 CGR after 35 Years for the Razorbill Population during the Non-breeding Season under the modelled impact scenario

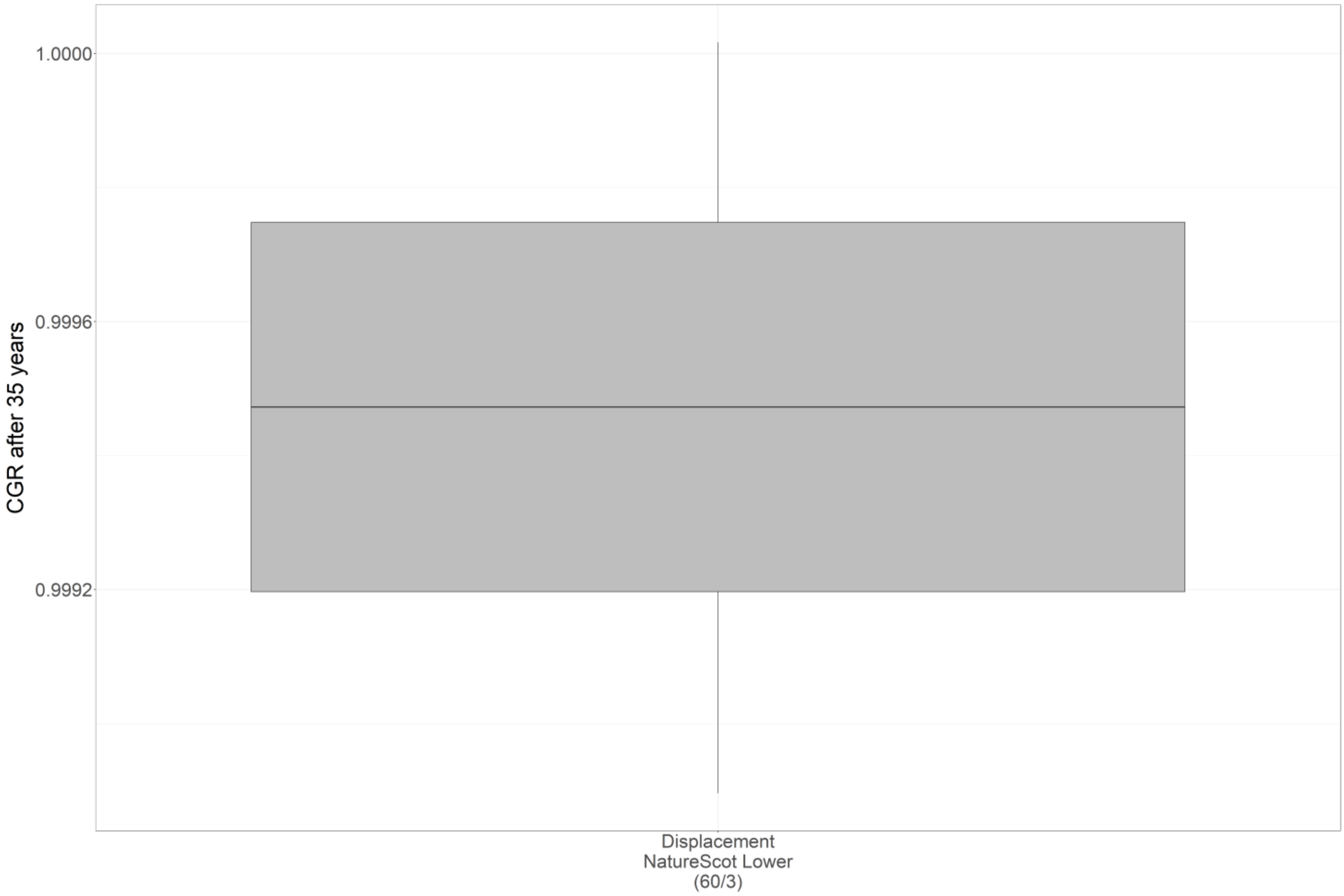


Plate 5-37 CGR after 35 Years for the Razorbill Population during the Post-breeding Season under the modelled impact scenario

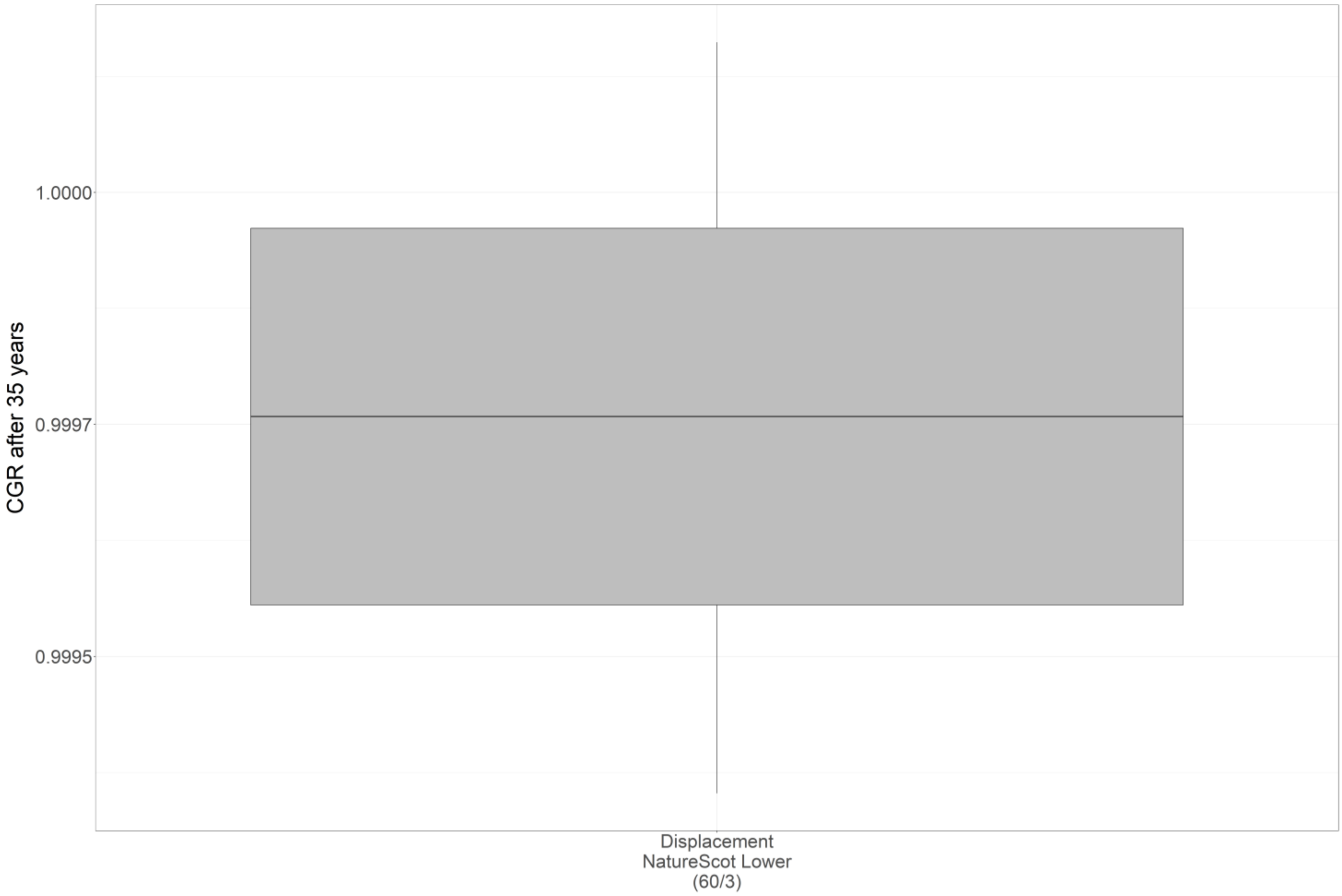


Plate 5-38 CGR after 35 Years for the Razorbill Annual Population under the modelled impact scenarios

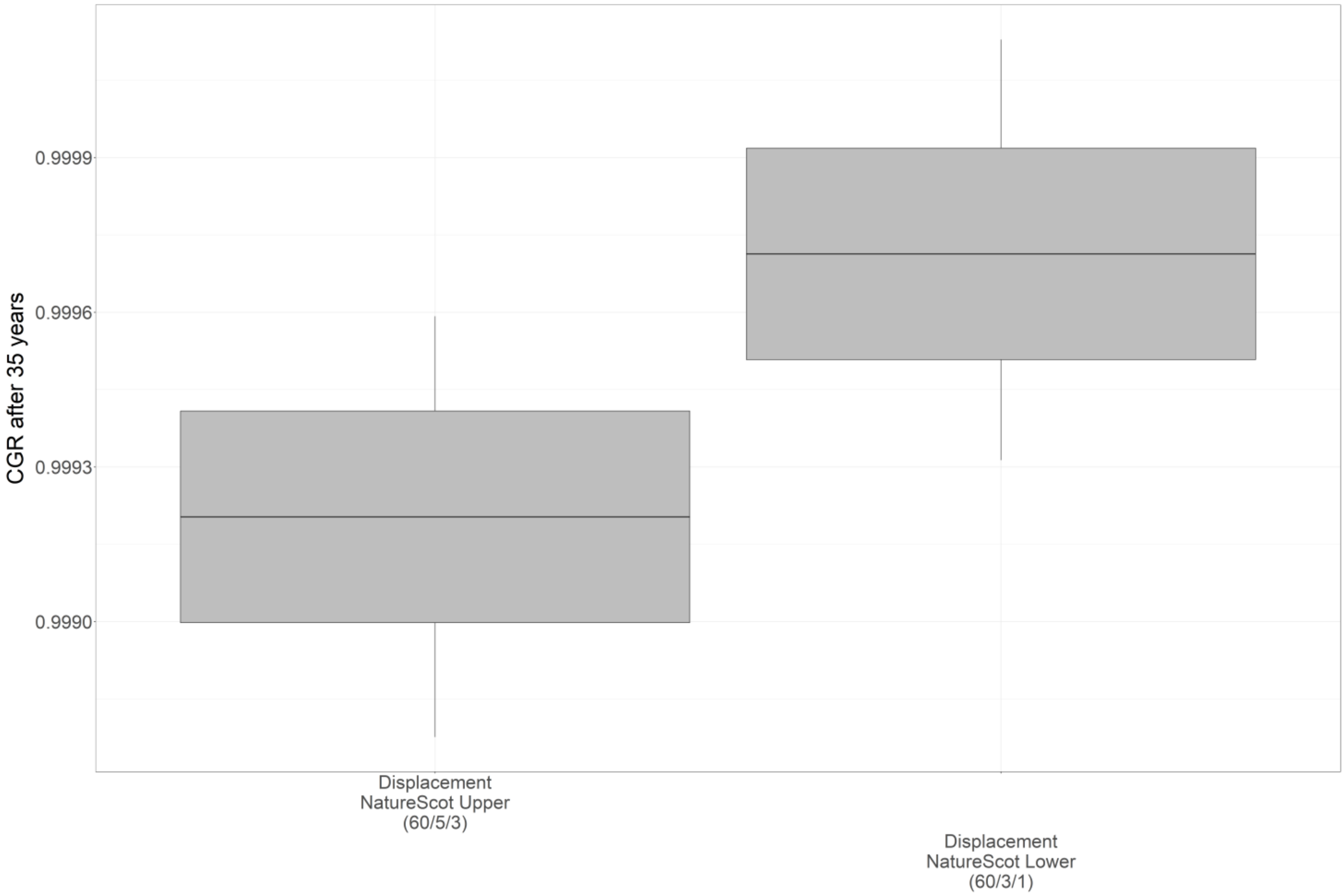


Plate 5-39 CPS for the Razorbill Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenario

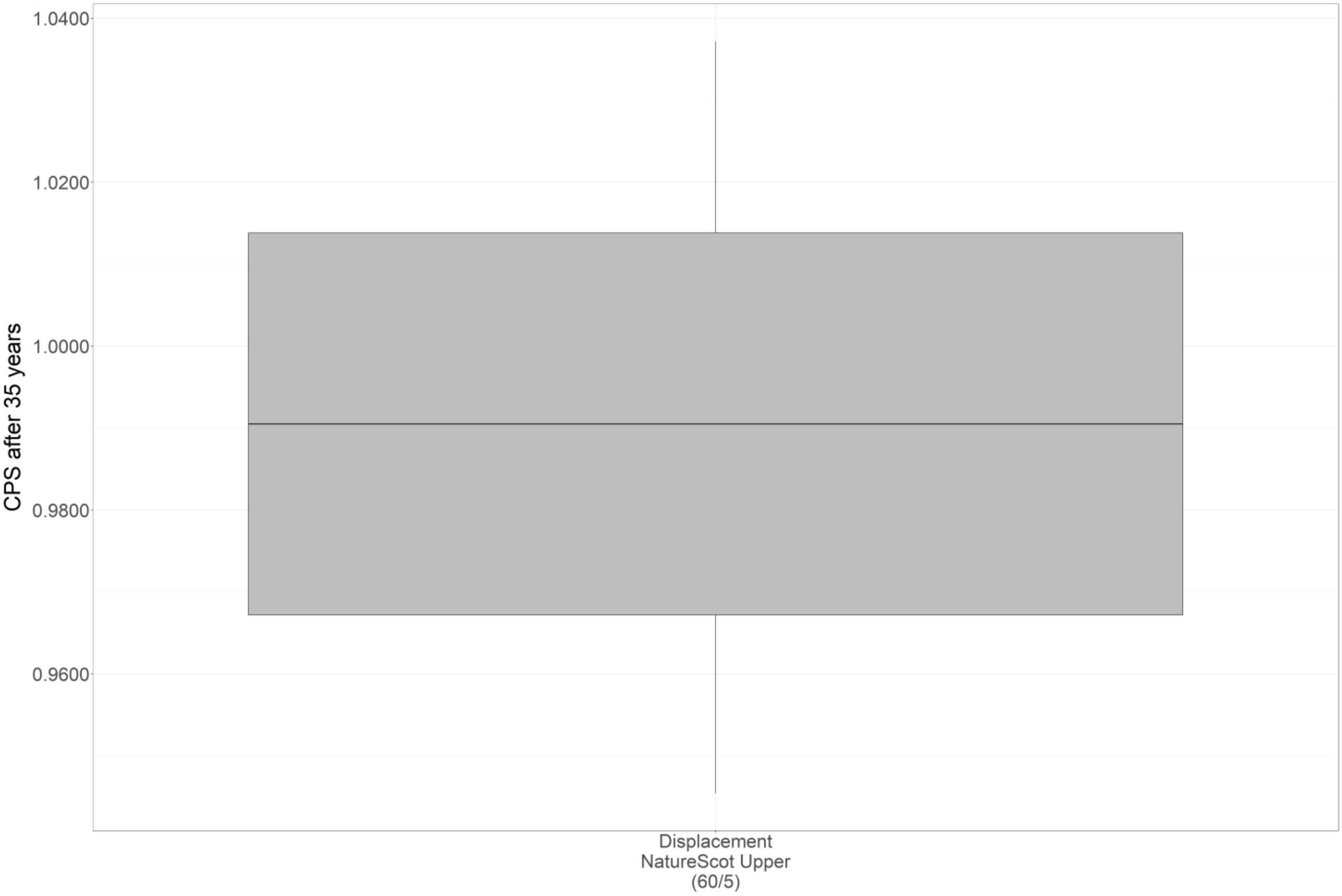


Plate 5-40 CPS for the Razorbill Population during the Non-breeding Season from the Simulations after 35 Years under the modelled impact scenario

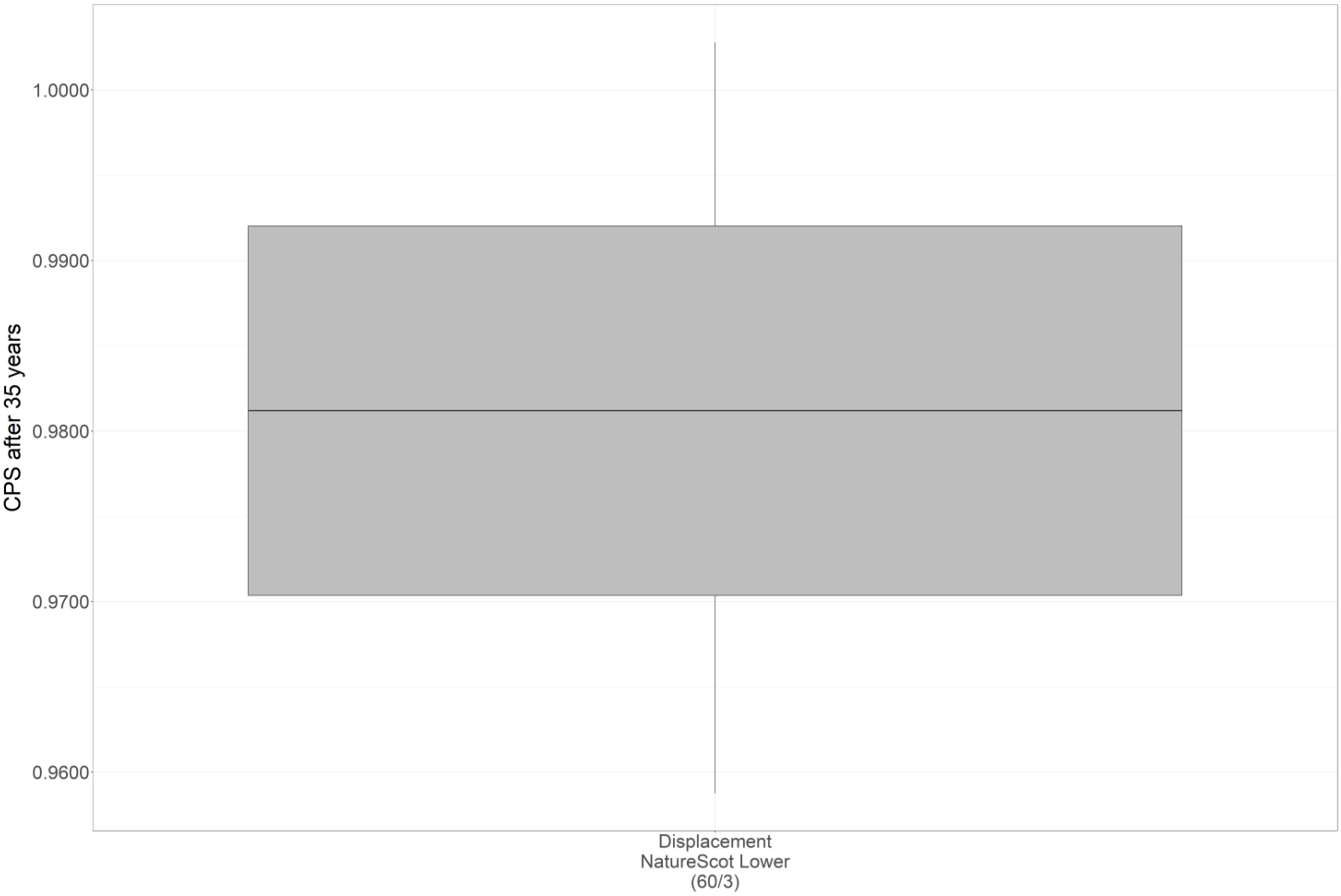


Plate 5-41 CPS for the Razorbill Population during the Post-breeding Season from the Simulations after 35 Years under the modelled impact scenario.

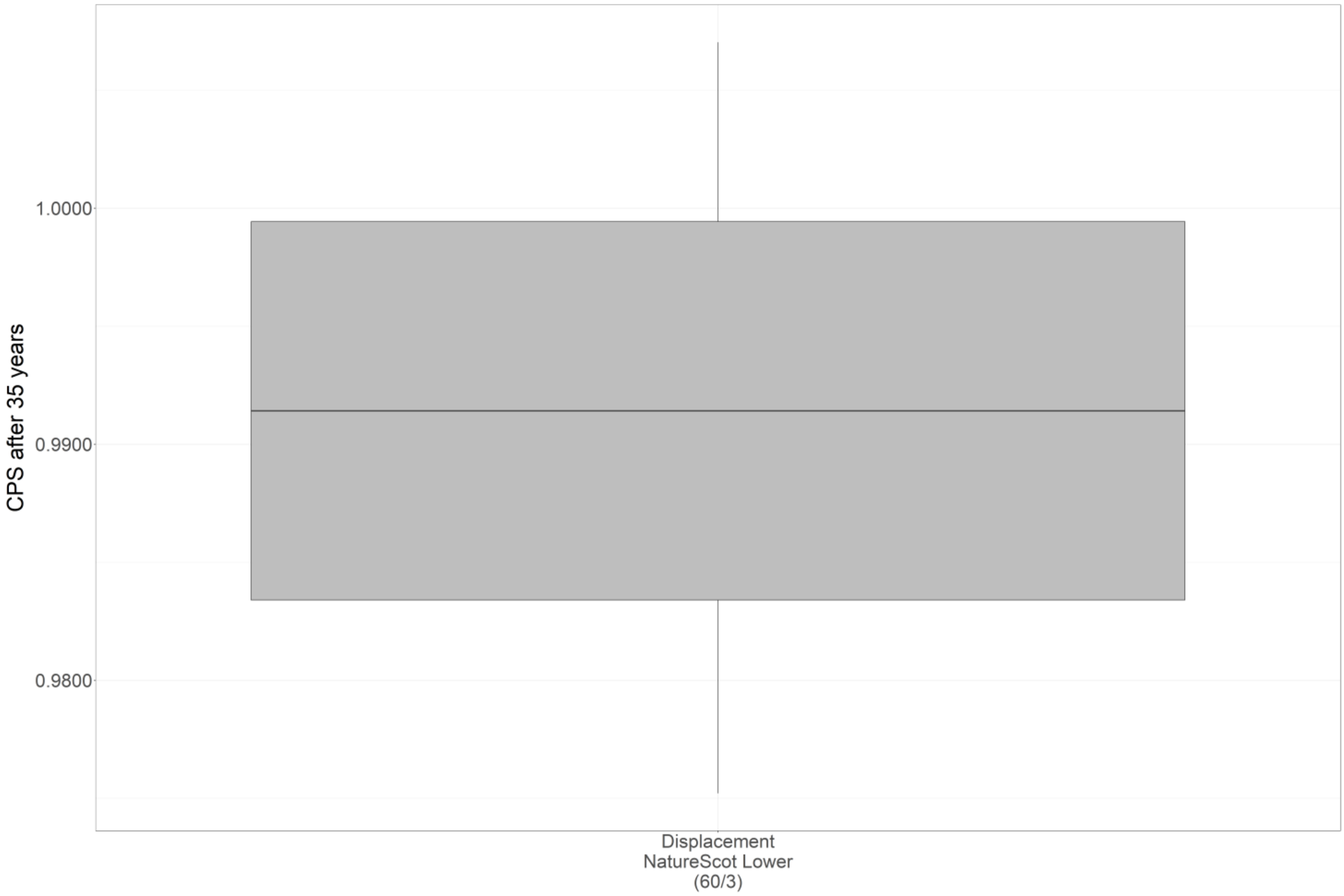
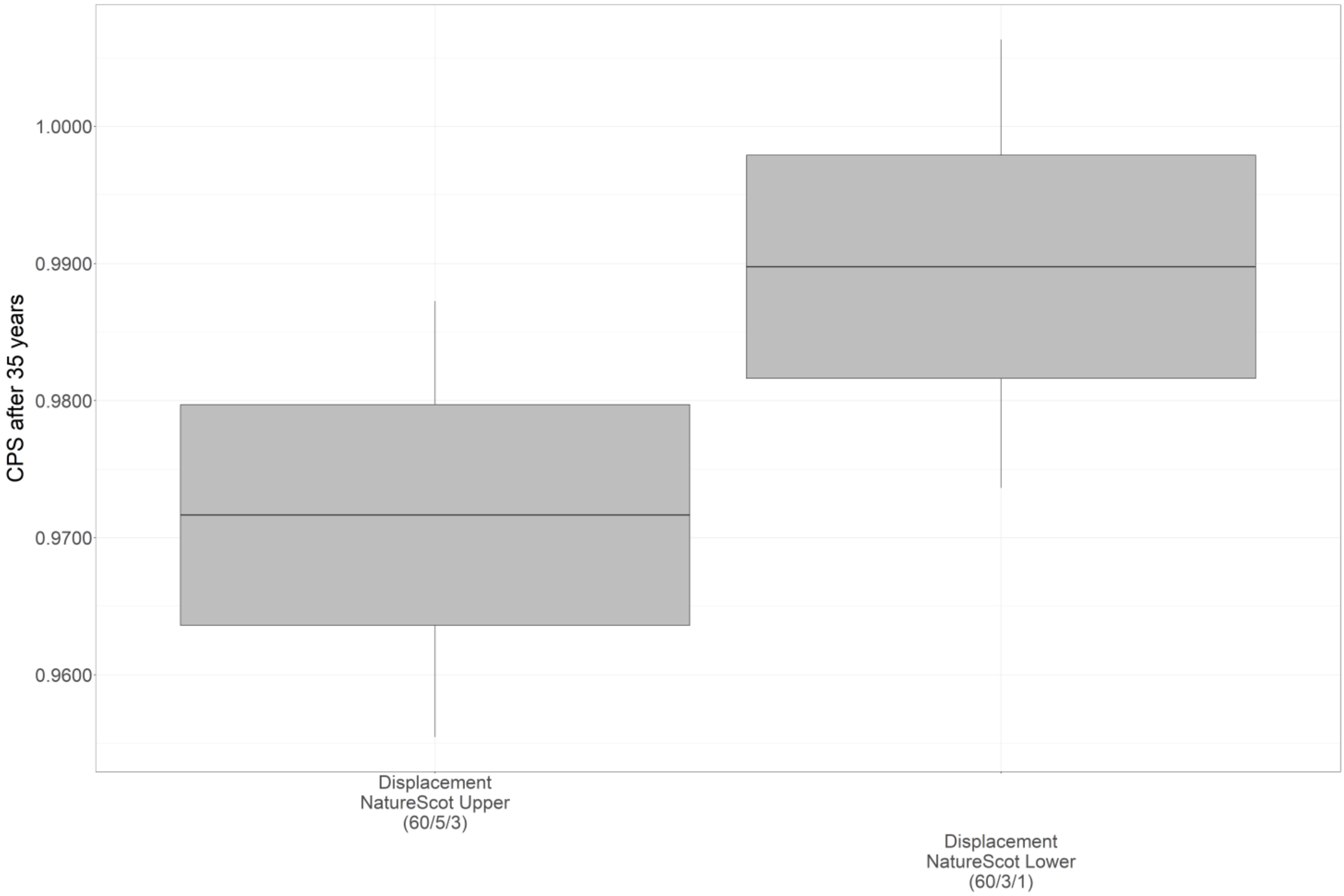


Plate 5-42 CPS for the Razorbill Annual Population from the Simulations after 35 Years under the modelled impact scenarios.



5.2.8 PUFFIN

5.2.8.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the puffin regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-8.

5.2.8.2 As part of NatureScot guidance (2023c), 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 Plate 5-43 for the breeding season, and Plate 5-44 for annually. Plate 5-45 show the CGR values for the breeding season, and Plate 5-46 for annually. Plate 5-47 show the CPS values for the breeding season, and Plate 5-48 for annually.

Table 5-8 Puffin 35 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9720	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Lower (60/3)	441.69	0.9716	0.9996	0.9844	0.04	1.56	49.02	51.12
	Displacement NatureScot Upper (60/5)	736.15	0.9713	0.9993	0.9743	0.07	2.57	48.08	52.34
Annual	Baseline	0	0.9720	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Lower (60/3/1)	454.14	0.9716	0.9996	0.9840	0.04	1.60	49.04	51.30
	Displacement NatureScot Upper (60/5/3)	793.08	0.9713	0.9992	0.9722	0.08	2.78	47.92	52.44

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Plate 5-43 Puffin Population Projection over 35-50 years during the Breeding Season under the modelled impact scenarios.

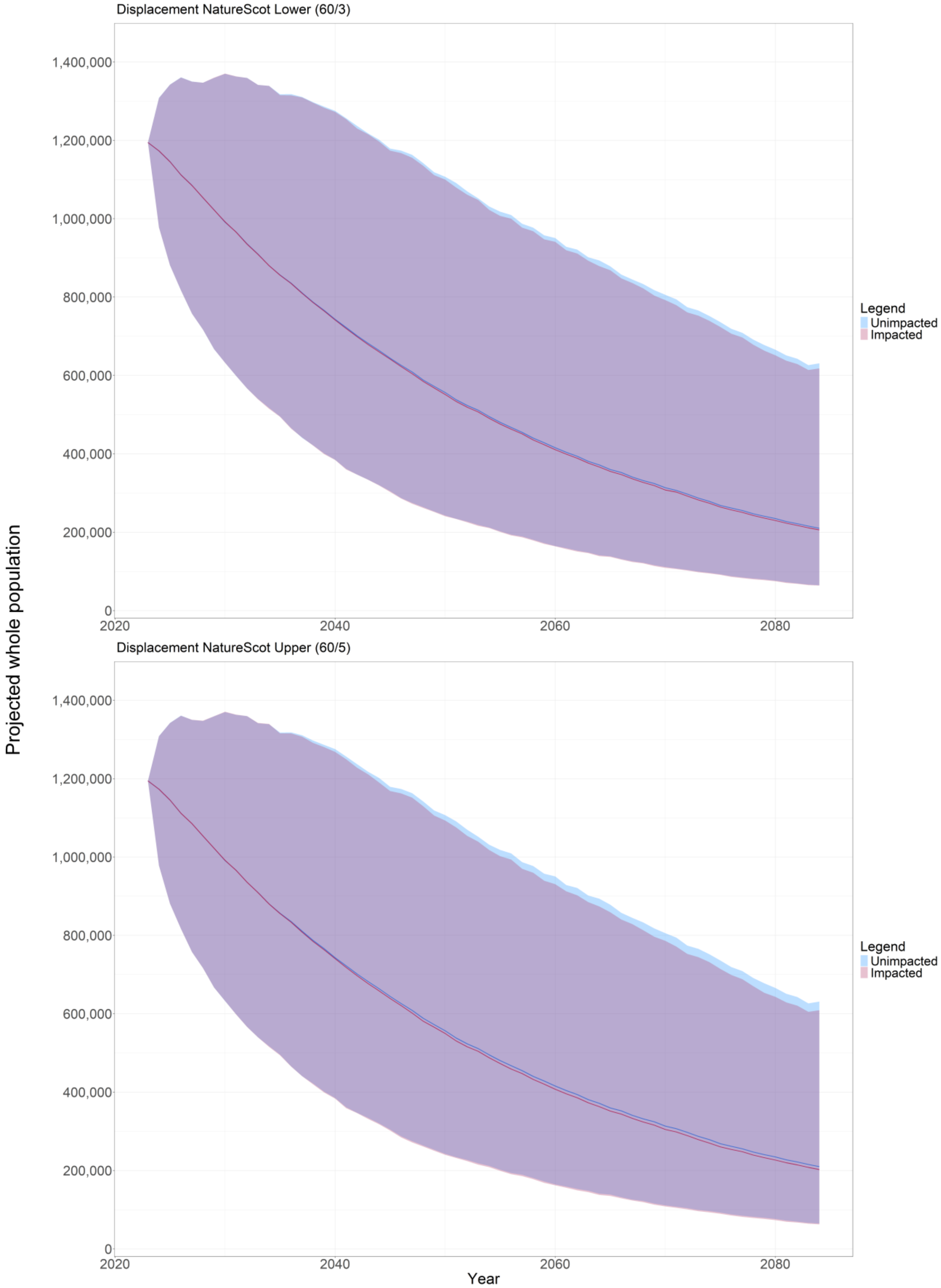


Plate 5-44 Puffin Annual Population Projection over 35-50 years under the modelled impact scenarios.

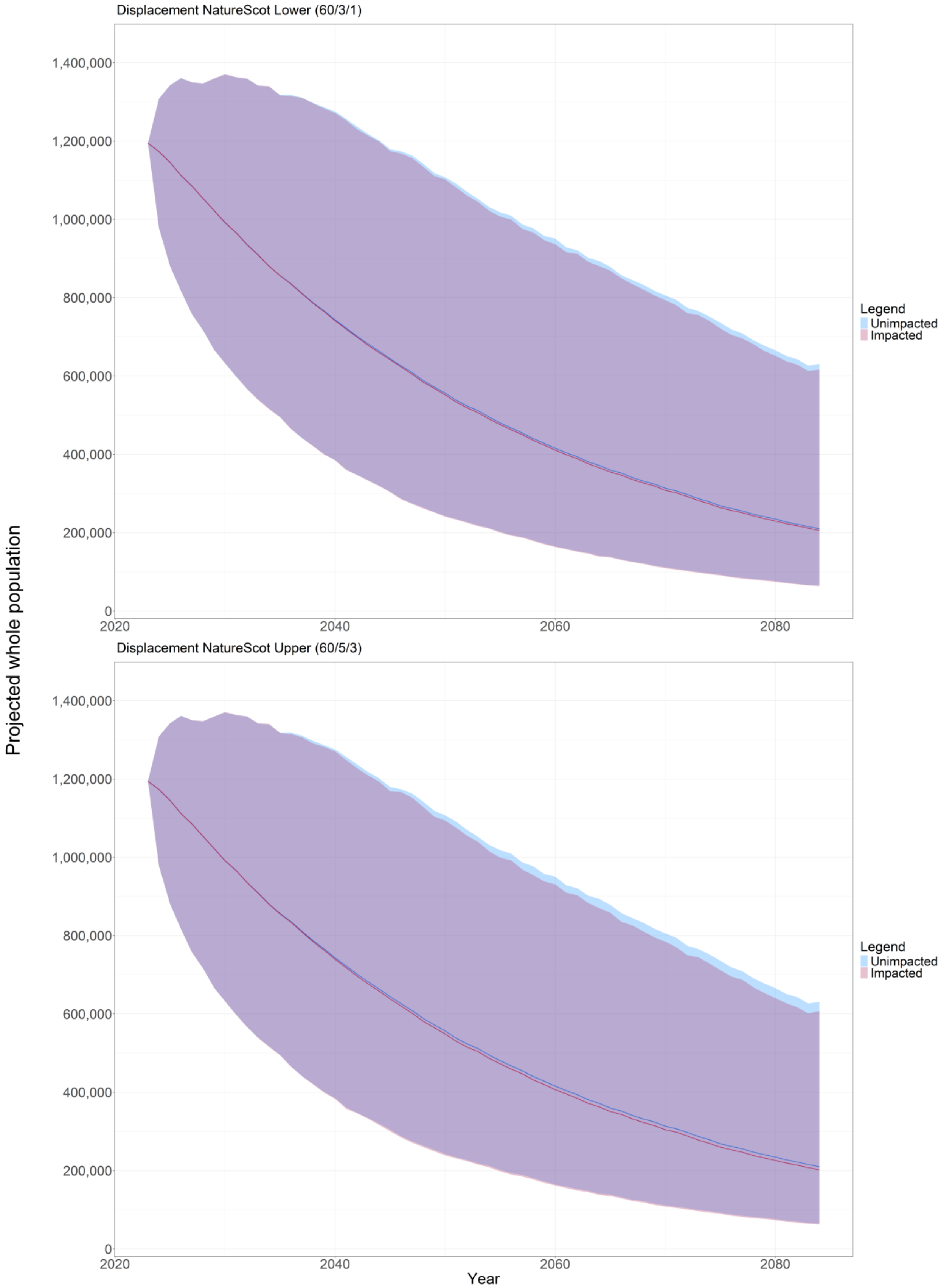


Plate 5-45 CGR after 35 Years for the Puffin Population during the Breeding Season under the modelled impact scenarios.

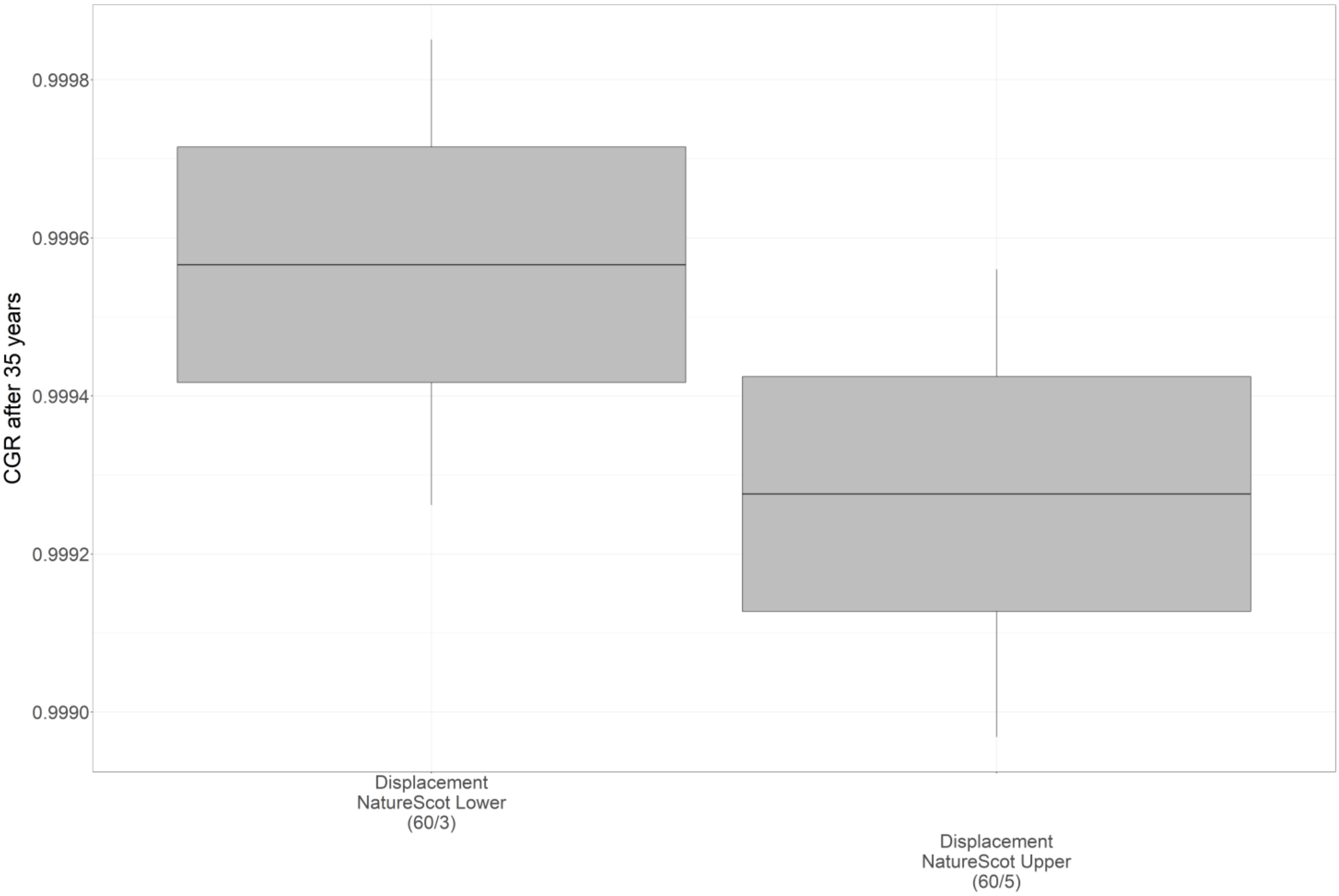


Plate 5-46 CGR after 35 Years for the Puffin Annual Population under the modelled impact scenarios.

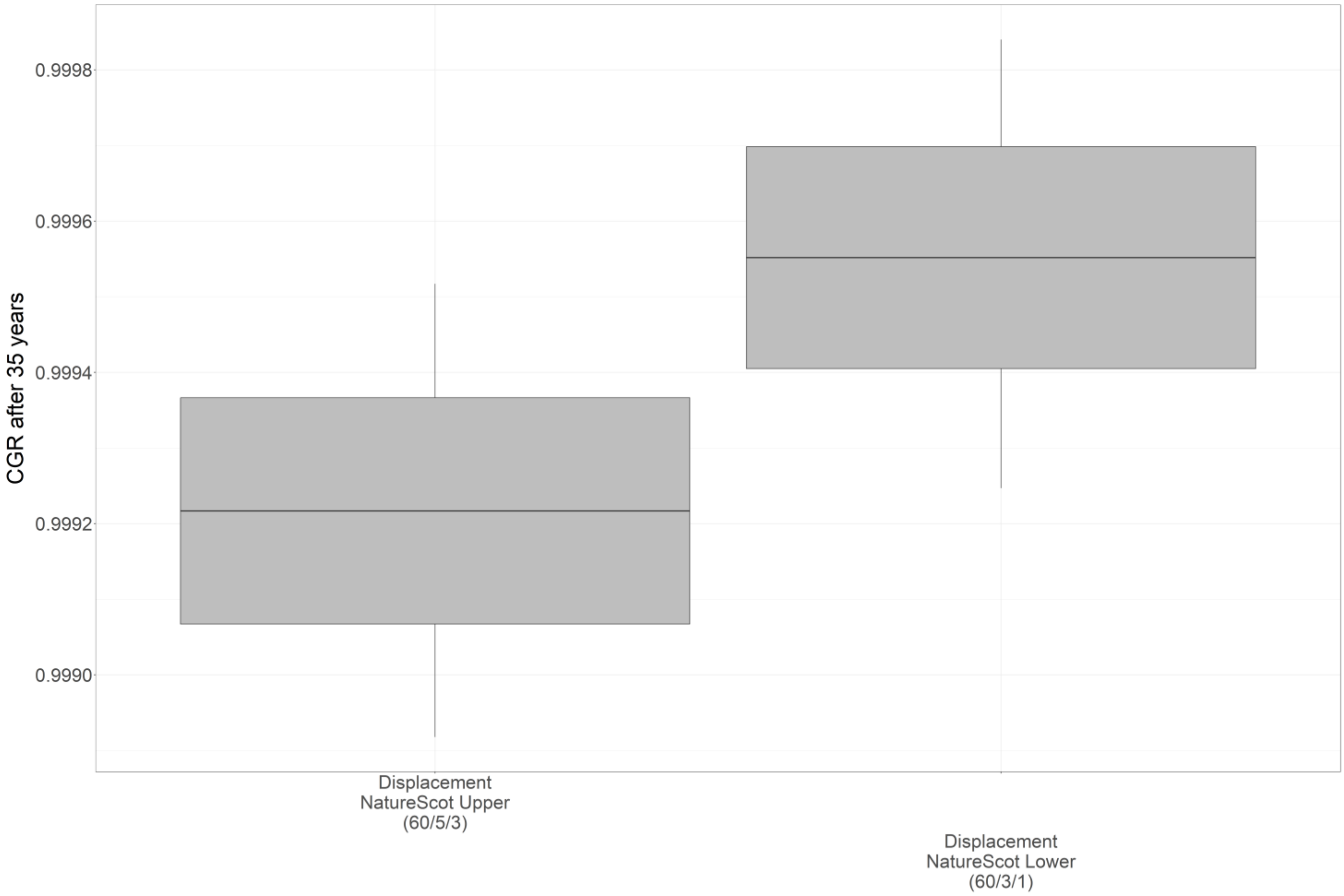


Plate 5-47 CPS for the Puffin Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenarios.

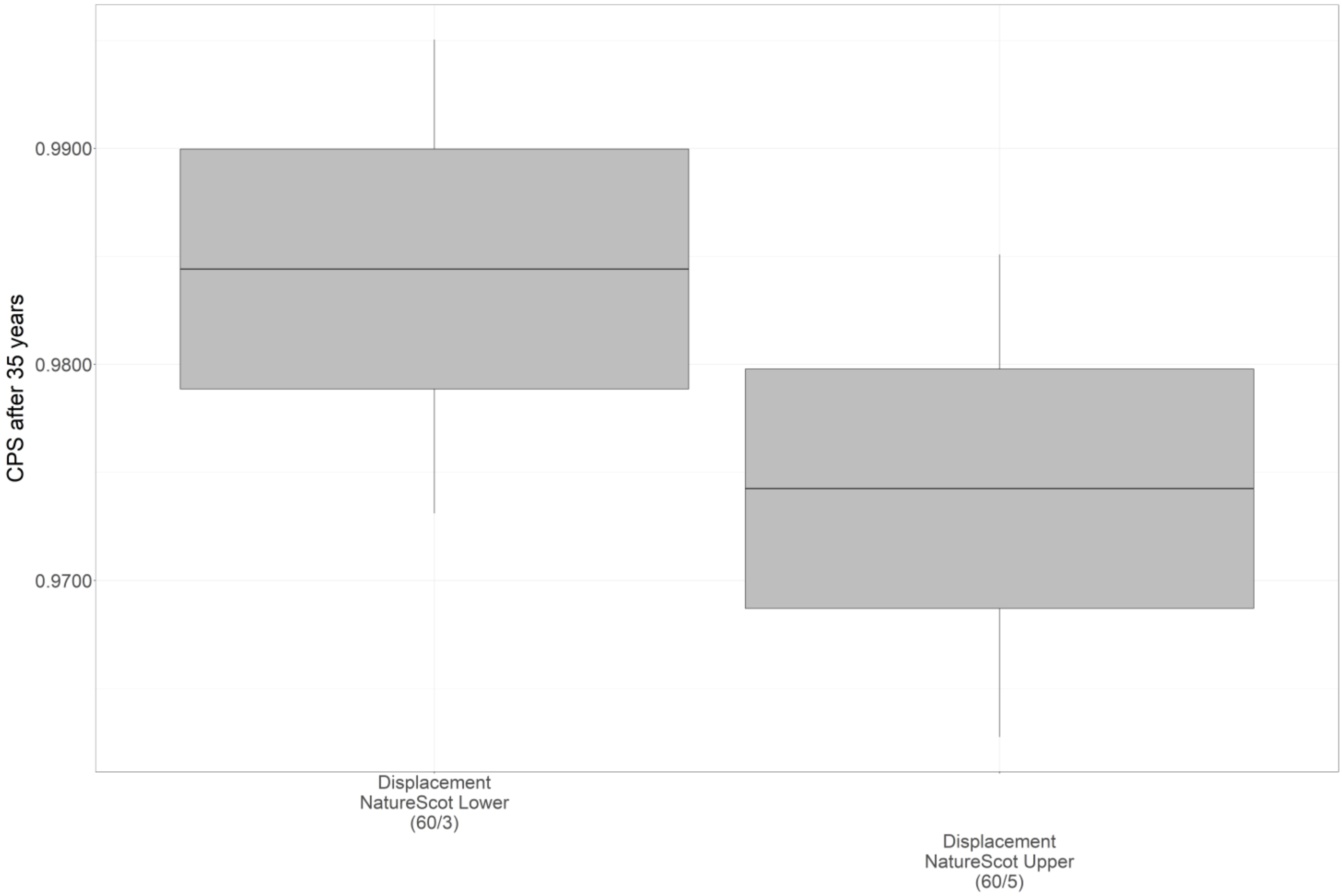
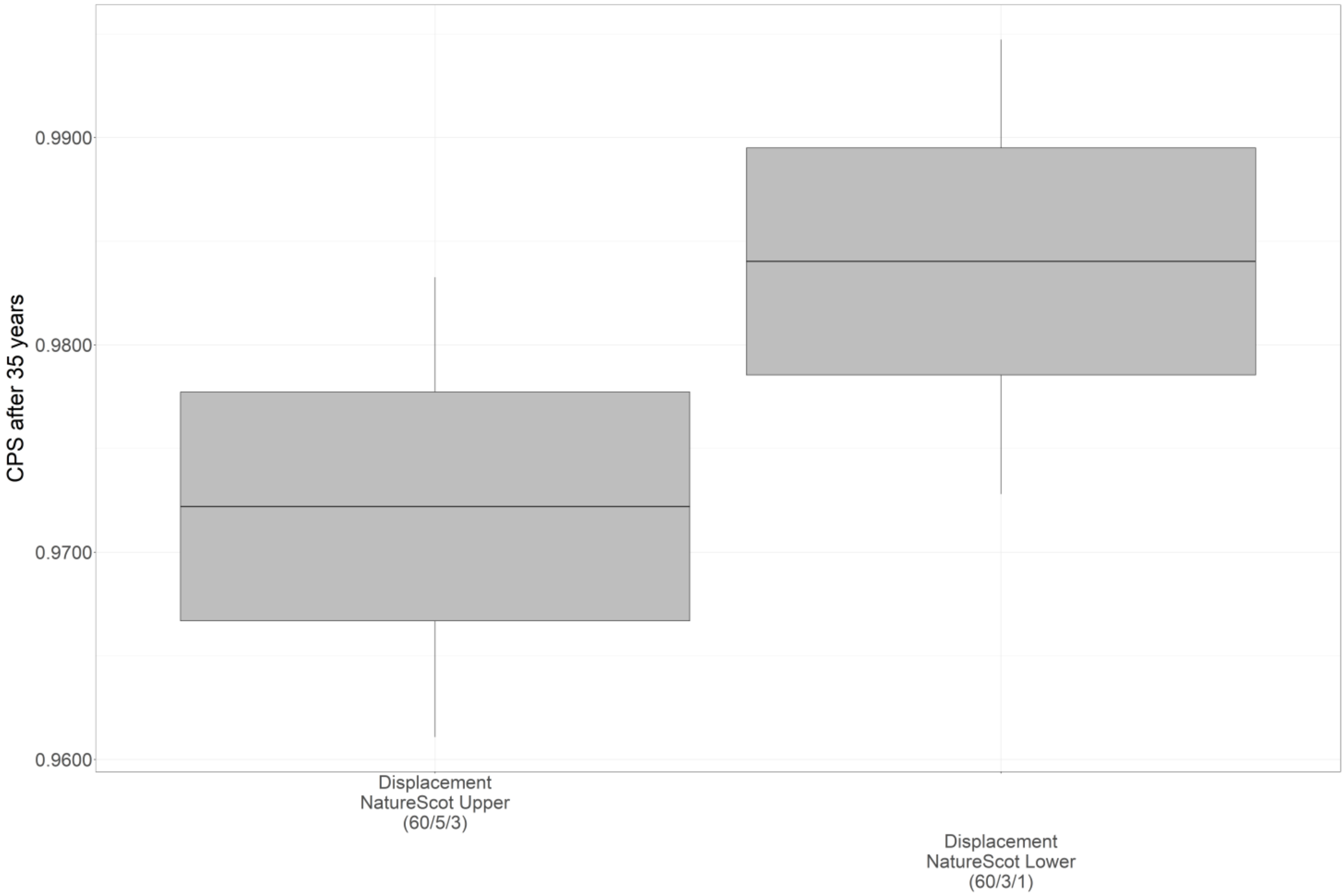


Plate 5-48 CPS for the Puffin Annual Population from the Simulations after 35 Years under the modelled impact scenarios.



5.2.9 RED-THROATED DIVER

5.2.9.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the red-throated diver regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-9.

5.2.9.2 As part of NatureScot guidance (2023c), 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 Plate 5-49 for the breeding season, and Plate 5-50 for annually. Plate 5-51 show the CGR values for the breeding season, and Plate 5-52 for annually. Plate 5-53 show the CPS values for the breeding season, and Plate 5-54 for annually.

Table 5-9 Red-Throated Diver 35 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9732	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot and Applicant (100/10)	0.40	0.9715	0.9981	0.9365	0.19	6.35	46.42	55.00
Annual	Baseline	0	0.9741	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot and Applicant (100/10)	1.76	0.9741	0.9995	0.9798	0.05	2.02	48.40	51.52

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Plate 5-49 Red-throated Diver Population Projection over 35-50 years during the Breeding Season under the modelled impact scenarios.

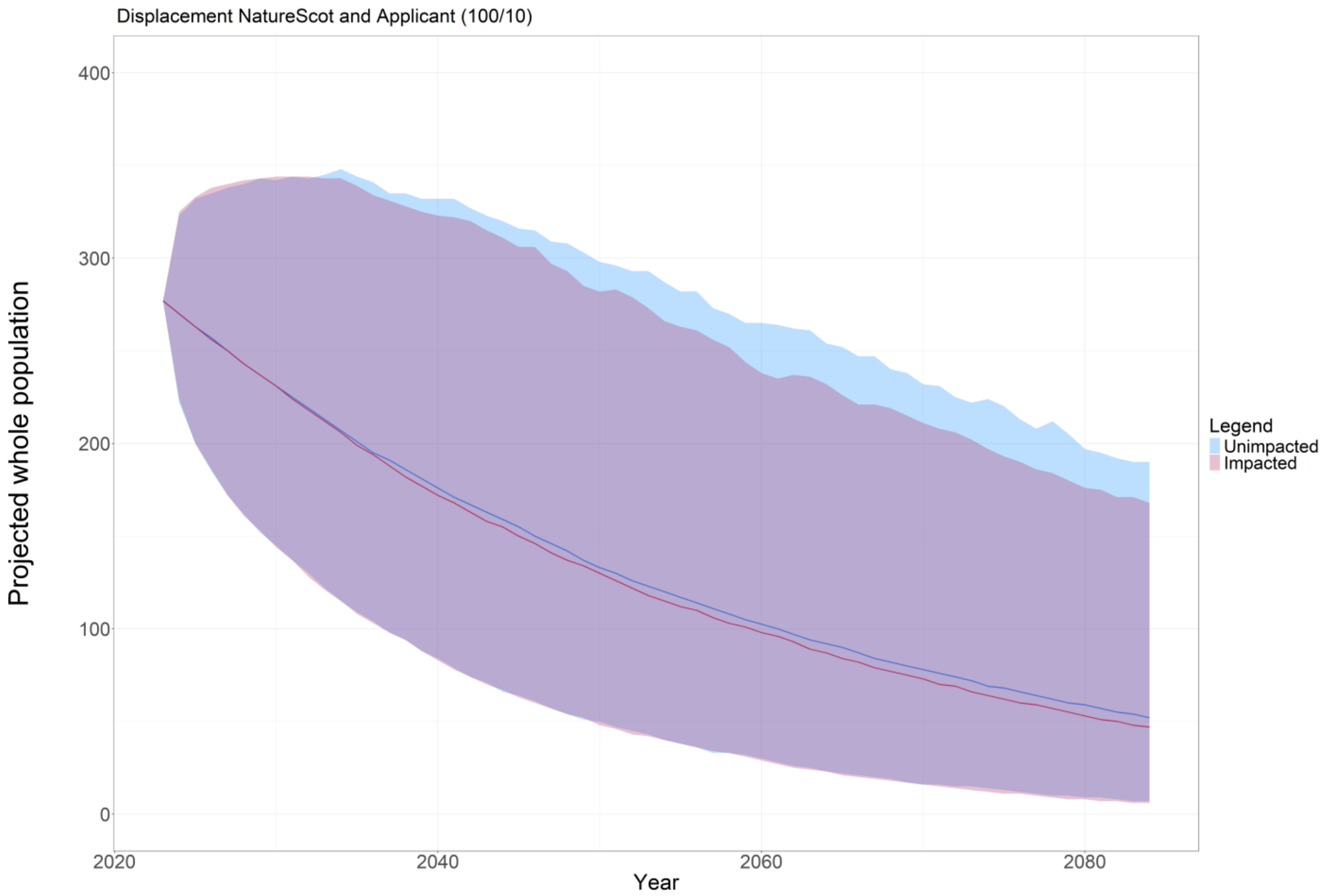


Plate 5-50 Red-throated Diver Annual Population Projection over 35-50 years under the modelled impact scenarios.

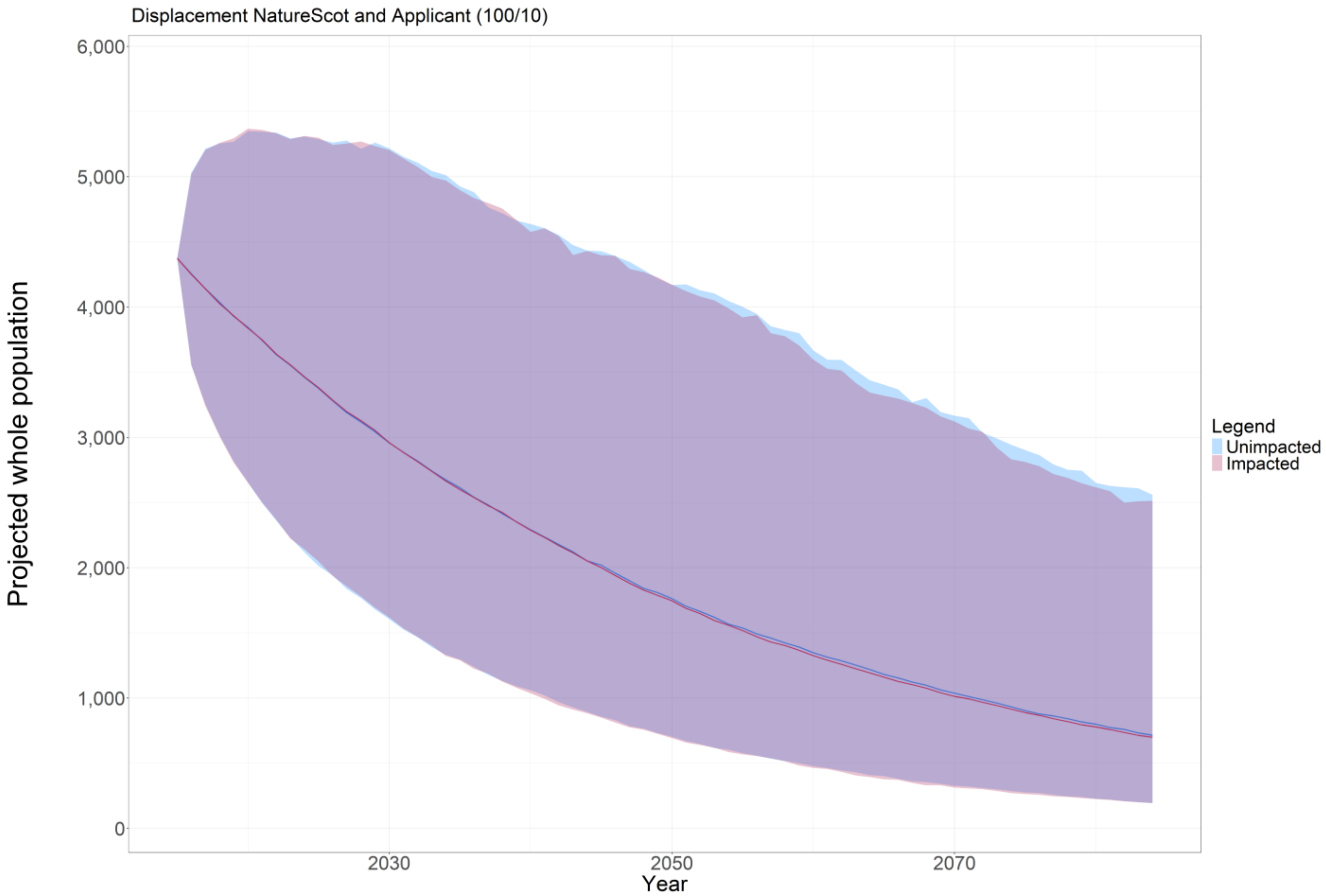


Plate 5-51 CGR after 35 Years for the Red-throated Diver Population during the Breeding Season under the modelled impact scenario.

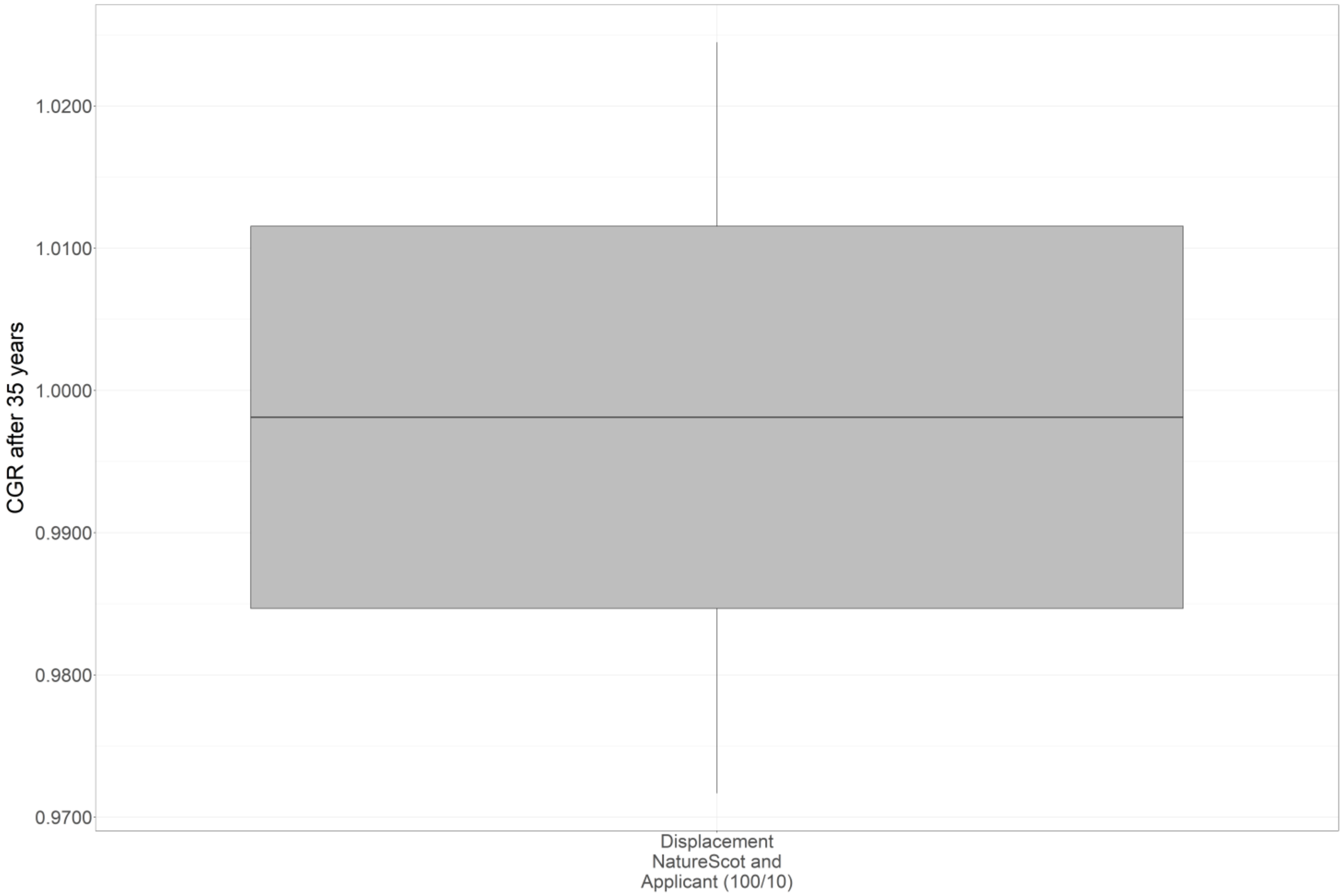


Plate 5-52 CGR after 35 Years for the Red-throated Diver Annual Population under the modelled impact scenario.

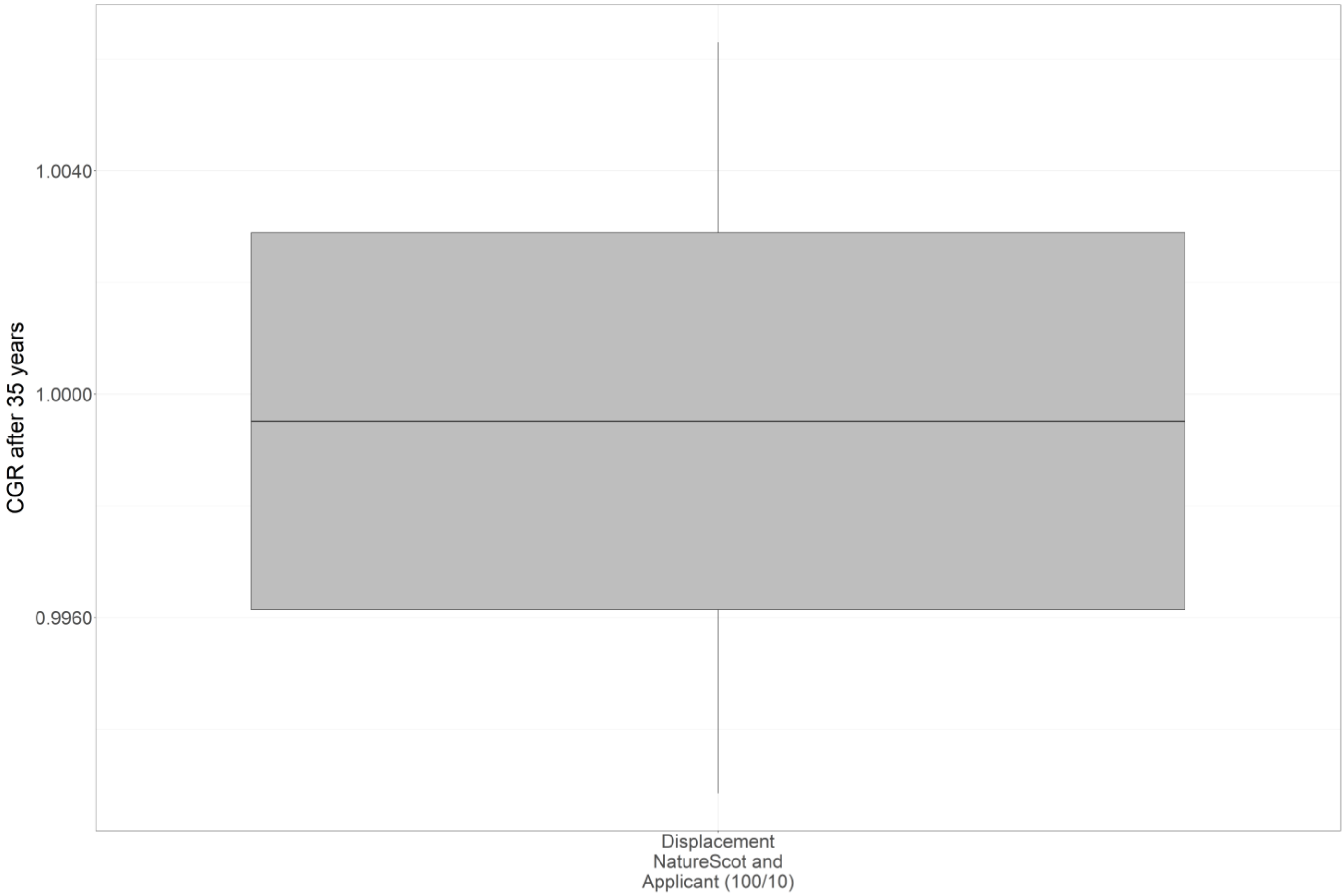


Plate 5-53 CPS for the Red-throated Diver Population during the Breeding Season from the Simulations after 35 Years under the modelled impact scenario.

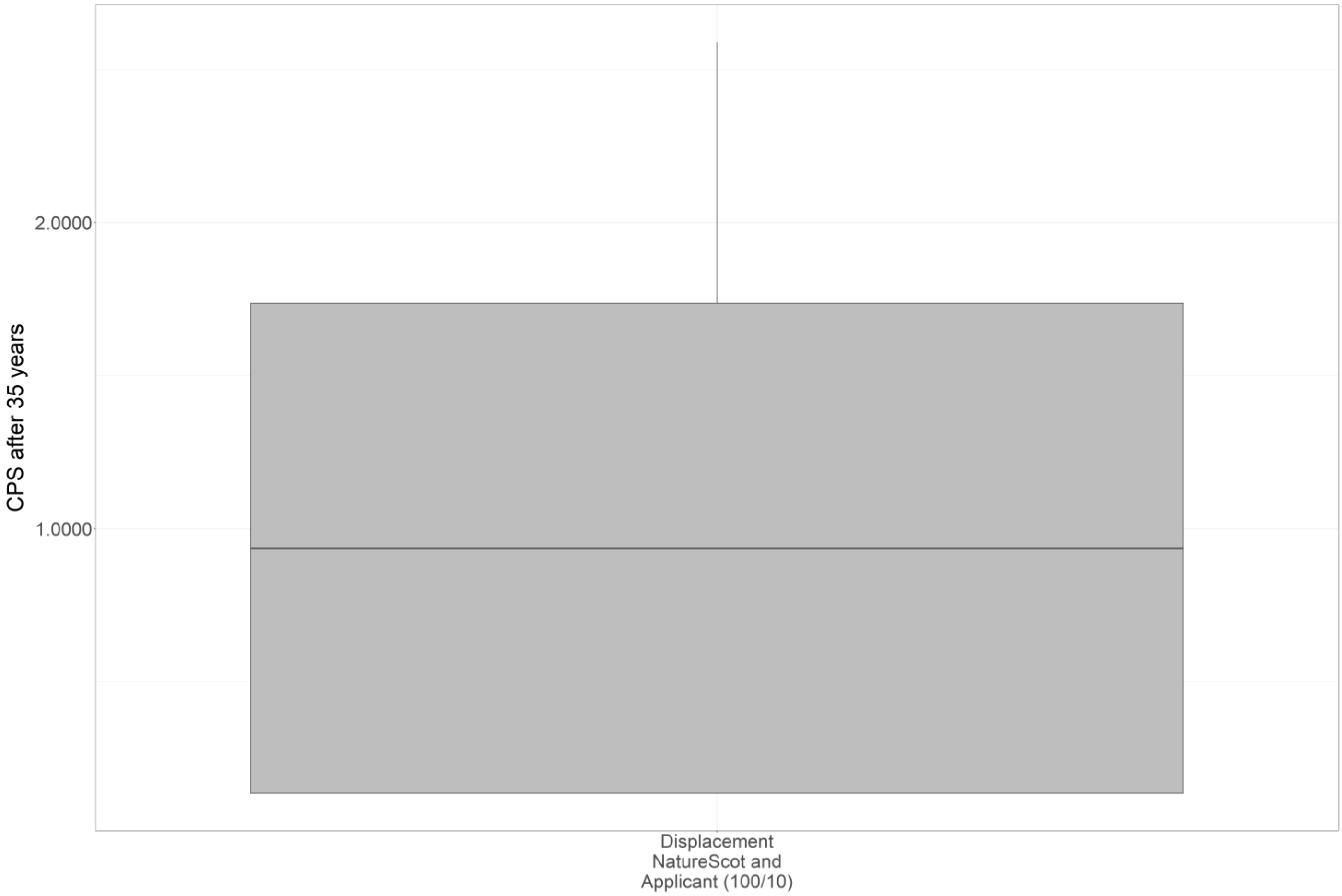
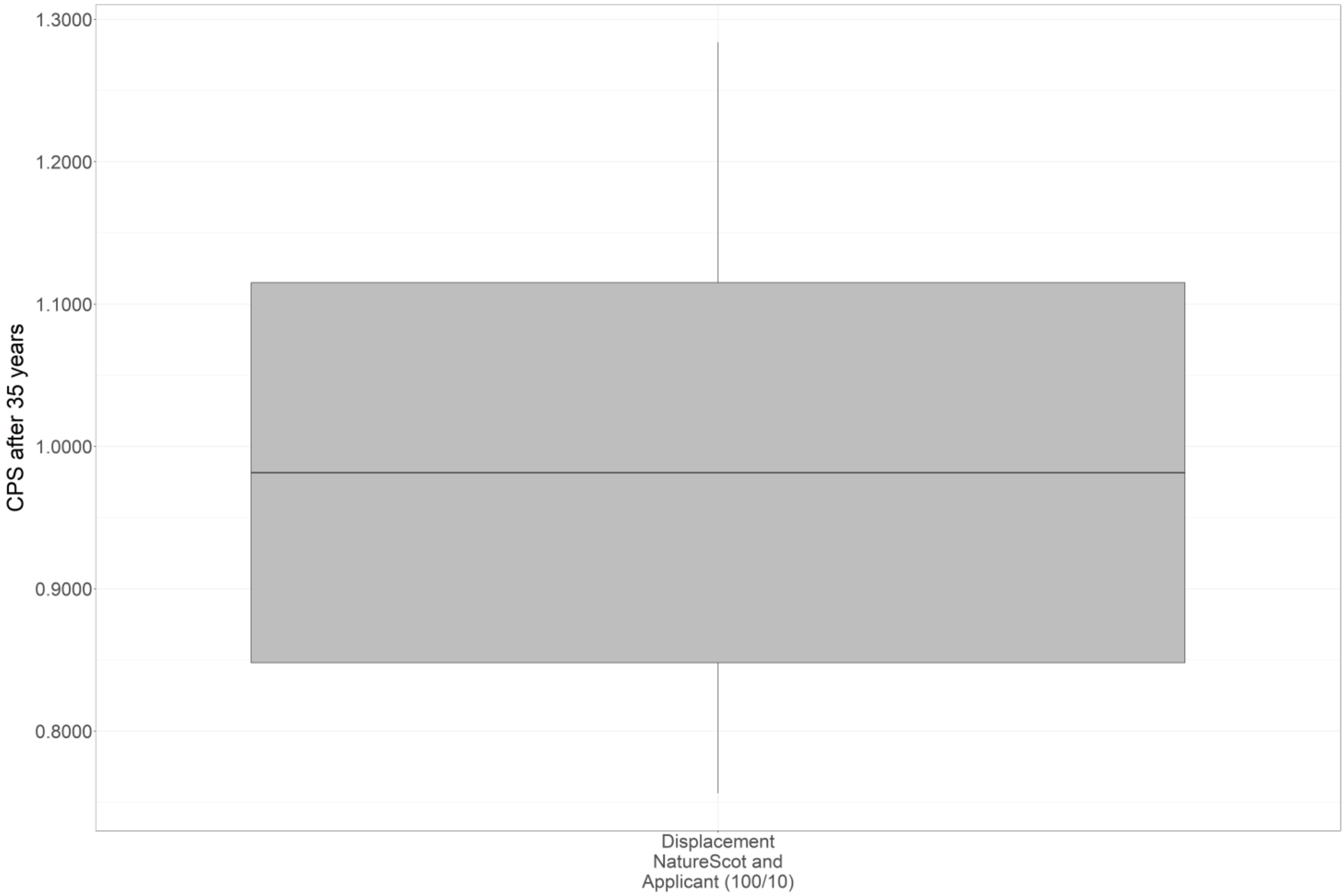


Plate 5-54 CPS for the Red-throated Diver Annual Population from the Simulations after 35 Years under the modelled impact scenario.



5.2.10 GREAT NORTHERN DIVER

5.2.10.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the great northern diver regional populations from the first year of full operation (estimated in 2034) and for a 35 year timespan are presented in Table 5-10.

5.2.10.2 As part of NatureScot guidance (2023c), 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 Plate 5-55 for the breeding season, and Plate 5-56 for annually. Plate 5-57 show the CGR values for the breeding season, and Plate 5-58 for annually. Plate 5-59 show the CPS values for the breeding season, and Plate 5-60 for annually.

Table 5-10 Great Northern Diver 35 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 35 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Non-breeding	Baseline	0	0.9572	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot (100/10)	2.70	0.9558	0.9983	0.9421	0.17	5.79	45.34	54.78
	Displacement Applicant Upper (100/5)	1.35	0.9564	0.9991	0.9681	0.09	3.19	47.26	52.96
Annual	Baseline	0	0.9572	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot (100/10)	2.70	0.9558	0.9983	0.9421	0.17	5.79	45.34	54.78
	Displacement Applicant Upper (100/5)	1.35	0.9564	0.9991	0.9681	0.09	3.19	47.26	52.96

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Plate 5-55 Great Northern Diver Population Projection over 35-50 years during the Non-breeding Season under the modelled impact scenarios.

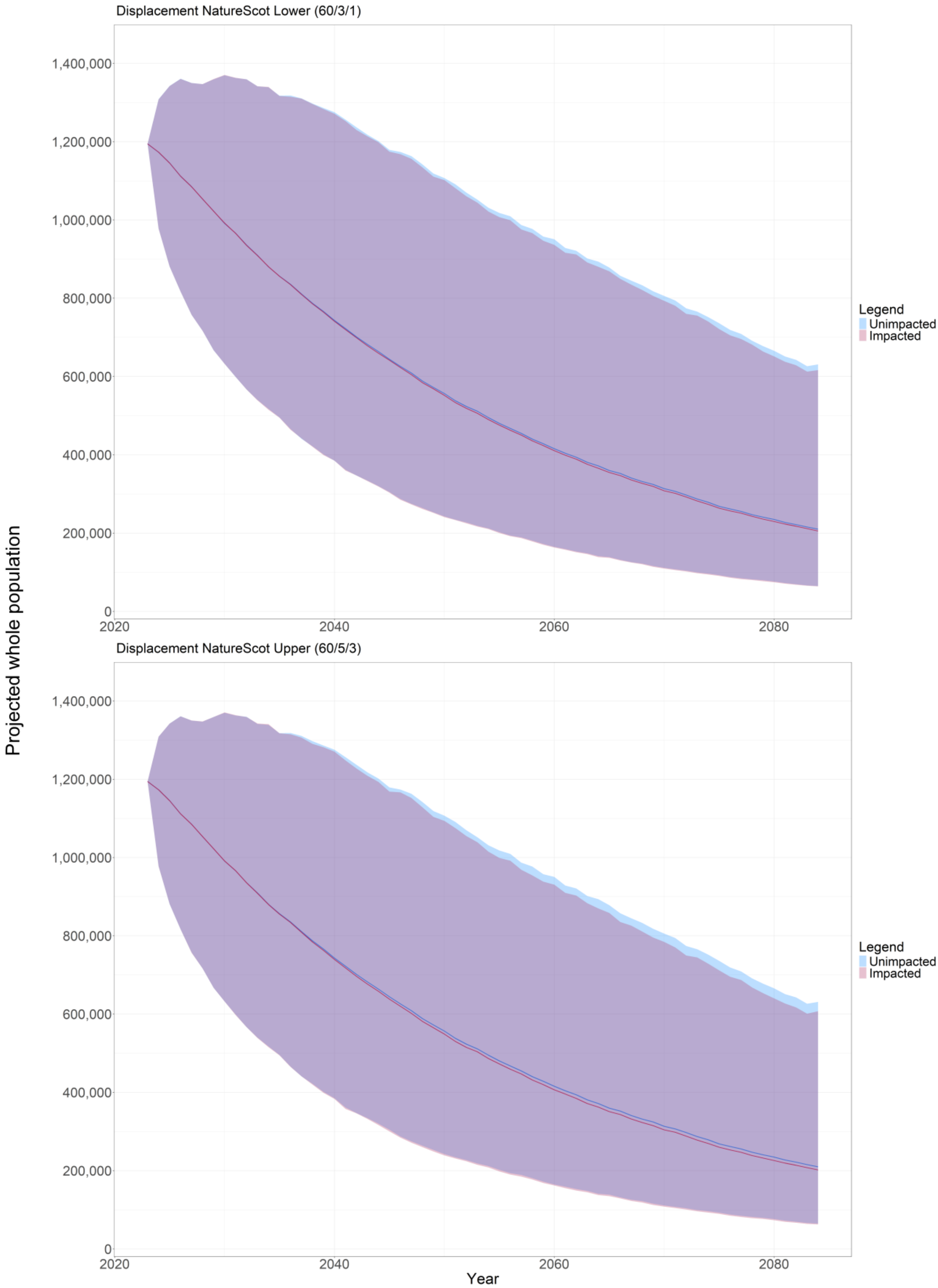


Plate 5-56 Great Northern Diver Annual Population Projection over 35-50 years under the modelled impact scenarios..

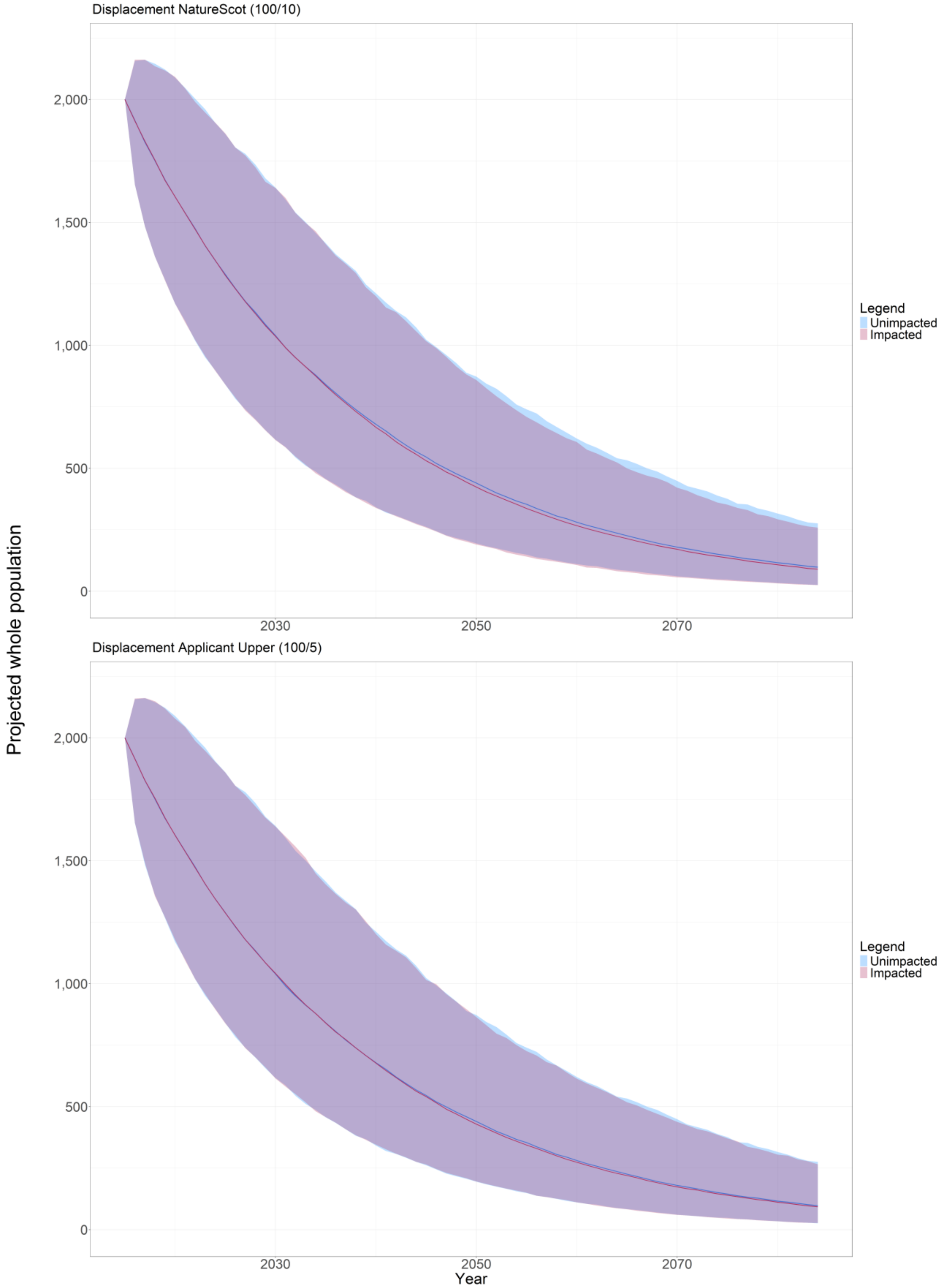


Plate 5-57 CGR after 35 Years for the Great Northern Diver Population during the Non-breeding Season under the modelled impact scenarios.

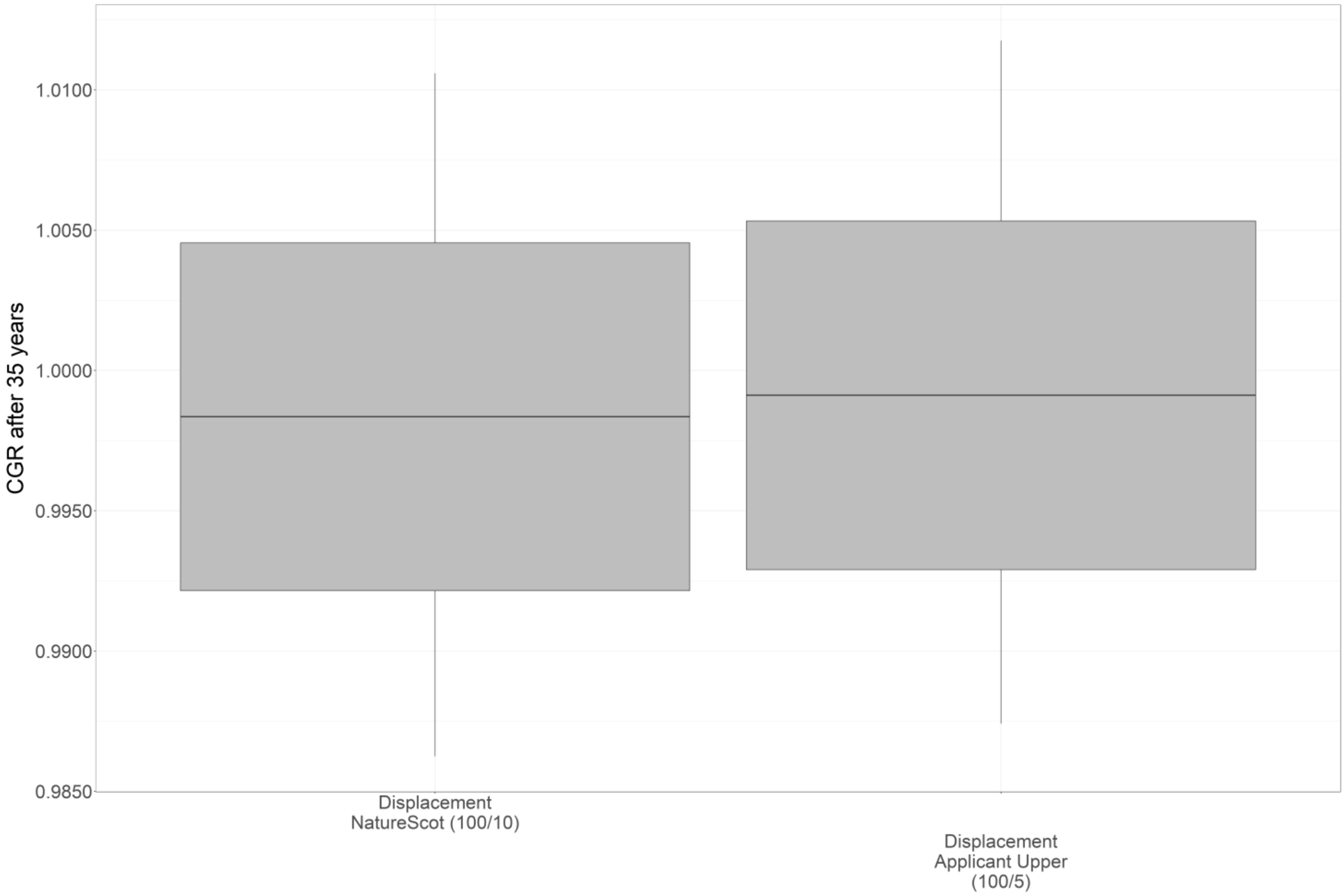


Plate 5-58 CGR after 35 Years for the Great Northern Diver Annual Population under the modelled impact scenarios.

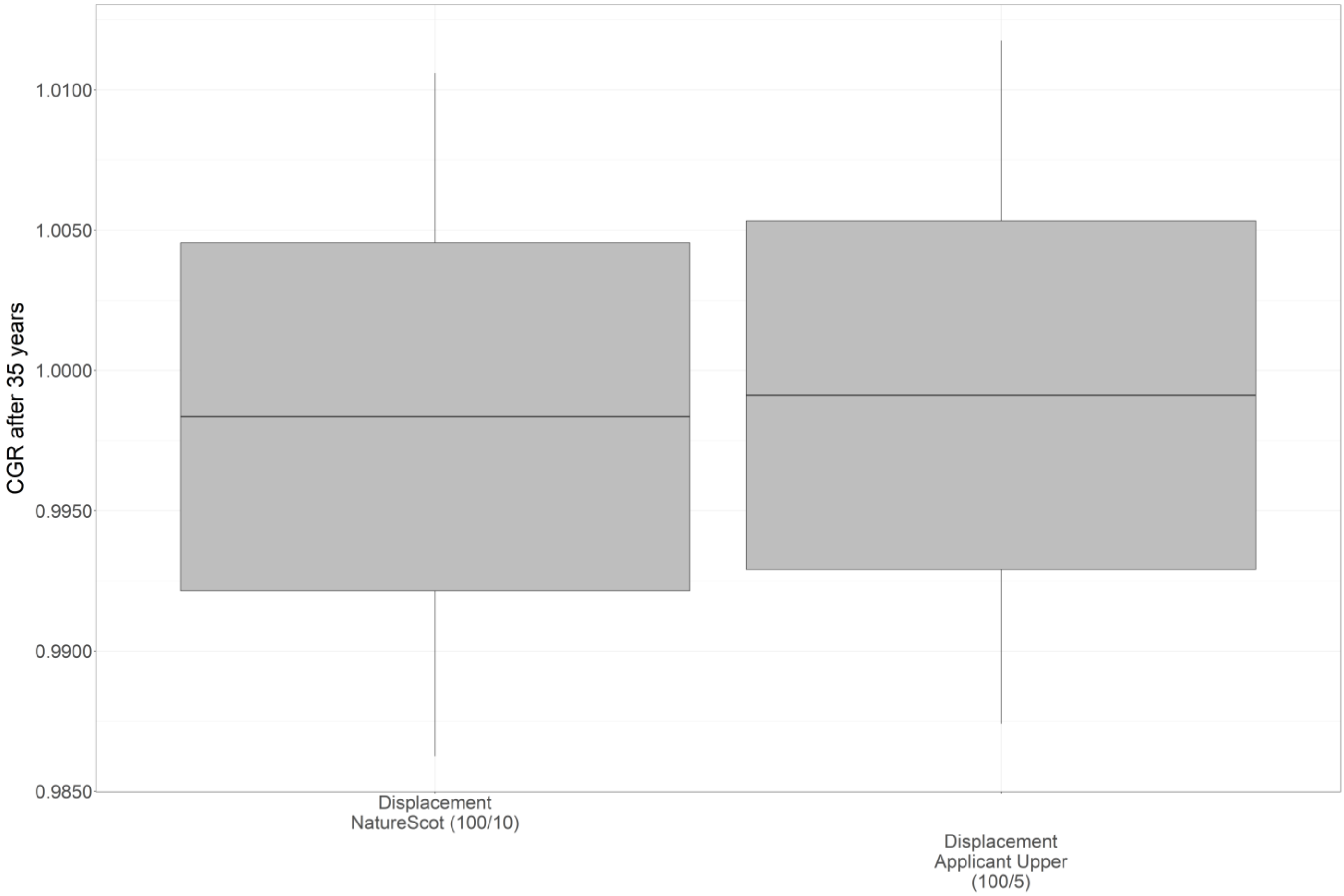


Plate 5-59 CPS for the Great Northern Diver Population during the Non-breeding Season from the Simulations after 35 Years under the modelled impact scenarios.

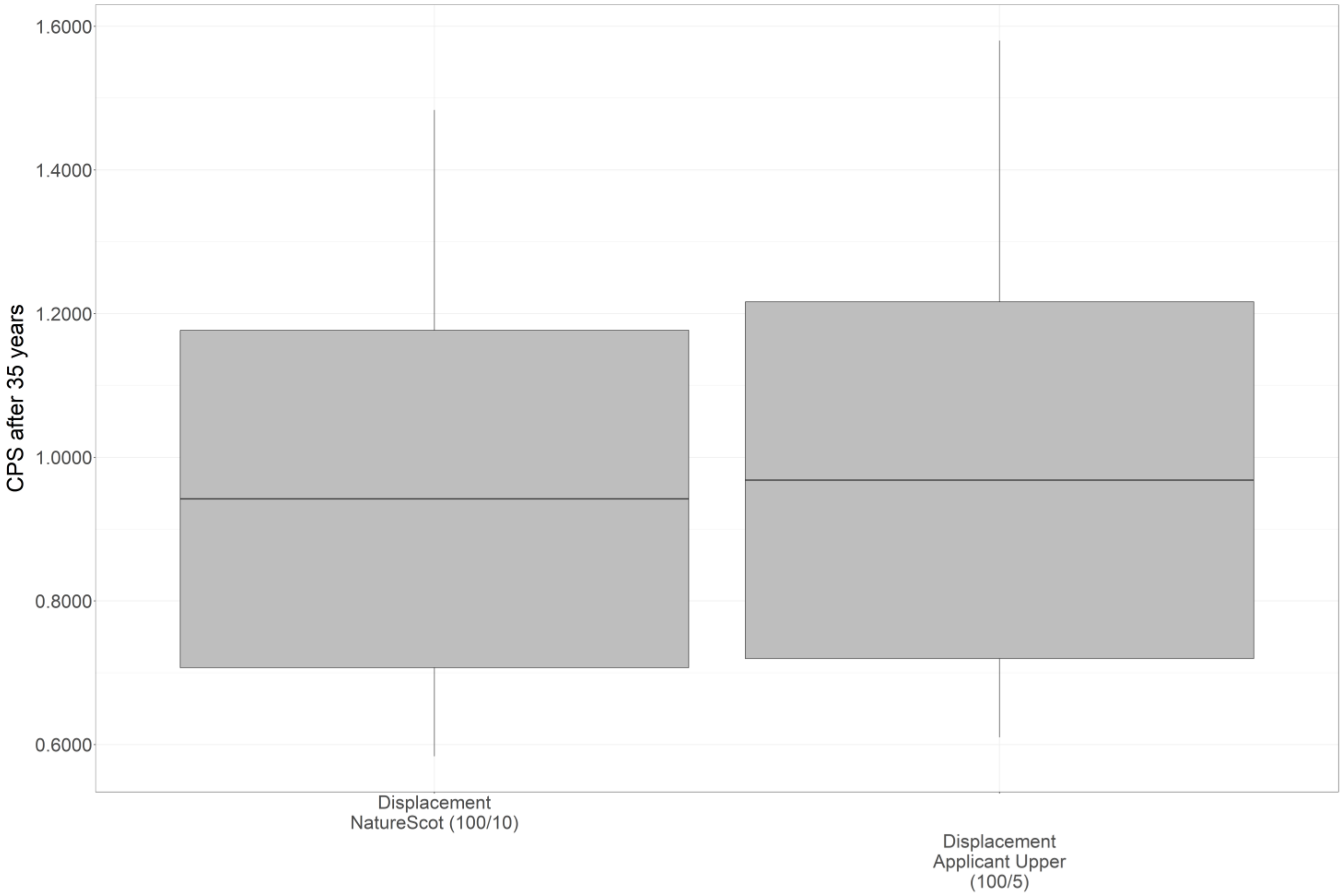
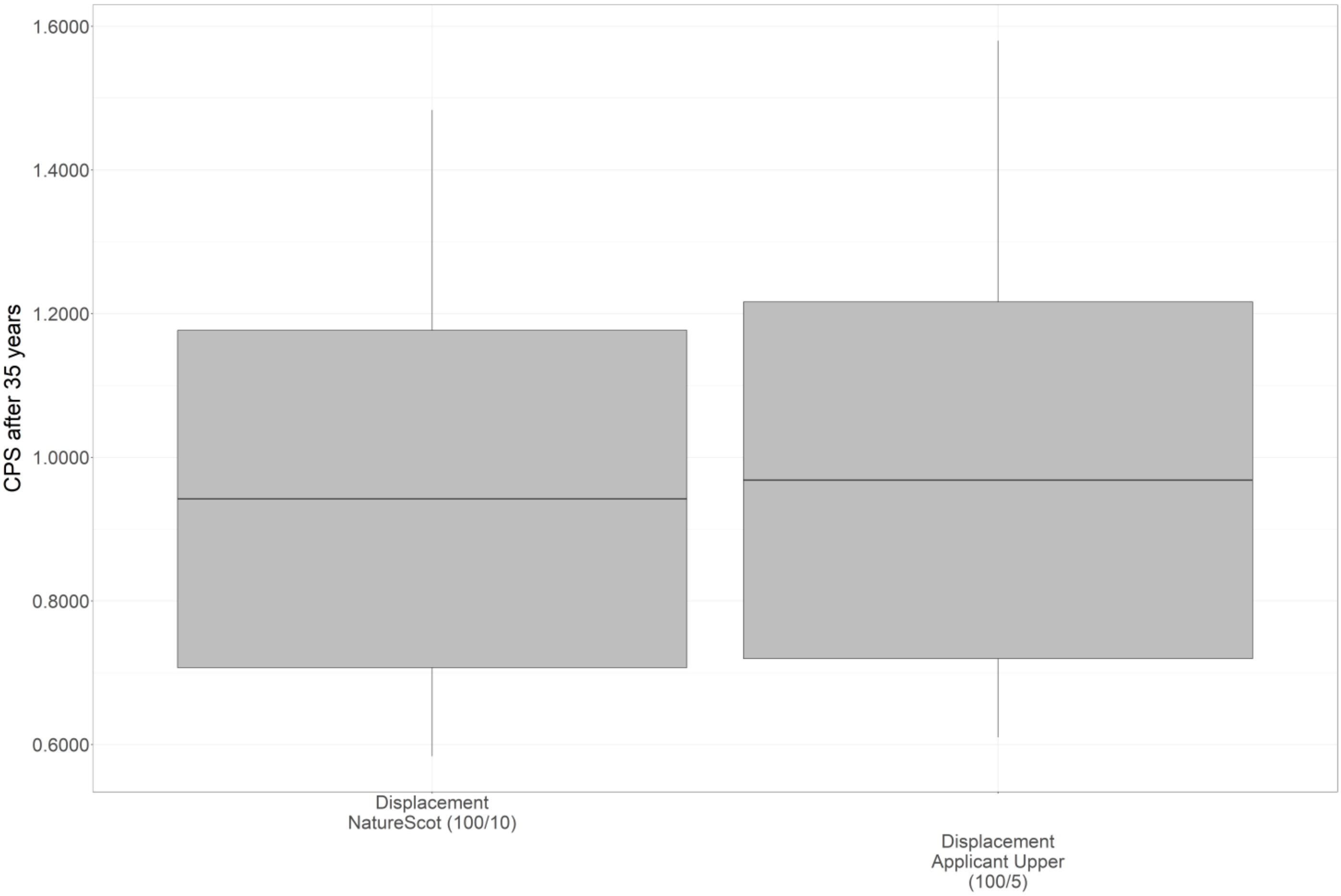


Plate 5-60 CPS for the Great Northern Diver Annual Population from the Simulations after 35 Years under the modelled impact scenarios.



5.3 RESULTS: AFTER 50 YEARS

5.3.1 KITTIWAKE

5.3.1.1 The results of the PVA runs for cumulative impacts from the Offshore Project with other plans and projects to the kittiwake regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-11. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-11 Kittiwake 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	1.0026	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	215.55	1.0014	0.9989	0.9428	0.11	5.72	44.58	54.72
	Displacement NatureScot Upper (30/3)	124.38	1.0019	0.9993	0.9666	0.07	3.34	46.60	52.70
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	255.78	1.0012	0.9986	0.9327	0.14	6.73	43.90	55.70
	Combined Collisions and Displacement NatureScot Upper (30/3)	339.94	1.0007	0.9982	0.9117	0.18	8.83	41.70	57.74
Post-breeding	Baseline	0	1.0022	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	250.63	1.0019	0.9997	0.9836	0.03	1.64	48.72	51.08

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	282.44	1.0019	0.9996	0.9815	0.04	1.85	48.5	51.16
	Combined Collisions and Displacement NatureScot Upper (30/3)	346.82	1.0018	0.9995	0.9773	0.05	2.27	48.20	51.46
Pre-breeding	Baseline	0	1.0022	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	256.79	1.0018	0.9996	0.9778	0.04	2.22	48.32	51.48
	Combined Collisions and NatureScot Lower and Applicant Displacement (30/1)	277.98	1.0008	0.9995	0.9762	0.05	2.38	48.06	51.70
	Combined Collisions and Displacement NatureScot Upper (30/3)	321.99	1.0017	0.9995	0.9724	0.05	2.76	47.88	52.00
Annual	Baseline	0	1.0023	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	722.96	1.0013	0.9991	0.9531	0.09	4.69	46.38	53.78
	Displacement NatureScot Upper (30/3)	285.79	1.0019	0.9996	0.9811	0.04	1.89	48.56	51.4
	Combined Collisions and NatureScot Lower and	816.20	1.0012	0.9989	0.9473	0.11	5.27	45.84	54.26

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Applicant Displacement (30/1)								
	Combined Collisions and NatureScot Upper and Displacement (30/1)	1008.75	1.0009	0.9987	0.9352	0.13	6.48	44.78	55.22

5.3.2 GREAT BLACK-BACKED GULL

5.3.2.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the great black-backed gull regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-12. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-12 Great Black-Backed Gull 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Non-breeding	Baseline	0	1.1263	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	15.28	1.1258	0.9995	0.9754	0.05	2.46	45.24	54.82

5.3.3 HERRING GULL

5.3.3.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the herring gull regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-13. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-13 Herring Gull 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Non-breeding	Baseline	0	0.9493	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	169.20	0.9483	0.9988	0.9426	0.12	5.74	45.94	54.28

5.3.4 ARCTIC TERN

5.3.4.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the Arctic tern regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-14. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-14 Arctic Tern 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.8945	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions	1.75	0.8937	0.9923	0.6667	0.77	33.33	52.76	53.36

5.3.5 GANNET

5.3.5.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the gannet regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-15. The baseline 'unimpacted' scenario is also shown for comparison purposes.

5.3.5.2 As set out in Section 2.4.3, several scenarios have been requested by the statutory consultees, one of which considers 'with Berwick Bank' and 'without Berwick Bank' options.

Table 5-15 Gannet 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (no. of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	1.0123	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions (with Berwick Bank)	580.66	1.0116	0.9993	0.9632	0.07	3.68	44.12	55.92
	Collisions (without Berwick Bank)	620.13	1.0116	0.9992	0.9608	0.08	3.92	43.74	56.54
	Displacement NatureScot Upper (70/3) (with Berwick Bank)	386.94	1.0118	0.9995	0.9753	0.05	2.47	46.18	54.02
	Displacement NatureScot Upper (70/3) (without Berwick Bank)	375.48	1.0118	0.9995	0.9762	0.05	2.38	46.18	53.78
	Combined Collisions and Displacement NatureScot Lower and Applicant (70/1) (with Berwick Bank)	650.07	1.0115	0.9992	0.9590	0.08	4.10	43.42	56.74

Season	Scenario	Predicted Mortality (no. of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Combined Collisions and Displacement NatureScot Lower and Applicant (70/1) (without Berwick Bank)	744.30	1.0114	0.9991	0.9531	0.09	4.69	42.64	57.72
	Combined Collisions and Displacement NatureScot Upper (70/3) (with Berwick Bank)	967.60	1.0111	0.9988	0.9395	0.12	6.05	40.26	59.92
	Combined Collisions and Displacement NatureScot Upper (70/3) (without Berwick Bank)	995.54	1.0110	0.9987	0.9378	0.13	6.22	39.96	60.14
Annual	Baseline	0	1.0123	N/A	N/A	N/A	N/A	N/A	N/A
	Collisions (with Berwick Bank)	609.17	1.0115	0.9992	0.9614	0.08	3.86	43.84	56.30
	Collisions (without Berwick Bank)	614.56	1.0115	0.9992	0.9586	0.08	4.14	43.42	56.92
	Displacement NatureScot Upper (70/3) (with Berwick Bank)	441.23	1.0118	0.9994	0.9718	0.06	2.82	45.74	54.50
	Displacement NatureScot Upper (70/3) (without Berwick Bank)	460.12	1.0117	0.9994	0.9707	0.06	2.93	45.26	54.68

Season	Scenario	Predicted Mortality (no. of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Combined Collisions and Displacement NatureScot Lower and Applicant (70/1) (with Berwick Bank)	677.36	1.0115	0.9991	0.9574	0.09	4.26	43.34	57.12
	Combined Collisions and Displacement NatureScot Lower and Applicant (70/1) (without Berwick Bank)	752.61	1.0113	0.9990	0.9500	0.10	5.00	41.92	58.10
	Combined Collisions and Displacement NatureScot Upper (70/3) (with Berwick Bank)	1050.40	1.0110	0.9987	0.9344	0.13	6.56	39.62	60.76
	Combined Collisions and Displacement NatureScot Upper (70/3) (without Berwick Bank)	1059.36	1.0109	0.9986	0.9313	0.14	6.87	38.88	61.22

5.3.6 GUILLEMOT

5.3.6.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the guillemot regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-16. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-16 Guillemot 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Annual	Baseline	0	1.0253	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/5/3)	62.43	1.0251	0.9997	0.9873	0.03	1.27	47.24	52.56

5.3.7 RAZORBILL

5.3.7.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the razorbill regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-17. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-17 Razorbill 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9764	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/5)	12.30	0.9762	0.9997	0.9873	0.03	1.27	49.08	51.18
Non-breeding	Baseline	0	0.9767	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/3)	152.35	0.9761	0.9995	0.9733	0.05	2.67	47.68	52.54
Post-breeding	Baseline	0	0.9767	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Upper (60/3)	125.45	0.9764	0.9998	0.9877	0.02	1.23	48.94	51.12
Annual	Baseline	0	0.9767	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Lower (60/3/1)	145.03	0.9764	0.9997	0.9853	0.03	1.47	48.82	51.36

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
	Displacement NatureScot Upper (60/5/3)	409.60	0.9758	0.9992	0.9599	0.08	4.01	46.82	53.74

5.3.8 PUFFIN

5.3.8.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the puffin regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-18. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-18 Puffin 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9719	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Lower (60/3)	441.69	0.9715	0.9996	0.9781	0.04	2.19	48.60	51.50
	Displacement NatureScot Upper (60/5)	736.15	0.9712	0.9993	0.9636	0.07	3.64	47.56	52.44
Annual	Baseline	0	0.9719	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot Lower (60/3/1)	454.14	0.9714	0.9996	0.9775	0.04	2.25	48.38	51.52
	Displacement NatureScot Upper (60/5/3)	793.08	0.9711	0.9992	0.9608	0.08	3.92	47.44	52.70

5.3.9 RED-THROATED DIVER

5.3.9.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the red-throated diver regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-19. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-19 Red-Throated Diver 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Breeding	Baseline	0	0.9727	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot and Applicant (100/10)	0.40	0.9706	0.9983	0.9062	0.17	9.38	45	56.68
Annual	Baseline	0	0.9742	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot and Applicant (100/10)	1.76	0.9739	0.9995	0.9730	0.05	2.70	49.16	51.04

5.3.10 GREAT NORTHERN DIVER

5.3.10.1 The results of the PVA runs for cumulative impacts from the Offshore Project, in-combination with impacts of other projects, to the great northern diver regional populations from the first year of full operation (estimated in 2034) and for a 50 year timespan are presented in Table 5-20. The baseline 'unimpacted' scenario is also shown for comparison purposes.

Table 5-20 Great Northern Diver 50 Year Cumulative PVA Results

Season	Scenario	Predicted Mortality (number of birds - all age classes)	Annual Growth Rate	Density-Independence (after 50 years)				Quantiles	
				Median CGR	Median CPS	Reduction in Growth Rate (%)	Reduction in Population Size (%)	U=50 %I	I=50 %U
Non-breeding	Baseline	0	0.9572	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot (100/10)	2.70	0.9556	0.9984	0.9201	0.16	7.99	45.32	56.86
	Displacement Applicant Upper (100/5)	1.35	0.9564	0.9992	0.9600	0.08	4.00	47.40	53.96
Annual	Baseline	0	0.9572	N/A	N/A	N/A	N/A	N/A	N/A
	Displacement NatureScot (100/10)	2.70	0.9556	0.9984	0.9201	0.16	7.99	45.32	56.86
	Displacement Applicant Upper (100/5)	1.35	0.9564	0.9992	0.9600	0.08	4.00	47.40	53.96

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6 GLOSSARY OF TERMS AND ABBREVIATIONS

6.1.1.1 A list of key terms and acronyms used in this Appendix are provided in Table 6-1 and Table 6-2.

Table 6-1 Acronyms and abbreviations

Term	Definition
BDMPS	Biologically Defined Minimum Population Scale
BTO	British Trust for Ornithology
CGR	Counterfactual of Growth Rate
CPS	Counterfactual of Population Size
CRM	Collision Risk Modelling
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
JNCC	Joint Nature Conservation Committee
MD-LOT	Marine Directorate – Licensing Operations Team
MHWS	Mean High Water Springs
OCAS	Offshore Cable Area of Search
OSP	Offshore Substation Platform
OWF	offshore wind farm
PVA	Population Viability Analysis
RIAA	Report to Inform Appropriate Assessment
SD	Standard Deviation
SNCB	Statutory Nature Conservation Bodies
WTG	Wind Turbine Generator

Table 6-2 Glossary

Term	Meaning
the Applicant	Spiorad na Mara Limited (the Project owner)
Array Area	The offshore area within which the offshore wind turbine generators (WTGs), associated foundations, Offshore Cables, and Offshore Substation Platform (OSP) (if required), will be located. This area encompasses the Turbine Area that will contain all above water surface infrastructure (WTGs / OSP) and an additional area within which further below water infrastructure (foundations and cables) may also be located.
Counterfactual of Growth Rate	The ratio of impacted to unimpacted annual growth rate.
Counterfactual of Population Size	The ratio of impacted to unimpacted population size.
Cumulative Effects	Considers the likely significant effects of multiple impacts and activities from several developments with insignificant impacts individually but which together represent a significant cumulative effect.

Term	Meaning
Offshore Project	The components of the Spiorad na Mara offshore wind farm (the Project) located seaward of Mean High Water Springs (MHWS).
Project	The Spiorad na Mara offshore wind farm development. This term describes the whole development, including all offshore and onshore components.
Population Viability Analysis	The process of determining the probability that a population will persist over a specified time period.
Sabbaticals	This refers to mature seabirds that do not attempt to breed in a given year, despite being capable of doing so. These individuals typically remain at sea or visit breeding colonies only briefly, without engaging in nesting or chick-rearing.
Turbine Area	A reduced area within the Array Area where above water surface infrastructure would be located i.e. wind turbine generators (WTG) and Offshore Substation Platform (OSP) (if required). This area has been developed and refined through stakeholder engagement and environmental assessment.
Wind Turbine Generator (WTG)	The wind turbines that generate electricity consisting of tubular towers and blades attached to a nacelle housing mechanical and electrical generating equipment.

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