Morven North Offshore Wind Array Project

Environmental Impact Assessment Report

Volume 3, Annex 11.6: Offshore Ornithology Regional Population Viability Analysis

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1 Introduction

1.1 Context

1.1.1.1 Seabirds can be impacted by offshore wind developments in a number of ways, including collision with wind turbine blades resulting in mortality, and displacement from an area due to the presence of wind turbines. These processes affect individuals, but the cumulative effects (when the Morven North Offshore Wind Array Project (hereafter "Morven North") alone effects are considered alongside any effects from other projects on the same receptor) have the potential to affect the productivity or elevate the baseline mortality of a population. The Environmental Impact Assessment (EIA) process allows for evaluating the potential impacts of offshore wind farms on different population scales.

1.1.1.2 One method to estimate the effect that offshore wind projects alone or cumulatively may have on a population is through Population Viability Analysis (PVA). PVA provides a robust framework using demographic parameters to predict changes in the population, using statistical population models to forecast future changes over a set period. Comparisons are made between 'baseline' conditions whereby conditions remain unimpacted (i.e. Morven North) is not constructed) and under 'scenario' conditions where an impact is applied to a population by the alteration of demographic parameters. Population metrics that are derived from comparisons of 'baseline' and 'impacted' 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 Aim of report

1.2.1.1 This Technical Report presents the PVA process conducted for the species and associated populations in relation to impacts associated with Morven North alone, the Morven programme (for ornithological receptors this refers to impacts from Morven North and Morven South Offshore Wind Array Project (hereafter "Morven South") combined, as set out in Volume 2, Chapter 11: Offshore Ornithology), and cumulatively with other plans and projects.

2 Methodology

2.1 Overview

2.1.1.1 PVA was undertaken using the Seabird PVA Tool developed by Natural England (Searle *et al.,* 2019). This software has a user-friendly interface (in the 'Shiny App' interface) and another series of code tools for direct use. Both are written within the computer software 'R' (R is a free software environment for statistical computing and graphics) and are intended to give the same fundamental calculations. The Seabird PVA Tool was accessed via the Shiny App interface, accessible via a standard web-browser that uses the nepva R package to perform the modelling and analysis. The tool constructs a stochastic Leslie matrix and can assess any type of impact in terms of change to demographic parameters, or as a cull or harvest of a fixed size per year (Searle *et al.,* 2019).

2.2 Identification of species and populations for consideration

2.2.1.1 Species are selected for further assessment where the predicted increase in baseline mortality exceeds a 0.02 percentage point increase in the baseline mortality of the relevant regional population. A 0.02 percentage point increase is the level that is regarded as the threshold for undertaking further assessments such as PVA as recommended by NatureScot (2023a) in both project alone and cumulative assessments.

2.2.1.2 When applying this threshold as part of the assessments undertaken for Morven North in Volume 2, Chapter 11: Offshore Ornithology, the species and associated seasons included in Table 2.1 require PVA modelling.

Table 2.1: Species and associated seasons for which Population Viability Analysis is required based on the assessments presented in Volume 2, Chapter 11: Offshore Ornithology

Species	Season
Morven North alone	
Common guillemot (*Uria aalge*)	All seasons
	Annual basis
Razorbill (*Alca torda*)	Annual basis
Morven Programme assessment (Morven North and Morven South combined)	
Common guillemot	All seasons
	Annual basis
Razorbill (*Alca torda*)	Post-breeding season
	Annual basis
Cumulative assessment	
Kittiwake (*Rissa tridactyla*)	All seasons
	Annual basis
Great black-backed gull (*Larus marinus*)	Non-breeding
	Annual basis
Common guillemot	All seasons
	Annual basis

Species	Season
Razorbill	All seasons
	Annual basis
Puffin (*Fratercula arctica*)	All seasons
	Annual basis
Gannet (*Morus bassanus*)	All seasons
	Annual basis

2.2.1.3 Impacts in other seasons both for the species included in Table 2.1 and those for which assessments are included in Volume 2, Chapter 11 Offshore Ornithology but not included in Table 2.1 did not exceed the 0.02 percentage point threshold and therefore did not require PVA.

2.3 Modelling approach

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

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

2.3.1.3 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 (Beta/Gamma option). For each simulated year, a value for each demographic rate was randomly generated from a probability distribution defined by the mean and standard deviation estimates of that rate for the population under consideration.

2.3.1.4 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 (WWT Consulting, 2012) and hence has been included.

2.3.1.5 PVA outputs can either be expressed as the counterfactual of population size (CPS) or the counterfactual of population growth rate (CGR). As models within this report have been run using density independence, the CGR is considered more robust and informative, while if the PVA is density dependent then the CPS is more robust and informative. While both CPS and CGR outputs are presented in line with NatureScot's guidance (NatureScot, 2023a), the interpretation of results in Volume 2, Chapter 11 Offshore Ornithology 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.

2.3.1.6 Additionally, the quantile from the unimpacted population that matched the 50% quantile for the impacted population (U=50%I) and the quantile from the impacted population that matched the 50% quantile for the unimpacted population (I=50%U) have 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.

2.4 Simulation parameterisation

2.4.1.1 All PVA modelling in this Technical Report was undertaken with environmental and demographic stochasticity. To ensure robust results, all simulations were set to run 5,000 times (5,000 runs is regarded as the standard approach and has been utilised in several offshore wind applications such as Hornsea Four Offshore Wind Farm, Awel Y Mor Offshore Wind Farm, Mona and Morgan Offshore Wind Farms, Berwick Bank Offshore Wind Farm and Green Volt Offshore Wind Farm). All models were run for a 35-year time span (the anticipated lifetime of Morven North) with outputs for 25 and 50 impacted years also presented for all impact scenarios.

2.4.1.2 Modelling has also been undertaken including a five year 'burn in' period within the model. Applying a 'burn in' period allows for a stable age structure to form when starting to run the model. Within the PVA model, impacts were set to commence the year Morven North is anticipated to start operating (2038) and were set to run for the lifetime of Morven North (35 years) until 2072 providing PVA models run for 35 impacted years.

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

2.4.1.4 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 is used as previous analyses demonstrated that stochastic models using a matched runs approach were likely the most precautionary (Cook and Robinson, 2017). Productivity rates were assumed to be unaffected by wind farm effects.

2.5 Model parametrisation

2.5.1 Demographic rates

2.5.1.1 The survival rates for the species considered were derived from the national values presented in Horswill and Robinson (2015), with updated productivity values taken from the Joint Nature Conservation Committee (JNCC) and the British Trust for Ornithology (BTO) (JNCC, 2024) Table 2.1). These values matched with those set out within the most recent version of the Seabird PVA Tool (Searle *et al.,* 2019).

2.5.1.2 Survival rates vary depending on age class, with 0 to 1 used to represent birds below the age of one, age class 1 to 2 used to represent birds aged one, age class 2 to 3 representing two years of age and so on. Adults are grouped together as survival rates are consistent between adult aged birds regardless of actual age (e.g. seven year olds have the same survival rate as eight year olds and so on) (Table 2.2:).

Table 2.2: Species demographic rates used in Population Viability Analysis

Species	Age first breeding (years)	No. of eggs/pair /annum	Metric	Survival rates (per age class)							Productivity	Source
				0-1	1-2	2-3	3-4	4-5	5-6	Adult		
Kittiwake	4	2	Mean	0.790	0.854	0.854	0.854	-	-	0.854	0.619	Survival: Horswill and Robinson (2015) Productivity: JNCC (2024)
			Standard deviation (SD)	0.001	0.077	0.077	0.077	-	-	0.077	0.127	
Great black-backed gull	5	3	Mean	0.798	0.834	0.834	0.834	0.834	-	0.834	1.061	Survival: Horswill and Robinson (2015) Productivity: JNCC (2024)
			SD	0.092	0.079	0.079	0.079	0.079	-	0.079	0.131	
Herring gull	5	3	Mean	0.798	0.834	0.834	0.834	0.834	-	0.834	0.498	Survival: Horswill and Robinson (2015) Productivity: JNCC (2024)
			SD	0.092	0.079	0.079	0.079	0.079	-	0.079	0.113	
Common guillemot	6	1	Mean	0.560	0.792	0.917	0.939	0.939	0.939	0.939	0.583	Survival: Horswill and Robinson (2015), standard deviations from nepva tool Productivity: JNCC (2024)
			SD	0.058	0.152	0.098	0.015	0.015	0.015	0.025	0.079	

Species	Age first breeding (years)	No. of eggs/pair /annum	Metric	Survival rates (per age class)							Productivity	Source
				0-1	1-2	2-3	3-4	4-5	5-6	Adult		
Razorbill	5	1	Mean	0.630	0.630	0.895	0.895	0.895	-	0.895	0.532	Survival: Horswill and Robinson (2015) Productivity: JNCC (2024)
			SD	0.209	0.209	0.670	0.670	0.670	-	0.670	0.084	
Puffin	5	1	Mean	0.709	0.709	0.709	0.760	0.805	-	0.907	0.557	Survival: Searle *et al.* (2019) derived from Horswill and Robinson (2015) Productivity: JNCC (2024)
			SD	0.108	0.108	0.108	0.093	0.083	-	0.083	0.115	
Gannet	5	1	Mean	0.424	0.829	0.891	0.895	0.919	-	-	0.766	Survival: Searle *et al.* (2019) derived from Horswill and Robinson (2015) Productivity: JNCC (2024)
			SD	0.045	0.026	0.019	0.019	0.042	-	-	0.054	

2.5.2 Populations

Morven North alone

2.5.2.1 During the breeding season, the population derived from Morven North alone assessment was utilised within the PVA modelling. Populations were derived using each species' foraging range as detailed within Volume 2, Chapter 11 Offshore Ornithology and Volume 3, Annex 11.1 Offshore Ornithology Baseline Characterisation Report. Breeding populations used within the PVAs are shown in Table 2.3.

2.5.2.2 During non-breeding seasons, impacts are put into the context of the Biologically Defined Minimum Population Scale (BDMPS) for each species Table 2.3) based on the populations presented in Furness (2015). For common guillemot, following NatureScot guidance provided during consultation, the non-breeding population is based upon a defined range utilising Buckingham *et al.* (2022). Baseline mortality was estimated using the respective demographic rates for each species, as detailed in Table 2.2

2.5.2.3 For the annual assessment, the population is defined as the largest of the individual seasonal regional populations, as further detailed within Volume 2, Chapter 11: Offshore Ornithology.

Table 2.3: Biologically defined population scales for use in the Morven North alone assessment

Species	Season	Region	BDMPS (no. of birds)
Common guillemot	Breeding	Foraging range + 1 SD (55.5+39.7km; Woodward *et al.*, 2019)	250,171
	Non-breeding	Foraging range generated from Buckingham *et al.* (2022)	474,821
	Post-breeding		
	Annual		
Razorbill	Annual	Foraging range + 1 SD (73.8+48.4km; Woodward *et al.*, 2019)	591,874

Morven Programme and cumulative assessment

The populations used in the Morven Programme and cumulative assessments take into account the additional populations that may be affected by projects considered cumulatively. A full description of the methodology used to derive populations for use in associated PVA models is provided in Volume 2, Chapter 11: Offshore Ornithology. The populations used for PVA modelling for relevant species are provided in Table 2.4.

Table 2.4: Biologically defined population scales for use in the Morven Programme and cumulative assessments

Species	Season	Region	BDMPS (no. of birds)
Morven Programme assessment			
Common guillemot	Breeding	Foraging range + 1 SD	250,171
	Non-breeding	Foraging range generated from Buckingham *et al.* (2022)	474,821

Species	Season	Region	BDMPS (no. of birds)
	Post-breeding		
	Annual		
Razorbill	Post-breeding	Foraging range + 1 SD	591,874
	Annual		
Cumulative assessment			
Kittiwake	Breeding	Foraging range + 1 SD (156.1+144.5km; Woodward *et al.*, 2019)	598,569
	Post-breeding	UK North Sea BDMPS population (Furness, 2015)	829,937
	Pre-breeding		627,816
	Annual		829,937
Great black-backed gull	Non-breeding	UK North Sea BDMPS population (Furness, 2015)	91,399
	Annual		
Herring gull	Breeding	Foraging range + 1 SD (58.8+26.8km; Woodward *et al.*, 2019)	22,121
	Non-breeding		
	Annual		
Common guillemot	Breeding	Foraging range + 1 SD (55.5+39.7km; Woodward *et al.*, 2019)	250,171
	Non-breeding	Foraging range generated from Buckingham *et al.* (2022)	474,821
	Post-breeding		
	Annual		
Razorbill	Breeding	Foraging range + 1 SD (73.8+48.4km; Woodward *et al.*, 2019)	89,065
	Post-breeding	UK North Sea and Channel BDMPS population (Furness, 2015)	591,874
	Non-breeding		218,622
	Pre-breeding		591,874
	Annual		591,874
Puffin	Breeding	Foraging range + 1 SD (137.1+128.3km; Woodward *et al.*, 2019)	439,494

Species	Season	Region	BDMPS (no. of birds)
	Non-breeding	UK North Sea and Channel BDMPS population (Furness, 2015)	231,957
	Annual	Foraging range + 1 SD (137.1+128.3km; Woodward *et al.*, 2019)	439,494
Gannet	Breeding	Foraging range + 1 SD (315.2+194.2km; Woodward *et al.*, 2019)	559,963
	Post-breeding	UK North Sea and Channel BDMPS population (Furness, 2015)	456,298
	Pre-breeding		248,385
	Annual	Foraging range + 1 SD (315.2+194.2km; Woodward *et al.*, 2019)	559,963

2.5.3 Impact scenarios

2.5.3.1 The impact from Morven North alone, the Morven Programme assessment and cumulatively with other projects has been parameterised as a 'relative harvest' (i.e. additional mortality as a result of the impact).

2.5.3.2 Note that for the purposes of the PVA model, specifying a relative harvest means that the absolute number of birds that could suffer mortality as a result of Morven Northis proportional to the population size. This is in line with the assessment approach for both collision risk and displacement analysis as described in Volume 3, Annex 11.2: Offshore Ornithology Collision Risk Modelling Report and Volume 3, Annex 11.4: Offshore Ornithology Displacement Modelling Report (Matrix Approach).

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

2.5.3.4 For all species, a range of impact levels has been modelled based on the impact values estimated in Volume 2, Chapter 11 Offshore Ornithology. As explained in Section 2.2, only the impact scenarios that surpassed the 0.02 percentage point threshold have been taken forward to PVA modelling.

2.5.3.5 The impacts for all species used in population modelling are presented in Table 2.5. The impact values used in the PVA assessment for all species are based on the assessments presented in Volume 2, Chapter 11: Offshore Ornithology.

Table 2.5: Impacts modelled for all species from impacts predicted in Volume 2, Chapter 11: Offshore Ornithology

Key to scenario names: "PA" = Project alone, "MPA" = Morven Programme assessment, "GU" = Guillemot

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
Morven North alone						
Common guillemot	Displacement	PA_GU_1	Breeding	NatureScot: 60% displacement, 3% mortality	74.3	0.0002968343
		PA_GU_2		NatureScot: 60% displacement, 5% mortality	123.8	0.0004947238
		PA_GU_3	Non-breeding	NatureScot: 60% displacement, 3% mortality	116.1	0.0002444096
		PA_GU_4	Post-breeding	NatureScot: 60% displacement, 1% mortality	138.5	0.0002916448
		PA_GU_5		NatureScot: 60% displacement, 3% mortality	415.4	0.0008749343
		PA_GU_6		Applicant: 50% displacement, 1% mortality	115.4	0.0002430373
		PA_GU_7	Annual	NatureScot: 60% displacement, 3% mortality (breeding), 1% mortality (non-breeding)	251.4	0.0005295092
		PA_GU_8		NatureScot: 60% displacement, 5% mortality (breeding), 3% mortality (non-breeding)	655.3	0.0013800015
		PA_GU_9		Applicant: 50% displacement, 1% mortality	168.3	0.0003543718
Razorbill	Displacement	PA_RA_1	Annual	NatureScot: 60% displacement, 5% mortality (breeding), 3% mortality (non-breeding)	138.6	0.0002341473
Morven Programme assessment						

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
Common guillemot	Displacement	MPA_GU_1	Breeding	NatureScot: 60% displacement, 3% mortality	89.3	0.0003569339
		MPA_GU_2		NatureScot: 60% displacement, 5% mortality	148.8	0.0005948899
		MPA_GU_4	Non-breeding	NatureScot: 60% displacement, 3% mortality	161.0	0.0003391036
		MPA_GU_5	Post-breeding	NatureScot: 60% displacement, 1% mortality	192.4	0.0004051242
		MPA_GU_6		NatureScot: 60% displacement, 3% mortality	577.1	0.0012153727
		MPA_GU_7		Applicant: 50% displacement, 1% mortality	160.3	0.0003376035
		MPA_GU_8	Annual	NatureScot: 60% displacement, 3% mortality (breeding), 1% mortality (non-breeding)	335.3	0.0007062184
		MPA_GU_9		NatureScot: 60% displacement, 5% mortality (breeding), 3% mortality (non-breeding)	886.9	0.0018679090
		MPA_GU_10		Applicant: 50% displacement, 1% mortality	229.8	0.0004840378
Razorbill	Displacement	MPA_RA_1	Post-breeding	NatureScot: 60% displacement, 3% mortality	170.4	0.0002879639
		MPA_RA_2	Annual	NatureScot: 60% displacement, 5% mortality (breeding), 3% mortality (non-breeding)	202.0	0.0003412595
Cumulative assessment						
Kittiwake	Collision	CEA_KI_1	Breeding	NatureScot	1418.44	0.0023697110
		CEA_KI_2		Applicant	475.80	0.0007948953

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
		CEA_KI_3	Post-breeding	NatureScot	928.21	0.0011184122
		CEA_KI_4		Applicant	336.51	0.0004054636
		CEA_KI_5	Pre-breeding	NatureScot	1038.96	0.0016548835
		CEA_KI_6		Applicant	373.82	0.0005954303
		CEA_KI_7	Annual	NatureScot	3385.61	0.0040793586
		CEA_KI_8		Applicant	1183.39	0.0014291807
	Displacement	CEA_KI_9	Breeding	NatureScot/Applicant: 30% displacement, 1% mortality	268.63	0.0004487896
		CEA_KI_10		30% displacement, 3% mortality	805.90	0.0013463689
		CEA_KI_11	Post-breeding	NatureScot/Applicant:30% displacement, 1% mortality	222.86	0.0002685240
		CEA_KI_12		30% displacement, 3% mortality	668.57	0.0008055720
		CEA_KI_13	Pre-breeding	NatureScot/Applicant:30% displacement, 1% mortality	198.89	0.0003168029
		CEA_KI_14		NatureScot: 30% displacement, 3% mortality	596.68	0.0009504087
		CEA_KI_15	Annual	NatureScot/Applicant:30% displacement, 1% mortality	690.38	0.0008318507
		CEA_KI_16		NatureScot: 30% displacement, 3% mortality	2071.15	0.0024955522
	Collision and displacement	CEA_KI_17	Breeding	NatureScot: 30% displacement, 1% mortality	1687.07	0.0028185007
		CEA_KI_18		NatureScot: 30% displacement, 3% mortality	2224.33	0.0037160799
		CEA_KI_19		Applicant	744.43	0.0012436849

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
		CEA_KI_20	Post-breeding	NatureScot: 30% displacement, 1% mortality	1151.07	0.0013869362
		CEA_KI_21		NatureScot: 30% displacement, 3% mortality	1596.79	0.0019239842
		CEA_KI_22		Applicant	559.37	0.0006739876
		CEA_KI_23	Pre-breeding	NatureScot: 30% displacement, 1% mortality	1237.86	0.0019716864
		CEA_KI_24		NatureScot: 30% displacement, 3% mortality	1635.64	0.0026052922
		CEA_KI_25		Applicant	572.71	0.0009122332
		CEA_KI_26	Annual	NatureScot: 30% displacement, 1% mortality	4075.99	0.0049112093
		CEA_KI_27		NatureScot: 30% displacement, 3% mortality	5456.76	0.0065749107
		CEA_KI_28		Applicant	1876.51	0.0022610314
Great black-backed gull	Collision	CEA_GB_1	Non-breeding	NatureScot	868.9	0.0095069462
		CEA_GB_2		Applicant	123.1	0.0013465724
		CEA_GB_3	Annual	NatureScot	867.9	0.0095172034
		CEA_GB_4		Applicant	123.2	0.0013480371
Herring gull	Collision	CEA_HG_1	Breeding	NatureScot	68.4	0.0030936818
		CEA_HG_2		Applicant	53.1	0.0023989342
		CEA_HG_3	Non-breeding	NatureScot	51.4	0.0023247753
		CEA_HG_4		Applicant	39.1	0.0017680398
		CEA_HG_5	Annual	NatureScot	119.9	0.0054184571
		CEA_HG_6		Applicant	92.2	0.0041669741

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
Common guillemot	Displacement	CEA_GU_1	Breeding	NatureScot: 60% displacement, 3% mortality	2624.8	0.0104921497
		CEA_GU_2		NatureScot: 60% displacement, 5% mortality	4374.7	0.0174869162
		CEA_GU_3		Applicant: 50% displacement, 1% mortality	729.1	0.0029144860
		CEA_GU_4	Post-breeding	NatureScot: 60% displacement, 1% mortality	192.4	0.0007689201
		CEA_GU_5		NatureScot: 60% displacement, 3% mortality	577.1	0.0023067602
		CEA_GU_6		Applicant: 50% displacement, 1% mortality	160.3	0.0006407667
		CEA_GU_7	Non-breeding	NatureScot: 60% displacement, 1% mortality	907.3	0.0019107623
		CEA_GU_8		NatureScot: 60% displacement, 3% mortality	2721.8	0.0057322870
		CEA_GU_9		Applicant: 50% displacement, 1% mortality	756.1	0.0015923019
		CEA_GU_10	Annual	NatureScot: 60% displacement, 3% mortality (breeding), 1% mortality (non-breeding)	3724.5	0.0078439387
		CEA_GU_11		NatureScot: 60% displacement, 5% mortality (breeding), 3% mortality (non-breeding)	7673.6	0.0161610798
		CEA_GU_12		Applicant: 50% displacement, 1% mortality	1645.5	0.0034654755
Razorbill	Displacement	CEA_RA_1	Breeding	NatureScot: 60% displacement, 3% mortality	407.6	0.0045766244

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
		CEA_RA_2		NatureScot: 60% displacement, 5% mortality	679.4	0.0076277073
		CEA_RA_3		Applicant: 50% displacement, 1% mortality	113.2	0.0012712845
		CEA_RA_4	Post-breeding	NatureScot: 60% displacement, 1% mortality	487.6	0.0008237439
		CEA_RA_5		NatureScot: 60% displacement, 3% mortality	1462.7	0.0024712317
		CEA_RA_6		Applicant: 50% displacement, 1% mortality	406.3	0.0006864532
		CEA_RA_7	Non-breeding	NatureScot: 60% displacement, 1% mortality	281.2	0.0012861440
		CEA_RA_8		NatureScot: 60% displacement, 3% mortality	843.5	0.0038584319
		CEA_RA_9		Applicant: 50% displacement, 1% mortality	234.3	0.0010717866
		CEA_RA_10	Pre-breeding	NatureScot: 60% displacement, 1% mortality	406.9	0.0006874564
		CEA_RA_11		NatureScot: 60% displacement, 3% mortality	1220.7	0.0020623693
		CEA_RA_12		Applicant: 50% displacement, 1% mortality	339.1	0.0005728804
		CEA_RA_13	Annual	60% displacement, 3% mortality (breeding), 1% mortality (non-breeding)	1583.2	0.0026749526
		CEA_RA_14		60% displacement, 5% mortality (breeding), 3% mortality (non-breeding)	4206.2	0.0071066098

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
		CEA_RA_15		Applicant: 50% displacement, 1% mortality	1092.9	0.0018465238
Puffin	Displacement	CEA_PU_1	Breeding	NatureScot: 60% displacement, 3% mortality	830.8	0.0018903173
		CEA_PU_2		NatureScot: 60% displacement, 5% mortality	1384.6	0.0031505288
		CEA_PU_3		Applicant: 50% displacement, 1% mortality	230.8	0.0005250881
		CEA_PU_4	Non-breeding	NatureScot: 60% displacement, 1% mortality	265.2	0.0011431728
		CEA_PU_5		NatureScot: 60% displacement, 3% mortality	795.5	0.0034295185
		CEA_PU_6		Applicant: 50% displacement, 1% mortality	221.0	0.0009526440
		CEA_PU_7	Annual	NatureScot: 60% displacement, 1% mortality	1096.0	0.0024936638
		CEA_PU_8		NatureScot: 60% displacement, 3% mortality	2180.1	0.0049605684
		CEA_PU_9		Applicant: 50% displacement, 1% mortality	451.8	0.0010278769
Gannet	Collision	CEA_GX_1	Breeding	NatureScot	850.8	0.0015194176
		CEA_GX_2		Applicant	834.6	0.0014903896
		CEA_GX_3	Post-breeding	NatureScot	124.7	0.0002731922
		CEA_GX_4		Applicant	124.6	0.0002730657
		CEA_GX_5	Annual	NatureScot	1017.7	0.0018174635
		CEA_GX_6		Applicant	1001.4	0.0017882789

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
	Displacement	CEA_GX_7	Breeding	NatureScot/Applicant: 70% displacement, 1% mortality	207.6	0.0003707402
		CEA_GX_8		70% displacement, 3% mortality	622.8	0.0011122207
		CEA_GX_9	Post-breeding	NatureScot/Applicant: 70% displacement, 1% mortality	186.5	0.0004087272
		CEA_GX_10		NatureScot: 70% displacement, 3% mortality	559.5	0.0012261815
		CEA_GX_11	Pre-breeding	NatureScot/Applicant: 70% displacement, 1% mortality	50.1	0.0002015406
		CEA_GX_12		NatureScot: 70% displacement, 3% mortality	150.2	0.0006046219
		CEA_GX_13	Annual	NatureScot/Applicant: 70% displacement, 1% mortality	444.2	0.0007931984
		CEA_GX_14		NatureScot: 70% displacement, 3% mortality	1332.5	0.0023795951
	Collision plus displacement	CEA_GX_15	Breeding	NatureScot: 70% displacement, 1% mortality	1058.4	0.0018901579
		CEA_GX_16		NatureScot: 70% displacement, 3% mortality	1473.6	0.0026316383
		CEA_GX_17		Applicant	1042.2	0.0018611298
		CEA_GX_18	Post-breeding	NatureScot: 70% displacement, 1% mortality	311.2	0.0006819193
		CEA_GX_19		NatureScot: 70% displacement, 3% mortality	684.2	0.0014993737
		CEA_GX_20		Applicant	311.1	0.0006817928
		CEA_GX_21	Pre-breeding	NatureScot: 70% displacement, 1% mortality	92.3	0.0003715899

Species	Impact	Scenario as used in this Technical Report	Season	Impact scenario	Predicted mortality (original impact) (no. of birds)	Predicted impact on adult survival rate (no. of absolute mortalities)
		CEA_GX_22		NatureScot: 70% displacement, 3% mortality	192.4	0.0007746711
		CEA_GX_23		Applicant	92.3	0.0003714695
		CEA_GX_24	Annual	NatureScot: 70% displacement, 1% mortality	1461.9	0.0026106618
		CEA_GX_25		NatureScot: 70% displacement, 3% mortality	2350.2	0.0041970585
		CEA_GX_26		Applicant	1445.5	0.0025814773

3 Results

3.1 Overview

3.1.1.1 The results of the PVA runs for impacts from Morven North alone, the Morven Programme assessment and Morven North cumulatively with other offshore wind farms on each species outlined in Section 2.2 are presented in Sections 3.2 to 3.8. PVA outputs are presented at the start of the operation and maintenance phase (2038), for the expected lifespan of Morven North (35 impacted years) (2072) and 50 impacted years (2087). The baseline 'unimpacted' scenarios (i.e. assuming no additional mortality other than baseline mortality exists) is also shown for comparison purposes.

3.2 Kittiwake

3.2.1 Cumulative assessment

3.2.1.1 The PVA outputs for impacts from Morven North cumulatively with other plans and projects on the regional populations of kittiwake are presented in Table 3.1.

Table 3.1: Population Viability Analysis results for Morven North cumulatively with other plans and projects in relation to impacts on regional populations of kittiwake

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %l	Quantile l=50 %U
1 (2038)	Breeding	Baseline (unimpacted)	-	630,338	-	1.0090	0.8599	1.1273	-	-	-	-
	Post-breeding		-	887,522	-	1.0075	0.8641	1.1234	-	-	-	-
	Pre-breeding		-	671,315	-	1.0077	0.8640	1.1234	-	-	-	-
	Annual		-	887,522	-	1.0075	0.8641	1.1234	-	-	-	-
35 (2072)	Breeding	Baseline (unimpacted)	-	680,958	9.21	1.0025	0.9812	1.0234	-	-	-	-
		CEA_KI_1	1418.4	616,634	-0.96	0.9997	0.9784	1.0206	0.9972	0.9064	40.78	59.06
		CEA_KI_2	475.8	658,502	5.69	1.0016	0.9803	1.0225	0.9991	0.9676	46.80	53.22
		CEA_KI_9	268.6	668,292	7.31	1.0020	0.9806	1.0229	0.9995	0.9814	48.14	52.00
		CEA_KI_10	805.9	643,825	3.35	1.0009	0.9796	1.0219	0.9984	0.9457	44.60	55.18
		CEA_KI_17	1687.1	605,024	-2.79	0.9992	0.9779	1.0201	0.9967	0.8896	39.02	60.70
		CEA_KI_18	2224.3	583,145	-6.36	0.9981	0.9768	1.0190	0.9956	0.8571	36.04	63.62
		CEA_KI_19	744.4	646,111	3.69	1.0010	0.9798	1.0220	0.9985	0.9497	44.92	54.70
	Post-breeding	Baseline (unimpacted)	-	965,263	10.66	1.0029	0.9814	1.0230	-	-	-	-
		CEA_KI_3	928.2	922,275	5.61	1.0016	0.9802	1.0217	0.9987	0.9546	46.22	54.02
		CEA_KI_4	336.5	950,074	8.71	1.0024	0.9811	1.0225	0.9995	0.9833	48.66	51.44
		CEA_KI_11	222.9	954,109	9.44	1.0026	0.9812	1.0227	0.9997	0.9889	49.06	50.96
		CEA_KI_12	668.6	933,453	6.88	1.0019	0.9805	1.0221	0.9990	0.9671	47.12	52.88
		CEA_KI_20	1151.1	911,597	4.60	1.0013	0.9800	1.0214	0.9984	0.9440	45.20	54.80
		CEA_KI_21	1596.8	891,773	2.11	1.0006	0.9791	1.0207	0.9977	0.9232	43.50	56.42

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %l	Quantile l=50 %U
		CEA_KI_22	559.4	937,233	7.57	1.0021	0.9808	1.0221	0.9992	0.9722	47.46	52.36
	Pre-breeding	Baseline (unimpacted)	-	729,117	10.53	1.003	0.981	1.023	-	-	-	-
		CEA_KI_5	1039.0	681,760	3.35	1.001	0.980	1.021	0.998	0.934	44.2	55.5
		CEA_KI_6	373.8	712,186	8.08	1.002	0.981	1.022	0.999	0.976	47.7	52.1
		CEA_KI_13	198.9	721,979	9.23	1.003	0.981	1.023	1.000	0.987	49.1	50.9
		CEA_KI_14	596.7	702,092	6.30	1.002	0.980	1.022	0.999	0.961	46.7	53.2
		CEA_KI_23	1237.9	671,965	1.90	1.001	0.979	1.021	0.998	0.921	43.2	56.5
		CEA_KI_24	1635.6	654,813	-0.75	1.000	0.979	1.020	0.997	0.898	41.3	58.7
		CEA_KI_25	572.7	702,591	6.46	1.002	0.980	1.022	0.999	0.963	46.7	53.1
	Annual	Baseline (unimpacted)	-	965,263	10.66	1.0029	0.9814	1.0230	-	-	-	-
		CEA_KI_7	3385.6	815,010	-6.69	0.9980	0.9766	1.0182	0.9952	0.8441	36.14	63.84
		CEA_KI_8	1183.1	909,485	4.28	1.0012	0.9799	1.0213	0.9983	0.9426	44.98	55.08
		CEA_KI_15	690.4	932,656	6.88	1.0019	0.9805	1.0220	0.999	0.966	46.98	52.96
		CEA_KI_16	2071.2	869,909	-0.26	0.9999	0.9786	1.0200	0.997	0.9015	41.68	58.48
		CEA_KI_26	4076.0	786,664	-9.93	0.9970	0.9759	1.0172	0.9942	0.8153	33.62	66.54
		CEA_KI_27	5456.8	735,003	-15.87	0.9951	0.9738	1.0152	0.9922	0.7607	28.68	72.5
		CEA_KI_28	1876.5	878,239	0.68	1.0002	0.9788	1.0203	0.9973	0.9103	42.42	57.74
50 (2087)	Breeding	Baseline (unimpacted)	-	707,577	14.20	1.0027	0.9850	1.0195	-	-	-	-
		CEA_KI_1	1418.4	614,681	-0.99	0.9998	0.9821	1.0165	0.9972	0.8690	38.74	61.34
		CEA_KI_2	475.8	676,058	8.85	1.0017	0.9840	1.0184	0.9991	0.9540	46.36	53.80
		CEA_KI_9	268.6	688,820	11.18	1.0021	0.9844	1.0189	0.9995	0.9736	47.70	52.10

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %l	Quantile l=50 %U
		CEA_KI_10	805.9	653,496	5.33	1.0010	0.9833	1.0178	0.9984	0.9234	43.44	56.46
		CEA_KI_17	1687.1	598,550	-3.49	0.9993	0.9815	1.0160	0.9967	0.8461	36.58	63.14
		CEA_KI_18	2224.3	567,705	-8.52	0.9982	0.9805	1.0150	0.9956	0.8022	32.50	66.72
		CEA_KI_19	744.4	657,224	6.01	1.0012	0.9834	1.0179	0.9985	0.9288	43.90	55.94
	Post-breeding	Baseline (unimpacted)	-	1,001,529	14.73	1.0028	0.9857	1.0198	-	-	-	-
		CEA_KI_3	928.2	935,966	7.33	1.0014	0.9844	1.0184	0.9987	0.9358	44.84	55.80
		CEA_KI_4	336.5	976,075	11.98	1.0023	0.9852	1.0193	0.9995	0.9762	48.32	52.08
		CEA_KI_11	222.9	983,718	12.92	1.0024	0.9853	1.0194	0.9997	0.9841	48.74	51.50
		CEA_KI_12	668.6	952,686	9.22	1.0018	0.9847	1.0187	0.9990	0.9534	46.16	54.18
		CEA_KI_20	1151.1	920,993	5.62	1.0011	0.9841	1.0181	0.9984	0.9211	43.84	56.88
		CEA_KI_21	1596.8	890,832	2.26	1.0004	0.9834	1.0175	0.9977	0.8921	41.44	59.28
		CEA_KI_22	559.4	959,805	10.19	1.0019	0.9849	1.0189	0.9992	0.9607	46.98	53.50
	Pre-breeding	Baseline (unimpacted)	-	756,640	14.69	1.0027	0.9857	1.0198	-	-	-	-
		CEA_KI_5	1039.0	685,036	3.78	1.0007	0.9837	1.0178	0.9980	0.9064	42.46	57.94
		CEA_KI_6	373.8	730,535	10.58	1.0020	0.9850	1.0191	0.9993	0.9652	47.62	52.88
		CEA_KI_13	198.9	741,426	12.51	1.0024	0.9853	1.0194	0.9996	0.9812	48.48	51.62
		CEA_KI_14	596.7	714,333	8.34	1.0016	0.9846	1.0186	0.9989	0.9452	45.50	54.64
		CEA_KI_23	1237.9	672,439	1.99	1.0004	0.9834	1.0174	0.9977	0.8897	41.20	59.32
		CEA_KI_24	1635.6	647,585	-1.66	0.9997	0.9825	1.0166	0.9969	0.8569	38.76	61.94
		CEA_KI_25	572.7	716,204	8.66	1.0017	0.9846	1.0186	0.9989	0.9473	45.86	54.54
	Annual	Baseline (unimpacted)	-	1,001,529	14.73	1.0028	0.9857	1.0198	-	-	-	-

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
		CEA_KI_7	3385.6	787,000	-9.95	0.9979	0.9809	1.0149	0.9952	0.7849	32.88	68.06
		CEA_KI_8	1183.4	919,268	5.32	1.0010	0.9839	1.0181	0.9983	0.9190	43.68	57.08
		CEA_KI_15	690.4	951,414	9.14	1.0018	0.9847	1.0188	0.9990	0.9519	46.10	54.22
		CEA_KI_16	2071.2	862,156	-1.11	0.9998	0.9827	1.0168	0.9970	0.8624	39.34	61.74
		CEA_KI_26	4076.0	747,166	-14.49	0.9969	0.9799	1.0139	0.9942	0.7471	29.82	71.32
		CEA_KI_27	5456.8	677,776	-22.34	0.9950	0.9779	1.0120	0.9922	0.6764	23.76	77.28
		CEA_KI_28	1876.5	874,739	0.36	1.0001	0.9830	1.0171	0.9973	0.8744	40.20	60.72

3.3 Great black-backed gull

3.3.1 Cumulative assessment

3.3.1.1 The PVA outputs for impacts from Morven North cumulatively with other plans and projects on the regional populations of great black-backed gull are presented in Table 3.2.

Table 3.2: Population Viability Analysis results for Morven North cumulatively with other plans and projects in relation to impacts on regional populations of great black-backed gull

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Non-breeding	Baseline (unimpacted)	-	146,242	-	1.0237	0.9019	1.1286	-	-	-	-
	Annual		-	146,242	-	1.0237	0.9019	1.1286	-	-	-	-
35 (2072)	Non-breeding	Baseline (unimpacted)	-	290,103	105.39	1.0206	1.0024	1.0383	-	-	-	-
		CEA_GB_1	868.9	193,680	37.00	1.0090	0.9907	1.0267	0.9885	0.6675	15.50	84.22
		CEA_GB_2	123.1	274,084	94.10	1.0191	1.0007	1.0368	0.9984	0.9447	44.18	55.38
	Annual	Baseline (unimpacted)	-	290,103	105.39	1.0206	1.0024	1.0383	-	-	-	-
		CEA_GB_3	869.9	193,636	37.09	1.0091	0.9906	1.0266	0.9885	0.6674	15.50	84.26
		CEA_GB_4	123.2	274,108	94.04	1.0191	1.0007	1.0368	0.9984	0.9447	44.22	55.54
50 (2087)	Non-breeding	Baseline (unimpacted)	-	395,866	176.71	1.0206	1.0052	1.0359	-	-	-	-
		CEA_GB_1	868.9	222,007	55.10	1.0088	0.9936	1.0242	0.9885	0.5614	9.86	89.90
		CEA_GB_2	123.1	365,457	154.76	1.0189	1.0035	1.0342	0.9984	0.9216	43.32	57.56
	Annual	Baseline (unimpacted)	-	395,866	176.71	1.0206	1.0052	1.0359	-	-	-	-
		CEA_GB_3	869.9	221,565	55.47	1.0088	0.9935	1.0241	0.9885	0.5609	9.68	89.88
		CEA_GB_4	123.2	364,531	154.93	1.0189	1.0035	1.0342	0.9984	0.9216	43.06	57.34

3.4 Herring gull

3.4.1 Cumulative assessment

3.4.1.1 The PVA outputs for impacts from Morven North cumulatively with other plans and projects on the regional populations of herring gull are presented in Table 3.3.

Table 3.3: Population Viability Analysis results for Morven North cumulatively with other plans and projects in relation to impacts on regional populations of herring gull

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Breeding	Baseline (unimpacted)	-	9,212	-	0.9536	0.8211	1.0671	-	-	-	-
	Non-breeding		-	9,212	-	0.9536	0.8211	1.0671	-	-	-	-
	Annual		-	9,212	-	0.9536	0.8211	1.0671	-	-	-	-
35 (2072)	Breeding	Baseline (unimpacted)	-	1,531	-84.03	0.9489	0.9288	0.9692	-	-	-	-
		CEA_HG_1	68.4	1,346	-86.03	0.9453	0.9252	0.9657	0.9963	0.8784	37.92	60.80
		CEA_HG_2	53.1	1,394	-85.58	0.9462	0.9255	0.9663	0.9971	0.9044	41.06	58.18
	Non-breeding	Baseline (unimpacted)	-	1,531	-84.03	0.9489	0.9288	0.9692	-	-	-	-
		CEA_HG_3	51.4	1,389	-85.51	0.9463	0.9257	0.9666	0.9972	0.9074	40.84	58.38
		CEA_HG_4	39.1	1,425	-85.11	0.9470	0.9264	0.9671	0.9979	0.9291	43.22	55.88
	Annual	Baseline (unimpacted)	-	1,531	-84.03	0.9489	0.9288	0.9692	-	-	-	-
		CEA_HG_5	119.9	1,218	-87.27	0.9428	0.9222	0.9630	0.9935	0.7951	30.66	68.82
		CEA_HG_6	92.2	1,291	-86.72	0.9440	0.9237	0.9645	0.9950	0.8381	34.34	64.44
50 (2087)	Breeding	Baseline (unimpacted)	-	702	-92.72	0.9490	0.9316	0.9658	-	-	-	-
		CEA_HG_1	68.4	581	-93.91	0.9456	0.9282	0.9624	0.9963	0.8332	36.16	63.78
		CEA_HG_2	53.1	606	-93.69	0.9462	0.9287	0.9630	0.9971	0.8641	39.02	60.70
	Non-breeding	Baseline (unimpacted)	-	702	-92.72	0.9490	0.9316	0.9658	-	-	-	-
		CEA_HG_3	51.4	608	-93.70	0.9462	0.9289	0.9630	0.9972	0.8692	39.08	60.44
		CEA_HG_4	39.1	630	-93.43	0.9470	0.9293	0.9640	0.9979	0.9004	41.88	57.64

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %l	Quantile l=50 %U
	Annual	Baseline (unimpacted)	-	702	-92.72	0.9490	0.9316	0.9658	-	-	-	-
		CEA_HG_5	119.9	506	-94.75	0.9428	0.9253	0.9595	0.9935	0.7200	26.96	73.10
		CEA_HG_6	92.2	547	-94.36	0.9441	0.9268	0.9611	0.9949	0.7757	31.90	68.44

3.5 Common guillemot

3.5.1.1 The PVA outputs for impacts from Morven North alone on the regional populations of common guillemot are presented in Table 3.4. The PVA outputs for impacts from the Morven Programme assessment on the regional populations of common guillemot are presented in Table 3.5. The PVA outputs for impacts from Morven North cumulatively with other plans and projects on the regional populations of common guillemot are presented in Table 3.6.

3.5.2 Project alone assessment

Table 3.4: Population Viability Analysis results for Morven North alone in relation to impacts on regional populations of common guillemot

Key to scenario names: "PA" = Project alone, "GU" = Guillemot

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Breeding	Baseline (unimpacted)	-	384,606	-	1.0268	0.9547	1.0897	-	-	-	-
	Non-breeding		-	729,748	-	1.0269	0.9548	1.0897	-	-	-	-
	Post-breeding		-	729,995	-	1.0269	0.9549	1.0892	-	-	-	-
	Annual		-	729,995	-	1.0269	0.9549	1.0892	-	-	-	-
35 (2072)	Breeding	Baseline (unimpacted)	-	897,874	140.01	1.0253	1.0165	1.0336	-	-	-	-
		PA_GU_1	74.3	887,337	137.09	1.0250	1.0162	1.0333	0.9997	0.9883	47.62	52.88
		PA_GU_2	123.8	880,115	135.29	1.0247	1.0160	1.0331	0.9994	0.9807	45.72	54.58
	Non-breeding	Baseline (unimpacted)	-	1,704,529	139.87	1.0253	1.0166	1.0336	-	-	-	-
		PA_GU_3	116.1	1,688,196	137.70	1.0250	1.0162	1.0333	0.9997	0.9905	47.86	52.46
	Post-breeding	Baseline (unimpacted)	-	1,703,305	139.93	1.0253	1.0166	1.0336	-	-	-	-
		PA_GU_4	138.5	1,683,996	137.21	1.0250	1.0162	1.0333	0.9997	0.9886	47.42	52.60
		PA_GU_5	415.4	1,646,494	131.72	1.0243	1.0155	1.0326	0.9990	0.9662	42.96	57.58
		PA_GU_6	115.4	1,687,368	137.67	1.0250	1.0162	1.0334	0.9997	0.9905	47.78	52.00
	Annual	Baseline (unimpacted)	-	1,703,305	139.93	1.0253	1.0166	1.0336	-	-	-	-
		PA_GU_7	251.4	1,668,346	135.01	1.0247	1.0159	1.0330	0.9994	0.9794	45.54	54.54

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
		PA_GU_8	655.3	1,613,204	127.38	1.0237	1.0149	1.0320	0.9985	0.9472	38.62	62.18
		PA_GU_9	168.3	1,679,913	136.62	1.0249	1.0161	1.0332	0.9996	0.9863	46.92	53.06
50 (2087)	Breeding	Baseline (unimpacted)	-	1,305,755	249.82	1.0254	1.0179	1.0322	-	-	-	-
		PA_GU_1	74.3	1,284,270	243.83	1.0250	1.0175	1.0319	0.9997	0.9835	47.14	53.10
		PA_GU_2	123.8	1,271,085	240.20	1.0248	1.0173	1.0317	0.9994	0.9725	45.16	55.36
	Non-breeding	Baseline (unimpacted)	-	2,479,951	249.55	1.0253	1.0179	1.0322	-	-	-	-
		PA_GU_3	116.1	2,445,099	244.90	1.0251	1.0176	1.0319	0.9997	0.9864	47.72	52.78
	Post-breeding	Baseline (unimpacted)	-	2,481,321	249.80	1.0254	1.0179	1.0322	-	-	-	-
		PA_GU_4	138.5	2,441,303	244.00	1.0250	1.0175	1.0319	0.9997	0.9838	47.24	53.24
		PA_GU_5	415.4	2,361,835	232.92	1.0243	1.0169	1.0312	0.9990	0.9521	40.92	59.78
		PA_GU_6	115.4	2,447,659	245.11	1.0251	1.0176	1.0319	0.9997	0.9865	47.76	52.86
	Annual	Baseline (unimpacted)	-	2,481,321	249.80	1.0254	1.0179	1.0322	-	-	-	-
		PA_GU_7	251.4	2,405,439	239.48	1.0247	1.0172	1.0316	0.9994	0.9707	44.20	55.98
		PA_GU_8	655.3	2,294,113	223.45	1.0238	1.0163	1.0306	0.9985	0.9255	35.22	64.94
		PA_GU_9	168.3	2,433,158	242.86	1.0249	1.0175	1.0318	0.9996	0.9803	46.70	54.00

3.5.3 Morven Programme assessment

Table 3.5: Common guillemot Population Viability Analysis results for the Morven Programme in relation to impacts on regional populations of common guillemot

Key to scenario names: "MPA" = Morven Programme assessment, "GU" = Guillemot

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Breeding	Baseline (unimpacted)	-	384,606	-	1.0268	0.9547	1.0897	-	-	-	-
	Non-breeding		-	729,995	-	1.0269	0.9549	1.0892	-	-	-	-
	Post-breeding		-	729,748	-	1.0269	0.9548	1.0897	-	-	-	-
	Annual		-	729,995	-	1.0269	0.9549	1.0892	-	-	-	-
35 (2072)	Breeding	Baseline (unimpacted)	-	897,874	140.01	1.0253	1.0165	1.0336	-	-	-	-
		MPA_GU_1	89.3	885,306	136.49	1.0249	1.0161	1.0332	0.9996	0.9859	46.96	53.42
		MPA_GU_2	148.8	877,085	134.41	1.0246	1.0158	1.0329	0.9993	0.9768	45.02	55.24
	Non-breeding	Baseline (unimpacted)	-	1,704,529	139.91	1.0253	1.0166	1.0336	-	-	-	-
		MPA_GU_4	161.0	1,681,566	136.88	1.0249	1.0161	1.0332	0.9996	0.9866	47.10	53.22
	Post-breeding	Baseline (unimpacted)	-	1,703,305	139.93	1.0253	1.0166	1.0336	-	-	-	-
		MPA_GU_5	192.4	1,675,648	136.26	1.0249	1.0160	1.0331	0.9995	0.9842	46.48	53.68
		MPA_GU_6	577.1	1,623,583	128.86	1.0239	1.0151	1.0322	0.9986	0.9533	39.80	60.48
		MPA_GU_7	160.3	1,681,684	136.77	1.0249	1.0161	1.0333	0.9996	0.9868	47.22	53.12
	Annual	Baseline (unimpacted)	-	1,703,305	139.93	1.0253	1.0166	1.0336	-	-	-	-
		MPA_GU_8	335.3	1,655,595	133.32	1.0245	1.0157	1.0328	0.9992	0.9726	44.04	56.22
		MPA_GU_9	886.9	1,582,489	122.92	1.0232	1.0144	1.0315	0.9979	0.9292	34.56	66.08

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
		MPA_GU_10	229.8	1,671,314	135.38	1.0248	1.0160	1.0331	0.9995	0.9812	45.90	54.10
50 (2087)	Breeding	Baseline (unimpacted)	-	1,305,755	249.82	1.0254	1.0179	1.0322	-	-	-	-
		MPA_GU_1	89.3	1,278,850	242.99	1.0250	1.0175	1.0318	0.9996	0.9800	46.26	53.68
		MPA_GU_2	148.8	1,263,651	238.10	1.0247	1.0172	1.0315	0.9993	0.9670	43.86	56.46
	Non-breeding	Baseline (unimpacted)	-	2,479,951	249.55	1.0253	1.0179	1.0322	-	-	-	-
		MPA_GU_4	161.0	2,432,119	243.14	1.0250	1.0175	1.0318	0.9996	0.9810	46.60	53.66
	Post-breeding	Baseline (unimpacted)	-	2,481,321	249.80	1.0254	1.0179	1.0322	-	-	-	-
		MPA_GU_5	192.4	2,422,673	241.83	1.0249	1.0174	1.0317	0.9995	0.9774	45.82	54.64
		MPA_GU_6	577.1	2,316,341	226.49	1.0239	1.0165	1.0308	0.9986	0.9341	37.06	63.20
		MPA_GU_7	160.3	2,432,781	243.11	1.0250	1.0175	1.0318	0.9996	0.9812	46.68	53.84
	Annual	Baseline (unimpacted)	-	2,481,321	249.80	1.0254	1.0179	1.0322	-	-	-	-
		MPA_GU_8	335.3	2,383,112	236.27	1.0246	1.0171	1.0314	0.9992	0.9611	42.68	58.08
		MPA_GU_9	886.9	2,233,025	214.90	1.0232	1.0157	1.0301	0.9979	0.9003	30.32	69.78
		MPA_GU_10	229.8	2,413,718	240.30	1.0248	1.0173	1.0317	0.9995	0.9732	45.20	55.38

3.5.4 Cumulative assessment

Table 3.6: Population Viability Analysis results for Morven North cumulatively with other plans and projects in relation to impacts on regional populations of common guillemot

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Breeding	Baseline (unimpacted)	-	384,628	-	1.0268	0.9951	1.0897	-	-	-	-
	Post-breeding		-	729,748	-	1.0269	0.9548	1.0897	-	-	-	-
	Non-breeding		-	729,748	-	1.0269	0.9548	1.0897	-	-	-	-
	Annual		-	729,748	-	1.0269	0.9548	1.0897	-	-	-	-
35 (2072)	Breeding	Baseline (unimpacted)	-	897,651	140.01	1.0253	1.0165	1.0337	-	-	-	-
		CEA_GU_1	2624.8	593,167	58.54	1.0133	1.0045	1.0215	0.9882	0.6607	1.08	99.40
		CEA_GU_2	4374.7	448,630	19.88	1.0052	0.9964	1.0135	0.9804	0.4998	0.00	100.00
		CEA_GU_3	729.1	800,198	113.97	1.0220	1.0132	1.0303	0.9967	0.8917	26.20	74.80
	Post-breeding	Baseline (unimpacted)	-	1,704,529	139.91	1.0253	1.0166	1.0336	-	-	-	-
		CEA_GU_4	192.4	1,677,167	136.14	1.0249	1.0161	1.0331	0.9995	0.9842	46.64	53.60
		CEA_GU_5	577.1	1,624,581	128.89	1.0239	1.0151	1.0322	0.9986	0.9533	40.00	60.64
		CEA_GU_6	160.3	1,680,867	136.78	1.0249	1.0162	1.0332	0.9996	0.9867	47.00	53.20
	Non-breeding	Baseline (unimpacted)	-	1,704,529	139.91	1.0253	1.0166	1.0336	-	-	-	-
		CEA_GU_7	907.3	1,580,621	122.59	1.0231	1.0143	1.0314	0.9979	0.9277	34.28	66.76
		CEA_GU_8	2,721.8	1,359,041	91.36	1.0187	1.0100	1.0270	0.9936	0.7979	10.46	90.08
		CEA_GU_9	756.1	1,599,641	125.40	1.0235	1.0147	1.0318	0.9982	0.9393	36.74	64.16

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
	Annual	Baseline (unimpacted)	-	1,704,529	139.91	1.0253	1.0166	1.0336	-	-	-	-
		CEA_GU_10	3724.5	1,250,536	76.03	1.0163	1.0075	1.0246	0.9912	0.7340	4.44	95.98
		CEA_GU_11	7673.6	898,236	26.46	1.0067	0.9980	1.0150	0.9819	0.5271	0.00	100.00
		CEA_GU_12	1645.5	1,486,401	109.30	1.0213	1.0126	1.0296	0.9961	0.8725	22.60	78.98
50 (2087)	Breeding	Baseline (unimpacted)	-	1,306,249	249.75	1.0254	1.0178	1.0322	-	-	-	-
		CEA_GU_1	2624.8	722,920	93.47	1.0133	1.0058	1.0201	0.9882	0.5533	0.34	99.96
		CEA_GU_2	4374.7	485,182	29.88	1.0052	0.9978	1.0121	0.9804	0.3713	0.00	100.00
		CEA_GU_3	729.1	1,108,194	196.86	1.0220	1.0145	1.0289	0.9967	0.8489	20.94	78.60
	Post-breeding	Baseline (unimpacted)	-	2,479,951	249.55	1.0253	1.0179	1.0322	-	-	-	-
		CEA_GU_4	192.4	2,423,707	241.77	1.0249	1.0174	1.0317	0.9995	0.9775	45.80	54.38
		CEA_GU_5	577.1	2,316,419	226.72	1.0240	1.0165	1.0308	0.9986	0.9340	37.06	63.04
		CEA_GU_6	160.3	2,432,587	243.13	1.0250	1.0175	1.0318	0.9996	0.9812	46.60	53.68
	Non-breeding	Baseline (unimpacted)	-	2,479,951	249.55	1.0253	1.0179	1.0322	-	-	-	-
		CEA_GU_7	907.3	2,229,774	214.26	1.0232	1.0157	1.0300	0.9979	0.8983	30.06	70.06
		CEA_GU_8	2,721.8	1,795,670	153.31	1.0188	1.0113	1.0256	0.9936	0.7243	5.88	94.86
		CEA_GU_9	756.1	2,266,405	219.77	1.0235	1.0161	1.0304	0.9982	0.9144	33.10	67.16
	Annual	Baseline (unimpacted)	-	2,479,951	249.55	1.0253	1.0179	1.0322	-	-	-	-
		CEA_GU_10	3724.5	1,594,222	124.92	1.0163	1.0088	1.0232	0.9912	0.6429	1.82	98.72
		CEA_GU_11	7673.6	993,808	40.10	1.0068	0.9993	1.0136	0.9819	0.4006	0.00	100.00
		CEA_GU_12	1645.5	2,041,483	187.80	1.0214	1.0139	1.0282	0.9961	0.8230	16.88	82.90

3.6 Razorbill

3.6.1.1 The PVA outputs for impacts from Morven North alone on the regional populations of razorbill are presented in Table 3.7. The PVA outputs for impacts from the Morven Programme assessment on the regional populations of razorbill are presented in Table 3.8. The PVA outputs for impacts from Morven North cumulatively with other plans and projects on the regional populations of razorbill are presented in Table 3.9.

3.6.2 Project alone assessment

Table 3.7: Population Viability Analysis results for Morven North alone in relation to impacts on regional populations of razorbill

Key to scenario names: "PA" = Project alone, "RA" = Razorbill

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Annual	Baseline (unimpacted)	-	340,779	-	0.9832	0.8305	1.1003	-	-	-	-
35 (2072)	Annual	Baseline (unimpacted)	-	148,324	-56.77	0.9763	0.9546	0.9954	-	-	-	-
	Annual	PA_RA_1	138.6	146,973	-57.16	0.9761	0.9545	0.9952	0.9997	0.9903	49.22	50.72
50 (2087)	Annual	Baseline (unimpacted)	-	103,775	-70.59	0.9761	0.9587	0.9929	-	-	-	-
	Annual	PA_RA_1	138.6	101,912	-70.79	0.9758	0.9584	0.9926	0.9997	0.9864	48.78	51.34

3.6.3 Morven Programme assessment

Table 3.8: Population Viability Analysis results for the Morven Programme in relation to impacts on regional populations of razorbill

Key to scenario names: "MPA" = Morven programme assessment, "RA" = Razorbill

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Post-breeding	Baseline (unimpacted)	-	341,066	-	0.9832	0.8305	1.1003	-	-	-	-
	Annual		-	340,779	-	0.9834	0.8301	1.1005	-	-	-	-
35 (2072)	Post-breeding	Baseline (unimpacted)	-	148,341	-56.72	0.9764	0.9549	0.9955	-	-	-	-
		MPA_RA_1	170.4	146,672	-57.28	0.9760	0.9544	0.9950	0.9997	0.9879	48.94	50.98
	Annual	Baseline (unimpacted)	-	148,324	-56.77	0.9763	0.9546	0.9954	-	-	-	-
		MPA_RA_2	202.0	146,365	-57.38	0.9759	0.9544	0.9951	0.9996	0.9861	48.90	51.22
50 (2087)	Post-breeding	Baseline (unimpacted)	-	103,476	-70.20	0.9761	0.9586	0.9929	-	-	-	-
		MPA_RA_1	170.4	101,801	-70.70	0.9757	0.9584	0.9926	0.9997	0.9830	48.64	51.72
	Annual	Baseline (unimpacted)	-	103,775	-70.15	0.9761	0.9587	0.9929	-	-	-	-
		MPA_RA_2	202.0	101,557	-70.79	0.9757	0.9583	0.9925	0.9996	0.9801	48.84	51.20

3.6.4 Cumulative assessment

Table 3.9: Population Viability Analysis results for Morven North cumulatively with other plans and projects in relation to impacts on regional populations of razorbill

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %l	Quantile l=50 %U
1 (2038)	Breeding	Baseline (unimpacted)	-	59,562	-	0.9823	0.8258	1.1046	-	-	-	-
	Post-breeding		-	340,968	-	0.9831	0.8309	1.1008	-	-	-	-
	Non-breeding		-	125,869	-	0.9834	0.8307	1.1001	-	-	-	-
	Pre-breeding		-	340,968	-	0.9831	0.8309	1.1008	-	-	-	-
	Annual		-	340,968	-	0.9831	0.8309	1.1008	-	-	-	-
35 (2072)	Breeding	Baseline (unimpacted)	-	25,831	-57.50	0.9758	0.9544	0.9961				
		CEA_RA_1	407.6	21,305	-64.70	0.9707	0.9492	0.9909	0.9946	0.8269	34.56	66.56
		CEA_RA_2	679.4	18,748	-68.96	0.9671	0.9458	0.9875	0.9910	0.7285	24.96	75.88
		CEA_RA_3	113.2	24,427	-59.61	0.9744	0.9529	0.9947	0.9985	0.9485	45.28	55.16
	Post-breeding	Baseline (unimpacted)	-	148,149	-56.74	0.9763	0.9548	0.9954	-	-	-	-
		CEA_RA_4	487.6	143,148	-58.20	0.9754	0.9538	0.9945	0.9990	0.9667	46.78	52.82
		CEA_RA_5	1462.7	133,819	-60.96	0.9735	0.9519	0.9926	0.9971	0.9030	41.32	58.38
		CEA_RA_6	406.3	144,338	-57.99	0.9755	0.9540	0.9946	0.9992	0.9720	47.40	52.30
	Non-breeding	Baseline (unimpacted)	-	54,768	-56.78	0.9763	0.9548	0.9954	-	-	-	-
		CEA_RA_7	281.2	51,947	-58.98	0.9749	0.9531	0.9939	0.9985	0.9482	45.50	54.46
		CEA_RA_8	843.5	46,699	-63.13	0.9719	0.9503	0.9910	0.9954	0.8519	36.54	63.04

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
		CEA_RA_9	234.3	52,462	-58.66	0.9751	0.9536	0.9942	0.9987	0.9563	46.08	53.70
	Pre-breeding	Baseline (unimpacted)	-	148,149	-56.74	0.9763	0.9548	0.9954	-	-	-	-
		CEA_RA_10	406.9	144,101	-57.97	0.9755	0.9539	0.9947	0.9992	0.9720	47.22	52.32
		CEA_RA_11	1220.7	136,377	-60.33	0.9739	0.9524	0.9930	0.9976	0.9182	43.04	57.12
		CEA_RA_12	339.0	144,996	-57.76	0.9757	0.9542	0.9947	0.9993	0.9765	47.82	51.78
	Annual	Baseline (unimpacted)	-	148,149	-56.74	0.9763	0.9548	0.9954	-	-	-	-
		CEA_RA_13	1583.2	132,638	-61.28	0.9733	0.9516	0.9923	0.9968	0.8953	40.60	59.04
		CEA_RA_14	4206.2	110,246	-67.83	0.9681	0.9465	0.9872	0.9916	0.7448	26.34	72.62
		CEA_RA_15	1092.9	137,280	-59.90	0.9742	0.9526	0.9932	0.9978	0.9265	43.68	56.44
50 (2087)	Breeding	Baseline (unimpacted)	-	17,718	-70.68	0.9758	0.9585	0.9927	-	-	-	-
		CEA_RA_1	407.6	13,474	-77.64	0.9705	0.9532	0.9874	0.9946	0.7629	29.86	68.74
		CEA_RA_2	679.4	11,243	-81.32	0.9670	0.9498	0.9839	0.9910	0.6359	19.98	79.78
		CEA_RA_3	113.2	16,385	-72.85	0.9743	0.9570	0.9913	0.9985	0.9271	44.22	55.60
	Post-breeding	Baseline (unimpacted)	-	103,596	-70.19	0.9761	0.9586	0.9928	-	-	-	-
		CEA_RA_4	487.6	98,660	-71.65	0.9751	0.9577	0.9919	0.9990	0.9525	46.48	53.86
		CEA_RA_5	1462.7	89,417	-74.25	0.9732	0.9558	0.9900	0.9971	0.8643	39.18	61.00
		CEA_RA_6	406.3	99,469	-71.38	0.9753	0.9579	0.9921	0.9992	0.9604	47.06	53.24
	Non-breeding	Baseline (unimpacted)	-	38,244	-70.14	0.9761	0.9588	0.9928	-	-	-	-
		CEA_RA_7	281.2	35,471	-72.43	0.9746	0.9573	0.9914	0.9985	0.9264	44.64	56.20
		CEA_RA_8	843.5	30,428	-76.21	0.9717	0.9541	0.9884	0.9955	0.7957	33.14	66.64

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %l	Quantile l=50 %U
		CEA_RA_9	234.3	35,925	-72.01	0.9749	0.9574	0.9916	0.9987	0.9383	45.54	55.24
	Pre-breeding	Baseline (unimpacted)	-	103,596	-70.19	0.9761	0.9586	0.9928	-	-	-	-
		CEA_RA_10	406.9	99,548	-71.36	0.9753	0.9579	0.9921	0.9992	0.9604	47.14	53.34
		CEA_RA_11	1220.7	91,618	-73.60	0.9737	0.9563	0.9905	0.9976	0.8852	40.84	59.60
		CEA_RA_12	339.0	100,133	-71.21	0.9754	0.9580	0.9922	0.9993	0.9667	47.58	52.76
	Annual	Baseline (unimpacted)	-	103,596	-70.19	0.9761	0.9586	0.9928	-	-	-	-
		CEA_RA_13	1583.2	88,359	-74.56	0.9730	0.9556	0.9898	0.9968	0.8538	38.34	62.12
		CEA_RA_14	4206.2	67,798	-80.45	0.9679	0.9505	0.9847	0.9916	0.6564	21.26	78.32
		CEA_RA_15	1092.9	92,787	-73.30	0.9739	0.9565	0.9908	0.9978	0.8966	41.56	58.60

3.7 Puffin

3.7.1 Cumulative assessment

3.7.1.1 The PVA outputs for impacts from Morven North cumulatively with other plans and projects on the regional populations of puffin are presented in Table 3.10.

Table 3.10: Population Viability Analysis results for Morven North cumulatively with other plans and projects in relation to impacts on regional populations of puffin

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Breeding	Baseline (unimpacted)	-	275,006	-	0.9823	0.8109	1.0976	-	-	-	-
	Non-breeding		-	121,749	-	0.9816	0.8109	1.0947	-	-	-	-
	Annual		-	275,006	-	0.9823	0.8109	1.0976	-	-	-	-
35 (2072)	Breeding	Baseline (unimpacted)	-	103,342	-63.27	0.9718	0.9467	0.9953	-	-	-	-
		CEA_PU_1	830.8	95,192	-66.04	0.9696	0.9445	0.9931	0.9978	0.9253	44.00	56.00
		CEA_PU_2	1384.6	90,492	-67.76	0.9682	0.9432	0.9916	0.9963	0.8783	40.76	59.78
		CEA_PU_3	230.8	100,879	-64.08	0.9712	0.9463	0.9947	0.9994	0.9788	48.32	51.86
	Non-breeding	Baseline (unimpacted)	-	46,502	-62.26	0.9725	0.9473	0.9943	-	-	-	-
		CEA_PU_4	265.2	44,325	-64.00	0.9712	0.9458	0.9931	0.9986	0.9533	46.82	53.52
		CEA_PU_5	795.5	40,276	-67.32	0.9685	0.9432	0.9905	0.9959	0.8674	39.62	59.74
		CEA_PU_6	221.0	44,644	-63.78	0.9714	0.9461	0.9932	0.9989	0.9611	47.46	52.76
	Annual	Baseline (unimpacted)	-	103,342	-63.27	0.9718	0.9467	0.9953	-	-	-	-
		CEA_PU_7	1095.9	93,016	-66.93	0.9689	0.9439	0.9924	0.9971	0.9025	42.54	57.90
		CEA_PU_8	2180.1	84,103	-70.10	0.9661	0.9412	0.9895	0.9942	0.8150	35.36	65.24
		CEA_PU_9	451.7	99,051	-64.74	0.9707	0.9456	0.9941	0.9988	0.9587	46.82	53.58
50 (2087)	Breeding	Baseline (unimpacted)	-	67,038	-75.93	0.9719	0.9513	0.9911	-	-	-	-
		CEA_PU_1	830.8	59,866	-78.51	0.9697	0.9491	0.9889	0.9978	0.8950	42.70	57.00
		CEA_PU_2	1384.6	55,532	-80.05	0.9683	0.9476	0.9874	0.9963	0.8309	37.72	61.48

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %l	Quantile l=50 %U
		CEA_PU_3	230.8	64,886	-76.64	0.9713	0.9507	0.9904	0.9994	0.9696	47.82	51.96
	Non-breeding	Baseline (unimpacted)	-	30,534	-75.22	0.9725	0.9515	0.9914	-	-	-	-
		CEA_PU_4	265.2	28,497	-76.85	0.9712	0.9505	0.9901	0.9986	0.9346	45.54	54.84
		CEA_PU_5	795.5	24,909	-79.70	0.9686	0.9476	0.9875	0.9960	0.8169	37.08	63.36
		CEA_PU_6	221.0	28,850	-76.60	0.9714	0.9504	0.9903	0.9989	0.9450	46.52	54.26
	Annual	Baseline (unimpacted)	-	67,038	-75.93	0.9719	0.9513	0.9911	-	-	-	-
		CEA_PU_7	1095.9	57,804	-79.23	0.9691	0.9483	0.9882	0.9971	0.8636	40.44	59.06
		CEA_PU_8	2180.1	50,073	-82.04	0.9662	0.9454	0.9854	0.9942	0.7464	31.56	68.26
		CEA_PU_9	451.7	63,027	-77.38	0.9707	0.9499	0.9898	0.9988	0.9414	45.88	53.90

3.8 Gannet

3.8.1 Cumulative assessment

3.8.1.1 The PVA outputs for impacts from Morven North cumulatively with other plans and projects on the regional populations of gannet are presented in Table 3.11.

Table 3.11: Population Viability Analysis results for Morven North cumulatively with other plans and projects in relation to impacts on regional populations of gannet

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
1 (2038)	Breeding	Baseline (unimpacted)	-	693,155	-	1.0159	0.9322	1.0769	-	-	-	-
	Post-breeding		-	605,905	-	1.0157	0.9339	1.0751	-	-	-	-
	Pre-breeding		-	329,922	-	1.0157	0.9332	1.0753	-	-	-	-
	Annual		-	693,155	-	1.0159	0.9322	1.0769	-	-	-	-
35 (2072)	Breeding	Baseline (unimpacted)	-	1,044,862	52.66	1.0122	1.0009	1.0232	-	-	-	-
		CEA_GX_1	850.8	980,527	43.29	1.0103	0.9991	1.0214	0.9982	0.9388	39.40	60.96
		CEA_GX_2	834.6	981,754	43.52	1.0104	0.9991	1.0214	0.9982	0.9398	39.52	60.98
		CEA_GX_7	207.6	1,028,743	50.34	1.0117	1.0004	1.0227	0.9996	0.9846	47.50	52.52
		CEA_GX_8	622.8	996,956	45.86	1.0108	0.9995	1.0219	0.9987	0.9548	42.18	58.08
		CEA_GX_15	1058.4	966,429	41.19	1.0099	0.9986	1.0209	0.9978	0.9242	37.10	63.44
		CEA_GX_16	1473.6	936,038	36.76	1.0090	0.9977	1.0200	0.9969	0.8963	32.36	69.04
		CEA_GX_17	1042.2	966,748	41.39	1.0099	0.9987	1.0209	0.9978	0.9254	37.14	63.34
	Post-breeding	Baseline (unimpacted)	-	919,044	54.42	1.0125	1.0014	1.0230	-	-	-	-
		CEA_GX_3	124.7	910,112	52.64	1.0122	1.0010	1.0227	0.9997	0.9888	48.56	51.66
		CEA_GX_4	124.6	909,171	52.58	1.0121	1.0011	1.0226	0.9997	0.9889	48.40	51.58
		CEA_GX_9	186.5	904,269	51.76	1.0120	1.0009	1.0225	0.9995	0.9832	47.54	52.88
		CEA_GX_10	559.5	874,148	46.72	1.0110	0.9999	1.0215	0.9985	0.9503	42.22	58.32
		CEA_GX_18	311.2	894,189	50.09	1.0117	1.0006	1.0222	0.9992	0.9722	45.82	54.70
		CEA_GX_19	684.2	864,064	45.07	1.0107	0.9995	1.0212	0.9982	0.9396	40.04	60.04

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
		CEA_GX_20	311.1	894,028	50.08	1.0117	1.0006	1.0222	0.9992	0.9721	45.78	54.62
	Pre-breeding	Baseline (unimpacted)	-	500,331	54.40	1.0125	1.0014	1.0229	-	-	-	-
		CEA_GX_11	50.1	496,472	53.12	1.0122	1.0011	1.0227	0.9998	0.9915	48.90	51.44
		CEA_GX_12	150.2	488,102	50.53	1.0118	1.0006	1.0223	0.9993	0.9752	46.30	54.06
		CEA_GX_21	92.3	492,726	51.98	1.0120	1.0009	1.0225	0.9996	0.9844	47.74	52.50
		CEA_GX_22	192.4	484,980	49.37	1.0115	1.0004	1.0221	0.9991	0.9683	44.98	55.40
		CEA_GX_23	92.3	493,723	52.06	1.0120	1.0009	1.0226	0.9996	0.9847	47.98	52.54
	Annual	Baseline (unimpacted)	-	1,044,862	52.66	1.0122	1.0009	1.0232	-	-	-	-
		CEA_GX_5	1017.7	968,548	41.50	1.0100	0.9986	1.0210	0.9978	0.9271	37.30	63.06
		CEA_GX_6	1001.4	969,885	41.69	1.0100	0.9987	1.0210	0.9979	0.9283	37.56	62.88
		CEA_GX_13	444.2	1,010,492	47.76	1.0112	0.9999	1.0222	0.9991	0.9674	44.48	55.72
		CEA_GX_14	1332.5	946,105	38.27	1.0093	0.9980	1.0203	0.9972	0.9057	34.02	67.24
		CEA_GX_24	1461.9	936,872	36.94	1.0090	0.9977	1.0200	0.9969	0.8970	32.60	68.78
		CEA_GX_25	2350.2	877,837	28.19	1.0071	0.9958	1.0181	0.9950	0.8395	23.18	77.52
		CEA_GX_26	1445.5	938,391	37.14	1.0091	0.9978	1.0201	0.9969	0.8981	32.82	68.66
50 (2087)	Breeding	Baseline (unimpacted)	-	1,252,098	83.26	1.0122	1.0029	1.0212	--	-	-	-
		CEA_GX_1	850.8	1,144,227	67.47	1.0104	1.0011	1.0194	0.9982	0.9137	36.24	63.14
		CEA_GX_2	834.6	1,146,111	67.68	1.0104	1.0012	1.0194	0.9982	0.9152	36.54	63.04
		CEA_GX_7	207.6	1,226,213	79.30	1.0117	1.0025	1.0207	0.9996	0.9781	46.82	53.20
		CEA_GX_8	622.8	1,172,677	71.55	1.0109	1.0016	1.0199	0.9987	0.9359	40.02	59.98
		CEA_GX_15	1058.4	1,119,488	63.71	1.0099	1.0007	1.0189	0.9978	0.8936	33.40	66.22

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %I	Quantile I=50 %U
		CEA_GX_16	1473.6	1,071,081	56.70	1.0090	0.9998	1.0180	0.9969	0.8551	27.58	71.96
		CEA_GX_17	1042.2	1,122,254	64.09	1.0100	1.0007	1.0190	0.9978	0.8952	33.70	66.14
	Post-breeding	Baseline (unimpacted)	-	1,103,466	85.68	1.0125	1.0032	1.0214	-	-	-	-
		CEA_GX_3	124.7	1,085,471	82.74	1.0121	1.0029	1.0210	0.9997	0.9838	47.44	52.20
		CEA_GX_4	124.6	1,086,316	82.62	1.0121	1.0029	1.0210	0.9997	0.9840	47.56	52.34
		CEA_GX_9	186.5	1,076,380	81.31	1.0120	1.0028	1.0209	0.9995	0.9761	45.94	53.56
		CEA_GX_10	559.5	1,027,880	72.59	1.0110	1.0017	1.0199	0.9985	0.9297	39.54	60.52
		CEA_GX_18	311.2	1,060,204	78.22	1.0116	1.0024	1.0205	0.9992	0.9604	43.86	55.96
		CEA_GX_19	684.2	1,009,986	69.73	1.0106	1.0014	1.0196	0.9982	0.9149	36.82	62.84
		CEA_GX_20	311.1	1,060,647	78.34	1.0116	1.0024	1.0205	0.9992	0.9604	43.90	55.92
	Pre-breeding	Baseline (unimpacted)	-	601,056	85.75	1.0125	1.0033	1.0213	-	-	-	-
		CEA_GX_11	50.1	593,639	83.36	1.0122	1.0030	1.0211	0.9998	0.9880	48.02	51.74
		CEA_GX_12	150.2	579,423	79.16	1.0117	1.0025	1.0206	0.9993	0.9648	44.44	55.32
		CEA_GX_21	92.3	587,979	81.42	1.0120	1.0027	1.0209	0.9996	0.9779	46.62	53.34
		CEA_GX_22	192.4	574,044	77.39	1.0115	1.0023	1.0204	0.9991	0.9550	42.94	57.00
		CEA_GX_23	92.3	587,905	81.52	1.0120	1.0028	1.0209	0.9996	0.9781	46.60	53.24
	Annual	Baseline (unimpacted)	-	1,252,098	83.26	1.0122	1.0029	1.0212	-	-	-	-
		CEA_GX_5	1017.7	1,123,730	64.59	1.0100	1.0008	1.0191	0.9978	0.8976	33.92	65.70
		CEA_GX_6	1001.4	1,126,416	64.76	1.0100	1.0008	1.0190	0.9979	0.8990	34.24	65.44
		CEA_GX_13	444.2	1,193,342	74.88	1.0112	1.0020	1.0202	0.9991	0.9539	42.68	57.22
		CEA_GX_14	1332.5	1,087,132	59.21	1.0093	1.0001	1.0183	0.9972	0.8681	29.26	70.06

Impacted year (Year)	Simulated season	Impact scenario	Impact (no. of birds)	Simulated population size	Change in population size (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS	Quantile U=50 %l	Quantile l=50 %U
		CEA_GX_24	1461.9	1,071,633	56.95	1.0091	0.9999	1.0181	0.9969	0.8562	27.64	71.78
		CEA_GX_25	2350.2	975,636	42.80	1.0072	0.9979	1.0161	0.9950	0.7788	17.80	82.28
		CEA_GX_26	1445.5	1,074,479	57.24	1.0091	0.9999	1.0181	0.9969	0.8577	27.96	71.62

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