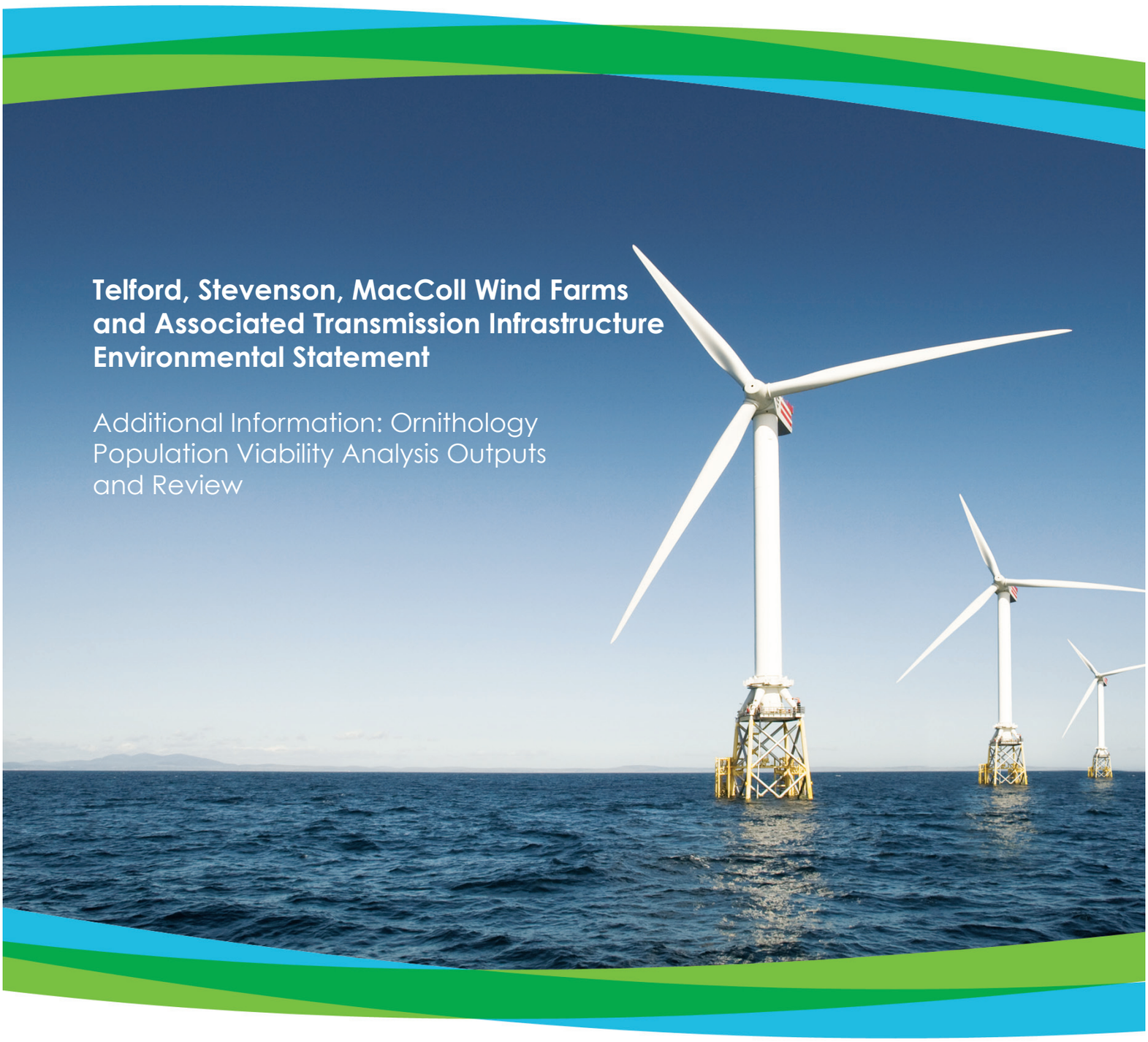
moray offshore renewables ltd

Developing Wind Energy In The Outer Moray Firth



Telford, Stevenson, MacColl Wind Farms and Associated Transmission Infrastructure Environmental Statement

Additional Information: Ornithology Population Viability Analysis Outputs and Review

edp renewables powered by nature

REPSOL

This document was produced by Natural Power Consultants on behalf of Moray Offshore Renewables Ltd

Document Owner	Dr Chris Pendlebury, Natural Power Consultants
Document Status	FINAL
File Name	1031388

Revision	Date	Description	Originated By	Checked By	Approved By
A	29/05/2013	Draft version for review	NPC	CJP	CR
B	07/06/2013	Draft version for review	NPC	CJP	CR
C	10/06/2013	Draft version for review	NPC	CJP	CR
D	12/06/2013	Final for issue	NPC	CJP	CR

moray offshore renewables limited

4th Floor
40 Princes Street
Edinburgh
EH2 2BY

Tel: +44 (0)131 556 7602

Table of Contents

List of Abbreviations

BOWL	-	Beatrice Offshore Wind Farm Ltd
BTO	-	British Trust for Ornithology
CI	-	Confidence Intervals
EDA	-	Eastern Development Area
EIA	-	Environmental Impact Assessment
ES	-	Environmental Statement
HRA	-	Habitats Regulation Appraisal
Index of Abundance	-	Abundance on a relative scale, compared to year 0.
JNCC	-	Joint Nature Conservation Committee
LSE	-	Likely Significant Effect
MORL	-	Moray Offshore Renewables Limited
MS-LOT	-	Marine Scotland License & Operations Team
MSS	-	Marine Scotland Science
QET	-	Quasi-Extinction Thresholds
PVA	-	Population Viability Analysis
PPT		Population Percentage Threshold
RS	-	Realistic Scenario
RSPB	-	Royal Society for the Protection of Birds
SMP	-	Seabird Monitoring Programme
SNH	-	Scottish Natural Heritage
SPA	-	Special Protection Area
TI	-	Transmission Infrastructure
WCS	-	Worst-Case Scenario
WDA	-	Western Development Area

%	-	Percentage
GW	-	Gigawatts
km	-	kilometre
km^2	-	square kilometre
m	-	metre
MW	-	Megawatts

Non Technical Summary

In August 2012 Moray Offshore Renewables Limited (MORL) submitted an Environmental Statement (ES) to accompany applications for consent under Section 36 of the Electricity Act 1989 and associated Marine Licences for the construction and operation of the Telford, Stevenson and MacColl wind farms (referred to as 'the three proposed wind farms') and Transmission Infrastructure (TI) which are collectively referred to as 'the Project'.

The ES included an assessment of effects on ornithological receptors:

- Chapter 7.4 for the effects from the three proposed wind farms;
- Chapter 10.4 for the effects from the TI;
- Chapter 12.1.10 for the effects from the whole project; and
- Chapter 14.4 for the cumulative impact assessment.

In addition, Chapter 12.2 of the ES (paragraphs 12.2.3.8 - 10 and relevant tables) presented information in support of the Habitats Regulations Appraisal (HRA). This information is also presented at the end of the assessment chapters of the ES.

MORL has been requested by the Joint Nature Conservation Committee (JNCC) and Scottish Natural Heritage (SNH) and Marine Scotland Licensing and Operations Team (MS-LOT) as advised by Marine Scotland Science (MSS) to provide additional information in relation to ornithology as set out in detail in Section 2 of this Report and Appendix A. The aim of this Report is to provide a re-presentation of population viability analysis (PVA) outputs, and to sensitivity test the assessments presented in the ES for the relevant species using the re-presented PVA outputs to identify whether there would be any change to the assessments and, if so, what those changes would be. Accordingly, Chapters 7.4, 10.4, 12.1.10, 12.2 (paragraphs 12.2.3.8 - 10 and relevant tables) and 14.4 of the ES and Technical Appendix 4.5 A should be read in conjunction with this Report. In all other respects the ES should be referred to for the baseline information and assessment of effects of the Project on ornithological receptors.

The Non Technical Summary of this Report is as follows:

- PVA as previously presented in the MORL ES has been re-presented in light of requests from JNCC and SNH. These requests are summarised in Section 2.

- Throughout the assessment process the 'precautionary approach' has been followed on several occasions, with the risk that when taken together this could make the assessments unrealistic and therefore overestimate the likely effects for the three proposed wind farm sites alone but even more so for the cumulative assessment. These precautionary elements are discussed in Section 3.

- Adjustments to the analysis presented in the ES were also requested by JNCC/SNH and accepted by MSS in relation to displacement; these are described in Section 4.1.

- A refinement was also made to the collision risk analysis based on a revision to collision model methodologies published after the submission of the MORL ES; this is described in Section 42.

- Section 5 provides details of the demographic parameters and growth rates used in the PVAs, giving a rationale for the parameters used. The parameters used in the models are the same as were used for the ES.

- The key outputs from the PVA used in the assessment are provided in Section 6.

- There would be no change to any of the overall assessments for the three proposed wind farms sites alone, individually or as a whole (all of '**no significant effects predicted'**), when compared to those made in the ES.

- Cumulatively (Whole Project and Whole Project with the Beatrice Offshore Windfarm Limited (BOWL) wind farm), the refinement to the collision risk assessment would mean that **no significant cumulative effects** would be predicted for gannet and herring gull; a change compared to the ES.

- Cumulatively, there would still be a **significant effect** predicted for great black-backed gull, with the majority of collisions (75%) predicted to occur at the BOWL site.

- Assessed alone, the three proposed wind farms would not be predicted to affect the Conservation Objectives, and therefore site integrity, of any SPAs.

- In-combination with the BOWL site, there would be a predicted cumulative effect on the Conservation Objectives, and therefore site integrity, of the East Caithness Cliffs Special Protection Area (SPA), due to the above collision impacts on great-black-backed gull.

1 Introduction

The Crown Estate has awarded EDP Renováveis (EDPR) and Repsol (previously SeaEnergy Renewables) the exclusive rights to develop wind farm sites within Zone 1 of the UK Round 3. EDPR and Repsol have formed MORL to develop the zone in the Moray Firth, Scotland.

The Moray Firth Zone is located 22.2 km from the coast, on the Smith Bank in the Moray Firth, and covers an area of 522.15 km^2. The water depths vary between approximately 35-57 m. Peak spring tidal speeds can be up to 1.2 knots.

MORL intends to develop up to 1.5 GW of offshore wind by 2020 within the Zone. The development will be split into two phases: a first phase of a maximum of 1.5 GW across three wind farm sites; Telford, Stevenson and MacColl, which are the subject of current Section 36 and Marine Licence applications, and the second phase of up to 500 MW (Western Development Area, WDA) if less than 1.5 GW of capacity is delivered by the three wind farms in Eastern Development Area (EDA).

An Environment Impact Assessment (EIA) has been undertaken for the three proposed wind farm sites, Telford, Stevenson and MacColl and associated TI. This included an assessment of effects on ornithological receptors in the ES:

- Chapter 7.4 for the effects from the three proposed wind farms;
- Chapter 10.4 for the effects from the transmission infrastructure;
- Chapter 12.1.10 for the effects from the whole project; and
- Chapter 14.4 for the cumulative impact assessment.

In addition, Chapter 12.2 of the ES (paragraphs 12.2.3.8 - 10 and relevant tables) presented information in support of the HRA. This information is also included at the end of the assessment chapters of the ES.

The ornithological assessment of the EIA was undertaken after a draft ES was produced in December 2011. This draft ES gave stakeholders the opportunity to discuss the assessment methodology prior to the ES being finalised (see Table 4.5-1 of Chapter 4.5 within the ES for a summary of the comments received on the ornithology assessment presented in the draft ES).

The ornithological assessment included PVA, with detailed outputs being presented in Appendix A to Technical Appendix 4.5 A, following discussions with JNCC on their requirements. These informed the assessment used in the EIA and the HRA, the latter being presented in the above ornithological chapters as well as being summarised in Chapter 12.2 of the ES.

2 Background

The post-application consultation with MSS and JNCC/SNH on the ornithology assessment for three proposed wind farms and associated TI was undertaken through the process described in Appendix A and summarised below.

PVA was undertaken as part of the ornithological section of the EIA, which was submitted in August 2012. During a meeting on 7 December and a subsequent conference call on the 14 December 2012, JNCC, SNH, MS-LOT as advised by MSS requested that additional presentation of the outputs and background was to be provided for certain species (see below). The aim of this Report is to provide a re-presentation of PVA outputs, and to sensitivity test the assessments presented in the ES for the relevant species using the re-presented PVA outputs to identify whether there would be any change to the assessments and, if so, what those changes would be.

Accordingly, the following sections of the ES and Technical Appendix should be read in conjunction with this Report:

- the displacement / disturbance section of the ES (paragraph 7.4.7.2);
- the collision risk analysis section of the ES (paragraphs 7.4.7.3 to 7.4.7.4);
- the PVA section of the ES (paragraphs 7.4.7.5 to 7.4.7.6);
- the baseline conditions (4.5.3 to 4.5.4) and primary impact assessments section (paragraphs 7.4.7.7 to 7.4.7.9);
- the collision risk methods section (section 2.1.5) of the Technical Appendix 4.5A;
- the displacement analysis methods section (section 2.1.8) of the Technical Appendix 4.5A;
- the PVA methods section (section 2.1.9) of the Technical Appendix 4.5A;
- the collision risk analysis results section (section 3.1.2) of the Technical Appendix 4.5A;
- the density estimates section (section 3.1.3) of the Technical Appendix 4.5A;
- the PVA results section (section 3.1.7) of the Technical Appendix 4.5A; and
- the PVA technical report (Appendix A to Technical Appendix 4.5A).

In all other respects the ES should be referred to for the baseline information and assessment of effects of the three proposed wind farms on ornithological receptors.

2.1 Population Viability Analysis

During the December 2012 consultations (meeting and conference call) the following requests were made:

1. Justification for growth rates.
2. Provision of absolute population decline tables.
3. Provision of graphed outputs of mean population size over time.
4. Update of previous outputs to include a plot of mean population decline.

In order to ensure that the requests were properly understood a report ("Revised Population Viability Analysis Outputs" dated 18 January 2013) was produced showing examples of each of the above items. Subsequent to this report the following clarifications and confirmations were received:

- Plotted outputs should be accompanied by a table of values to allow more detailed interrogation of the model outputs as required. The scale of the y-axis should be adjusted to

ensure that plot lines clustered around a particular range of values are more clearly presented (e.g. maximum of 0.5 if all values are less than 0.5). The range of values presented on the x-axis should be similar to those already presented, i.e. range up to a predicted 'worst case' plus 10-20%. It is not necessary at this stage for the x-axis to be extended until and unless an 'obvious' effect is found.

- The outputs should include probabilities of change in the end population (i.e. after 25 years of wind farm operation).

A list of species and SPAs for which PVAs would be required was confirmed via letters from JNCC/SNH (dated 22 March 2013) and MSS (dated 25 March 2013). A list of these species and SPAs is provided in Table 1 (which corresponds to a reduction on the number of PVAs undertaken for the ES). In addition to the SPAs highlighted in Table 1, a PVA for Hoy SPA was also requested only if a qualitative assessment suggested that an adverse effect may occur.

Table 1. List of PVAs requested by JNCC/SNH. An "x" marks the impacts requested to be included in the PVA for that species / SPA combination.

	Displacement	Collision	Displacement & Collision
Fulmar			
East Caithness Cliffs	x	x	x
North Caithness Cliffs	x	x	x
Gannet			
Troup Head	x	x	x
Kittiwake			
East Caithness Cliffs	x	x	x
North Caithness Cliffs	x	x	x
Herring Gull			
East Caithness Cliffs		x	
Great Black-backed gull			
East Caithness Cliffs		x	
Guillemot			
East Caithness Cliffs	x		
North Caithness Cliffs	x		
Razorbill			
East Caithness Cliffs	x		
North Caithness Cliffs	x		
Puffin			
East Caithness Cliffs	x		
North Caithness Cliffs	x		

2.2 Refinement of displacement analysis

Also during the December 2012 consultations, and a further meeting on 1 February 2013, the following information was requested:

1. Comments on SPA population estimates as provided by SNH/JNCC.
2. Justification for displacement approaches used in the ES.

These requests were confirmed by email from on 14 February 2013. A Report ("Response to Queries dated 14th February 2013"; dated 12 March 2013) was produced on behalf of MORL to provide the above information. Subsequent to this report the following confirmations were received via letters from JNCC/SNH (dated 22 March 2013) and MSS (dated 25 March 2013):

- Confirmation that JNCC and SNH accepted the SPA (Special Protection Area) population estimates used previously in the PVAs.
- Confirmation that displacement modelling should:
    - Include birds on the sea and birds in flight; and
    - Be based on mean of peaks.

The above responses also included a request to include turnover (the rate at which birds return to a particular site) in the estimate of site usage in the displacement modelling. This was discussed further with MSS. Following discussions with SNH/JNCC and MSS, MS-LOT confirmed that it agreed with the approach of not incorporating turnover. The key rationale for not including turnover in the estimate of site usage is that site usage was being calculated based on an peak estimate of abundance, rather than a mean estimate. This peak estimate would take into account a large level of turnover by representing the maximum number of birds recorded on the site (adjusted for detection rates and site coverage).

2.3 Refinement of collision risk modelling

In addition, information on avoidance rates used in the collision risk modelling was requested during the December 2012 consultations. A report ("Avoidance Rate Calculations" dated 13 February 2013) was produced on behalf of MORL to provide this information, which was then provided to consultants undertaking a review of avoidance rates as part of a strategic work commissioned by MSS. A decision on guidance for avoidance rates has yet to be made on this matter, therefore a range of rates has been presented in this Report.

The outputs from the revised PVA modelling indicate that a revision to the Band model (2012) (see section 4.2 for more details) changes both the Worst Case Scenario (WCS) and the predicted level of impacts. The use of the revised Band model was discussed with MSS and MS-LOT who confirmed following consultation with JNCC/SNH that collision risk analysis should be presented using both the Band model as adopted in the ES (Option 1) and the revised Band model (Option 3). In addition it was confirmed that comparisons with the assessments presented in the ES should be carried out using Option 3.

3 Precautionary Approach

Throughout the process of data analysis and modelling there are several assumptions that have been made due to high-certainty information not being available. On each of these occasions the 'precautionary approach' has been followed and a level of conservatism has been built into the estimate. This has a limited effect on individual parameters, but when these parameters are combined when estimating the magnitude of effect, the issue of cumulative precaution becomes greater.

In order to put the estimates of effect magnitude into context, MS-LOT as advised by MSS requested a summary of each of the assumptions where the precautionary approach was followed; this is provided below.

Apportioning of individuals to SPAs

The ES used data from the boat-based and aerial surveys to inform estimates of the proportions of breeding birds using the three proposed wind farms that would be breeding in each of the three Moray Firth SPAs (East Caithness Cliffs SPA, North Caithness Cliffs SPA, and Troup, Pennan & Lion's Heads SPA). It was recognised that there was a level of uncertainty in these estimates, and this was factored into estimates by summing the percentages for each species to greater than 100% (up to 150%) for those species that are known to be breeding at more than one of the above SPAs (Table 2). This therefore over-estimates total displacement for the three proposed wind farms, but ensures that the precautionary approach is being followed.

Table 2. Precautionary estimates of the percentages of birds of each species using the sites, from three SPAs.

	Percentages of birds using the sites, from the three SPAs.			**Total Percentage**
Species	**North Caithness Cliffs SPA**	**East Caithness Cliffs SPA**	**Troup, Pennan & Lion's Heads SPA**	
Fulmar	25%	90%	25%	140%
Gannet			100%	100%
Kittiwake	30%	75%	25%	130%
Herring gull	75%		75%	150%
Great black-backed gull	100%			100%
Guillemot	50%	60%	5%	115%
Razorbill	40%	75%	5%	120%
Puffin	100%	5%	0%	105%

During a discussion of SPA population estimates with SNH/JNCC during the meeting of 7 December, it was commented that near to 100% of puffins using the three sites are likely to be breeding at North Caithness Cliffs SPA. The percentages of puffins using the three sites from the three above SPAs was therefore re-assessed to give the percentages in Table 2.

Displacement modelling – use of average peak estimates

As requested by JNCC and SNH, average peak estimates of site usage have been used in the displacement modelling. A mean estimate during the breeding season was used for the ES as this was considered to be a more appropriate estimate of the number of individuals at the risk of displacement on a regular basis, i.e. not including individuals that more frequently foraged elsewhere. The effect that using average peaks on the population estimate for the sites is shown in Table 3, with this varying from 134% (fulmar) to 231% (kittiwake).

Table 3. Comparison of average peak and mean population estimates for the three wind farm sites.

Species	Average peak estimate	Mean estimate	% increase
Fulmar	1573	1177	134%
Gannet	238	164	145%
Kittiwake	5719	2473	231%
Guillemot	11475	7499	153%
Razorbill	2639	1817	145%
Puffin	3175	2002	159%

This change in methodology will impact upon the population modelling with respect to breeding. It has been assumed in the population modelling that a displaced bird will not breed during the current year. It is considered that whilst this may be the case for birds that regularly use the three proposed wind farm sites (characterised by using a mean estimate), this is less likely to be the case for birds that only infrequently use an area to forage (which are included in the estimate of site usage by using an average peak estimate).

Displacement modelling – inclusion of birds in flight

Displacement modelling in the ES was undertaken using only numbers of birds using the sea. This meant that the assessment was based on birds that would be using the site for activities such as foraging and resting, and not birds that would solely be flying over the site. Birds in flight have now been included in the modelling, as requested by JNCC and SNH, and considered as being at risk of displacement and at risk of collision. Since it is assumed that displaced birds will fail during their current breeding attempt, the inclusion of all birds recorded in the displacement analysis therefore means that the model assumes that displacement of birds flying over the site will also lead to these birds failing to breed in that year. It is considered unlikely that 'displacement' of a bird flying over the site would lead to the same impact on breeding success, and the assumption that these birds fail in the current year is therefore very precautionary. Section 4.1 of this Report provides further detail.

The effect that including birds in flight on the population estimate for the sites is shown in Table 4, with this varying from 101% (puffin) to 169% (gannet).

Table 4. Impact on population estimates for the three wind farm sites of including birds in flight.

Species	Including birds in flight	Excluding birds in flight	% increase
Fulmar	1573	1141	138%
Gannet	238	140	169%
Kittiwake	5719	4570	125%
Guillemot	11475	10809	106%
Razorbill	2639	2532	104%
Puffin	3175	3158	101%

Overall assessment of displacement

A range of displacement rates has been presented and incorporated into the PVAs, as requested by SNH and JNCC; this range of rates is shown in Table 5 below. Based on a literature review, the lower of these rates has been used for the assessment in the ES and in this report due to these being considered to be more realistic. See paragraph 7.4.7.2 and Table 7.4-7 of the ES which set out the WCS and Realistic Scenario (RS) which has now been adapted to take into account use of average peak estimates and inclusion of birds in flight. Also in Table 5 is a summary of the literature review; further details of this can be found in the ES (Technical Appendix 4.5 A, Section 2.1.8). The literature

review shows that a level of precaution has still been incorporated into the displacement rates used in the assessment.

Table 5. Displacement estimates.

Species	Rates presented	Robin Rigg[1]	Other literature
Fulmar	50 % and 100 %		No studies identified during the literature review for the ES.
Gannet	50 % and 100 %	50 %	50 % at Thornton Bank, Belgium compared to control area[2].
Kittiwake	10 % and 50 %	0-10 %	No impact on distribution during construction of Egmond aan Zee, Netherlands[3].
Guillemot	50 % and 100 %	30 %	No changes recorded post-construction at Thornton Bank, Belgium compared to control area[2].
Razorbill	50 % and 100 %	30 %	No changes recorded post-construction at Thornton Bank, Belgium compared to control area[2].
Puffin	50 % and 100 %		Displacement rates assumed to be similar to those shown by other auks, e.g. 30 % at Robin Rigg, and no changes at Thornton Bank.

References: 1- Shenton & Walls, 2011; 2 – Vanermen & Stienen, 2009; 3 – Leopold *et al*., 2011)

Collision risk modelling – mean blade width

It is assumed by the Band (2011) model, and the Band (2012) refinement, that blade width is uniform along the entire blade length. This is not the case, with blade width being narrower at the blade tip. Given that within the rotor swept area, this also corresponds to the region of highest bird numbers (the lower part of the rotor swept area; Cook *et al*. 2012), this leads to an over-estimate in collisions which cannot be quantified through empirical data at present. Section 4.2 of this Report provides further detail.

Overall assessment of collision risk

A range of avoidance rates has been presented and incorporated into the PVAs, as requested by SNH and JNCC. A literature review was used to inform the rates used for the assessment (99.5% for gannet, 99.0% for kittiwake, and 98.5% for herring gull and great black-backed gull) in the ES (see paragraphs 7.4.6.4 to 7.4.6.17 and Table 7.4-4) which was updated at the request of MS-LOT (see report 'Avoidance Rate Calculations' dated 13 February 2013). These avoidance rates, whilst higher than the 98% proposed in guidance, are still conservative based on this literature review. Based on the available data, avoidance rates were calculated as:

- 99.9% for gannet (compared to 99.5% used in the assessment; equivalent to a non-avoidance rate 370% of the mean value calculated in the Avoidance Rate Calculations report);
- 99.2% for kittiwake (compared to 99.0% used in the assessment; equivalent to a non-avoidance rate 29% greater than the mean value calculated in the Avoidance Rate Calculations report); and
- 98.8% for herring gull and great black-backed gull (compared to 98.5% used in the assessment; equivalent to a non-avoidance rate 28% greater than the mean value calculated in the Avoidance Rate Calculations report).

The avoidance rates used in the ES and this Report for the assessment therefore already incorporate a reasonable degree of precaution (discussed further in the Avoidance Rate Calculations report).

Cumulative impact assessment

The overall accumulated precaution becomes more significant when undertaking the cumulative impact assessment, since the precautions listed previously in this section for each of the three proposed wind farms sites will be added to the precautions used in the assessments of other sites.

4 Displacement and Collision Risk

Estimates of displacement and collision risk are provided below. For displacement the information provided is a re-presentation of data available in the ES. For collision risk a refinement has been made to the analysis based on a revision to the collision risk model methodologies made available subsequent to the ES submission (specifically, the updated Band model as described in Section 4.2 below). This Report shows the results for the version of the Band Model used in the ES, and the updated Band approach (Band 2012).

4.1 Displacement

As requested by SNH/JNCC, displacement estimates have been made based on average peak estimates of all birds using the site (including birds in flight); see Section 3 for commentary on this precautionary approach. Tables 6 to 11 present the numbers of breeding individuals assumed to be displaced from the sites. The displacement rates presented in the PVAs are shown in Table 5.

Table 6. Potential number of fulmar pairs failing to breed due to displacement, at different rates of displacement and breeding failure.

Pairs failing to breed		**% Individuals fail to breed**				
		10	**25**	**50**	**75**	**100**
% Displaced	**10**	8	20	39	59	79
	20	16	39	79	118	157
	30	24	59	118	177	236
	40	31	79	157	236	315
	50	39	98	197	295	393
	60	47	118	236	354	472
	70	55	138	275	413	551
	80	63	157	315	472	629
	90	71	177	354	531	708
	100	79	197	393	590	787

Table 7. Potential number of gannet pairs failing to breed due to displacement, at different rates of displacement and breeding failure.

Pairs failing to breed		**% Individuals fail to breed**				
		10	**25**	**50**	**75**	**100**
% Displaced	**10**	1	3	6	9	12
	20	2	6	12	18	24
	30	4	9	18	27	36
	40	5	12	24	36	48
	50	6	15	30	45	59
	60	7	18	36	54	71
	70	8	21	42	62	83
	80	10	24	48	71	95
	90	11	27	54	80	107
	100	12	30	59	89	119

Table 8. Potential number of kittiwake pairs failing to breed due to displacement, at different rates of displacement and breeding failure.

Pairs failing to breed		% Individuals fail to breed				
		10	**25**	**50**	**75**	**100**
% Displaced	**10**	29	71	143	214	286
	20	57	143	286	429	572
	30	86	214	429	643	858
	40	114	286	572	858	1144
	50	143	357	715	1072	1430
	60	172	429	858	1287	1716
	70	200	500	1001	1501	2002
	80	229	572	1144	1716	2287
	90	257	643	1287	1930	2573
	100	286	715	1430	2144	2859

Table 9. Potential number of guillemot pairs failing to breed due to displacement, at different rates of displacement and breeding failure.

Pairs failing to breed		% Individuals fail to breed				
		10	**25**	**50**	**75**	**100**
% Displaced	**10**	57	143	287	430	574
	20	115	287	574	861	1148
	30	172	430	861	1291	1721
	40	230	574	1148	1721	2295
	50	287	717	1434	2152	2869
	60	344	861	1721	2582	3443
	70	402	1004	2008	3012	4016
	80	459	1148	2295	3443	4590
	90	516	1291	2582	3873	5164
	100	574	1434	2869	4303	5738

Table 10. Potential number of razorbill pairs failing to breed due to displacement, at different rates of displacement and breeding failure.

Pairs failing to breed		% Individuals fail to breed				
		10	**25**	**50**	**75**	**100**
% Displaced	**10**	13	33	66	99	132
	20	26	66	132	198	264
	30	40	99	198	297	396
	40	53	132	264	396	528
	50	66	165	330	495	660
	60	79	198	396	594	792
	70	92	231	462	693	924
	80	106	264	528	792	1055
	90	119	297	594	891	1187
	100	132	330	660	990	1319

Table 11. Potential number of puffin pairs failing to breed due to displacement, at different rates of displacement and breeding failure.

Pairs failing to breed		% Individuals fail to breed				
		10	**25**	**50**	**75**	**100**
% Displaced	**10**	16	40	79	119	159
	20	32	79	159	238	317
	30	48	119	238	357	476
	40	63	159	317	476	635
	50	79	198	397	595	794
	60	95	238	476	714	952
	70	111	278	556	833	1111
	80	127	317	635	952	1270
	90	143	357	714	1072	1429
	100	159	397	794	1191	1587

4.2 Collision Risk

The collision risk estimates have been refined based on the updated Band (2012) model (as recommended by MSS, and subsequently agreed by SNH/JNCC), which was published after submission of the MORL ES. A description of the approach used is provided below, along with a rationale for why this approach is considered to be a more realistic assessment of collision risk.

In order to assess the collision risk to birds it is necessary to estimate both the density of birds in flight and the proportion of those birds in flight that fly within the area occupied by the turbine rotors; the rotor swept height. The approach typically used is for boat-based survey observers to estimate the flight heights of birds during surveys and then calculate the proportion of birds flying at rotor swept height. Due to the known issues with accurately estimating flight heights of birds at sea, broad flight height categories which correspond to the potential rotor swept height were used by the observers, following standard guidance (Camphuysen *et al*. 2004). By collecting data in this way an assumption is made of a uniform distribution of birds across each flight height band. However, it was shown by the British Trust for Ornithology (BTO) that for most species there is an exponential decline in the proportion of birds with increasing height (Cook *et al*. 2012). Consequently, the proportion of flights at the lower end of the rotor swept area is higher than through the rest of the area (Cook *et al*. 2012). There is also a reduced risk of collision at the lower end of the rotor swept area when compared with the average of the whole area for several reasons:

- the rotor swept zone in the lower part of the swept area has a smaller width than the middle of the zone, so the expected number of rotor transits is reduced (Band 2012);
- the single transit collision risk is lower for birds at the edge of the rotor than those in the middle; and
- the blade width is smaller and pitch lower than average towards the tip.

This means that by assuming an even distribution of flight heights across the whole rotor swept area an over estimate of collision risk is made. Since the updated Band (2012) model still uses both the average blade width and the average pitch along the length of the blades as input values, despite using modelled flight distribution across the rotor swept area, the estimate is still conservative.

Cook *et al*. (2012) collated and analysed flight height data collected by boat-based observers from 29 sites; sample sizes for relevant species are shown in Table 12. Since these data were collected using

broad flight height categories the frequency distribution was modelled using a thin-plate log-spline (with six knots).

Table 12. Sample sizes and model fit for the four relevant species. Model fit is calculated using Pearson's correlation coefficient.

Species	Sample size	Number of sites	Model fit, R	Confidence
Gannet	44851	27	0.94	Very high
Kittiwake	62975	25	0.95	Very high
Herring gull	25153	19	0.90	Very high
Great black-backed gull	8911	19	0.88	Very high

The final version of the Band (2012) model, which was developed in consultation with a number of organisations including MSS, SNH, JNCC and the Royal Society for the Protection of Birds (RSPB), provides three options to account for the flight height distribution of birds.

- Option 1 uses the proportion of flight heights in the rotor swept area from the site-specific boat-based survey data. This assumes an even distribution of flight heights across the rotor swept area. This is the same model as used in the MORL ES.
- Option 2 is the same collision risk model but uses the UK-wide data reviewed by Cook *et al*. (2012) to calculate the proportion of birds flying in the rotor swept area. This uses a larger sample size from a wide range of sites and takes in to account the distribution of birds across the rotor swept area. However, it still applies this overall proportion evenly across the whole rotor swept area, and so also over estimates the collision risk.
- Option 3 is also the same collision risk model but applies the shape of the flight height distribution across the rotor swept area. This is based on the data reviewed by Cook *et al*. (2012) and the result accounts for the differences in collision risk across the rotor swept area.

While there may be some advantages to using site-specific data to inform the proportion of birds at rotor-swept height (compared to the UK-wide data used in Option 3), it is considered to be more realistic to use an approach that predicts the distribution of flight heights throughout the rotor swept height. The outputs of Options 1 and 3 of the Band (2012) model are provided in Table 13. Full details of the Option 3 results, which are used in this Report and compared with the assessments presented in the ES are provided in Table 14.

The WCS Rochdale Envelope (RE) parameters that were used in the collision risk analysis are provided in Table 15. This is different to that in the ES (Table 7.4-2) due to the change in the model. The revised model was run using the different turbine scenario options (3.6 MW, 5.0 MW, 6.0 MW and 7.0 MW) to confirm the WCS Rochdale Envelope.

Review of the revised collision risk model outputs highlighted two inconsequential errors in the ES. These are as follows:

- Within the secondary assessment of section 7.4.10 (paragraph 7.4.10.1) the WCS for each of the individual sites should be 139 x 3.6 MW turbines (and not 72 x 7 MW turbines as erroneously stated). The assessment provided in the ES was actually undertaken on the basis of 139 x 3.6 MW for each wind farm and therefore the assessment in the ES is correct.
- Within the cumulative assessment section 14.4 (Table 14.4-4) of the ES, the RE parameters used for the WDA should have been stated as 72 x 7 MW turbines (and not 100 x 5 MW). This was queried by RSPB in their consultation response to the applications. As explained in the ES

(see Table 14.4-7) the assessment for the WCS for the WDA was estimated by scaling the estimates for the three proposed wind farm sites based on the WDA being 33 % in MW capacity (equating approximately to 33% of number of turbines, disturbance / displacement risk and collision risk). Therefore the assessment in the ES is correct.

Table 13. Comparison of collision risk estimates produced by the Option 1 and Option 3 models.

Species	Model	Avoidance rate, %			
		99.50	99.00	98.50	98.00
Gannet	Option 1 – even flight height distribution	57	113	170	227
	Option 3 – modelled flight height distribution	13	26	39	53
Kittiwake	Option 1 – even flight height distribution	37	75	112	150
	Option 3 – modelled flight height distribution	24	48	72	96
Herring gull	Option 1 – even flight height distribution	52	104	156	208
	Option 3 – modelled flight height distribution	24	49	73	98
Great black-backed gull	Option 1 – even flight height distribution	35	70	105	139
	Option 3 – modelled flight height distribution	20	39	59	79

Table 14. Results of collision risk model (option 3), presented at a conservative 98% avoidance rate and a more realistic avoidance rate as used by MORL in the assessment.

Species	Avoidance rate %	Annual	Breeding season	Non-breeding season
Gannet	98	53	29	24
	99.5	13	7	6
Kittiwake	98	96	70	27
	99	48	35	13
Great black-backed gull	98	79	21	58
	98.5	59	16	43
Herring gull	98	98	10	88
	98.5	73	[7]	66

Table 15. Rochdale Envelope parameters relevant to collision risk assessment.

Site	Rochdale Envelope scenario assessed for collision risk
1	139 x 3.6 MW turbines (130 m rotor diameter, 4.20 m maximum blade width, and maximum rotation speed of 13.4 rpm)
2	100 x 5 MW turbines (135 m rotor diameter, 4.35 m maximum blade width, and maximum rotation speed of 15.1 rpm)
3	100 x 5 MW turbines (135 m rotor diameter, 4.35 m maximum blade width, and maximum rotation speed of 15.1 rpm)

The collision estimates shown in Table 13 are those for three proposed wind farm sites combined. For the PVAs, an estimate is required of the numbers that are affected from each colony modelled. As for the PVAs carried out for the ES (Appendix A of Technical Appendix 4.5A), this used an estimate of the proportion of birds using each SPA (as per Section 3.1.5 of Technical Appendix 4.5A; also see Section 3). For great black-backed gull and herring gull an estimate of immigration was also incorporated at this stage (as per Section 3.1.5 of Technical Appendix 4.5A).

4.3 Cumulative impact assessment: BOWL Wind Farm

The average peak population estimates for the breeding season used for the displacement analysis for the BOWL site are shown in Table 16. The collision estimates, using the refined Band (2012) option 3 model (modelled flight height distributions), for the BOWL site are shown in Table 17. These data were used to update the cumulative impact assessment that was originally included in the MORL ES and it is in line with the information provided in BOWL's addendum (May 2013).

Table 16. Average peak population estimates for the BOWL site for the breeding season.

Species	Average peak estimate
Fulmar	1156
Gannet	151
Kittiwake	786
Guillemot	5187
Razorbill	880
Puffin	160

Table 17. Annual collision risk estimates for the BOWL site, using the Band (2012) Option 3 model, at a range of avoidance rates.

Species	Avoidance rate, %			
	99.50	99.00	98.50	98.00
Fulmar	3	6	9	13
Gannet	6	13	19	25
Kittiwake	11	22	33	44
Great black-backed gull	60	119	179	239
Herring gull	84	169	253	337

5 Demographic Parameters and Growth Rates

The purpose of this section is to provide details of the demographic parameters and growth rates used in the PVAs. The aim is to provide a rationale for the parameters used, which were identified from literature searches, with selection of data being based on distance from the Moray Firth and time since study.

All demographic rates used in the PVAs presented in this report are the same as those used in the ES. Both stochastic and deterministic growth rates are presented here for comparison, with the stochastic growth rates being the ones used in the PVAs. Carrying capacity has not been incorporated into the models as data to inform carrying capacity calculations is not available; this should be particularly noted when looking at population projections for the 25-35 year period for populations that are increasing.

Annual population growth rates as predicted from both the deterministic and stochastic population models produced to assess effects from the three proposed wind farms were compared with estimates from count data. Various data sets were available to estimate the empirical annual population growth rate (lambda) at various spatial scales for comparison with the predicted rates. For each species there were data sets available at the UK and Scotland levels, and at a colony-level for gannet, and a part-site (SPA) level for fulmar and guillemot. Data were collated from the JNCC Seabird Monitoring Programme (SMP) database; all data are presented, including count data, estimated population change (from SMP), and calculated annual population growth rate. The SMP is an ongoing (since 1986) annual monitoring programme of regularly breeding seabirds in Britain and Ireland, organised by JNCC.

UK and Scottish population estimates were available from three UK wide counts: Operation Seafarer (1969-70), Seabird Colony Register (1985-88) and Seabird 2000 (1998-2002). In addition a UK-wide estimate of total percentage change in population was available for 2000 – 2011 from the SMP. From this the UK population in 2011 was calculated and a value of annual population growth rate was calculated for the same time period. There was no similar total percentage change in population size available for Scotland only from the SMP. Consequently, the plotted trend in the Scottish population estimated by JNCC index is shown. These data are shown in Appendix B.

The growth rates produced by the model differ for some species with the mean UK and Scottish population trends, although they are within the 95% Confidence Intervals (CIs). The reasons for this are set out under each section below where applicable. For these species it would be technically feasible to adjust the models to produce a population growth rate that matched one of the known population trends. If this was attempted questions would remain as to which population trend the model should follow and by how much the parameters should be changed. With no robust data available to inform this, the model would provide an apparently correct output by using input values not based on empirical data, thus any inferences drawn from the model would be weak.

The models used to understand the effects of impacts on the populations relevant to the three proposed wind farms are necessarily approximations of reality. As such the models should be considered robust for use as a comparative tool to understand the significance of effects.

5.1 Fulmar

5.1.1 Demographic parameters

Demographic parameters used for modelling the fulmar populations are shown in Table 18.

Table 18. Demographic parameters used for fulmar PVAs.

Population parameter	Rate (variance)	Reference	Reason for selection
Adult survival	0.951 (0.0015)	Dunnet and Ollason, 1978	Adult survival rate calculated over 17 years between 1958 and 1975 from Eynhallow, Orkney. Selected based on availability of variance about the mean and duration of study and proximity to site.
Juvenile survival	0.951 (0.0015)	As above	As above as no suitable data available for juvenile survival.
Average breeding age	9 years	Maclean *et al.*, 2007	Based on data collected at Eynhallow, Orkney by Dunnet and Ollason.
Number of eggs per clutch	1	Snow and Perrins, 1998	Number from widely accepted source.
Fledglings per nest	0.08 (0.005)	Mavor *et al.*, 2008	Mean across Easter Ross and Wilkhaven in 2006. Selected due to proximity to the site and recent date.

5.1.2 Growth Rates

Available growth rates for fulmar at multiple spatial and temporal scales are presented in Table 19.

Table 19. Estimated annual population growth rate of fulmar at multiple spatial and temporal scales.

Spatial scale	Temporal scale	Lambda
UK	1969/70 to 1985/88	1.0343
	1985/88 to 1998/02	0.9979
	2000 to 2011	1.0070
	1969/70 to 2011	1.0149
Scotland	1969/70 to 1985/88	1.0342
	1985/88 to 1998/02	0.9973
	2000 to 2011	no data
	1969/70 to 1998/02	1.0173
North Caithness Cliffs SPA - Stroma Island only	1986 to 2002	0.7660
Deterministic growth rate – mean		0.9807
Stochastic growth rate – mean		0.9804
Stochastic growth rate – lower 95% CI		0.9654
Stochastic growth rate – upper 95% CI		0.9957

5.1.3 UK growth rates

Based on only three data points from the three national seabird surveys it appeared that the UK annual population growth rate declined from 1.0343 between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) to 1.0070 across the period 2000 to 2011 (Table 19). However, the absolute population size has increased by a factor of 1.7 from 1969/70 to 2011, with an annual growth rate of 1.0149. The annual population growth rates from both the deterministic and stochastic population models (0.9807 and 0.9804 respectively) are smaller than these estimates, though the difference is not significant. While the growth rates are not large it should be noted that the fulmar population in Europe has increased dramatically since the mid-18th century and it is only recently (the last 15 years) that the population has stabilised.

5.1.4 Scottish growth rates

In general the growth rates for Scotland are very similar to that of the whole of the UK, which is unsurprising given that the bulk of the UK fulmar population (97%) is in Scotland. The annual population growth rate was smaller between the Seabird Colony Register (1985-88) and Seabird 2000 (1998-2002) counts than between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) counts (0.9973 and 1.0342 respectively). The overall annual population growth rate across all three counts was 1.0173. Again the difference between this value and the model predictions are not significant.

5.1.5 Site specific growth rates

There were only site-specific data available for one of the two SPAs for which PVAs are required; the North Caithness Cliffs SPA. The only multi-year data available was from the island of Stroma, which is only one part of the North Caithness Cliffs SPA, so data should be considered with this in mind. This showed a much lower growth rate than the other empirical data as well as the model outputs.

The population change on Stroma from 1986 to 2002 was quite large with the count decreasing from 1,032 to 285 pairs, thus there was an overall annual growth rate well below 1 (at 0.7760) over the period of the data set. The population peaked in 1993 and subsequently declined considerably by 2000 (Figure 1).

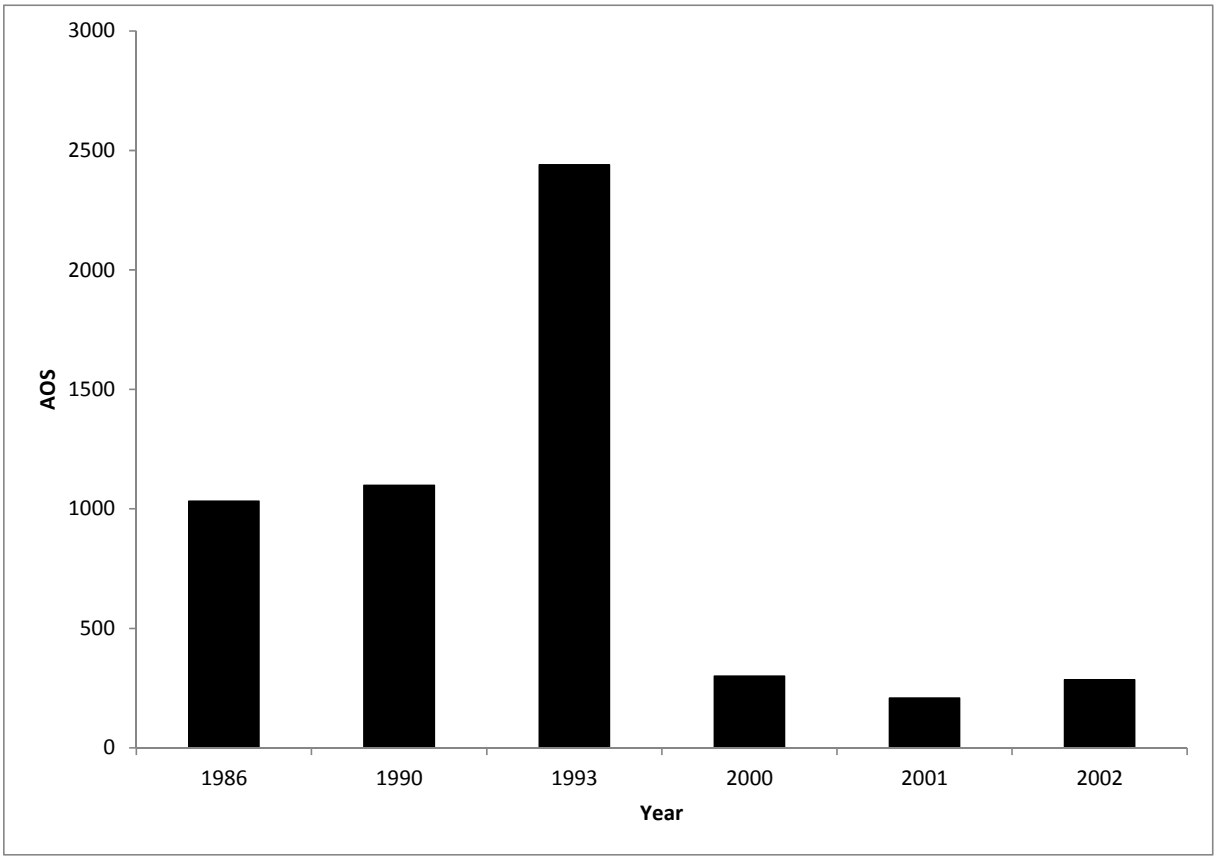


Figure 1. Number of Apparently Occupied Sites (AOS) of fulmar on the island of Stroma from 1986 to 2002.

5.1.6 Discussion

The annual population growth rates for fulmar from both the deterministic and stochastic models were very similar. The model rates were lower than most of the rates available from currently available sources, except for those for the single site counts of Stroma since 2000. The reasons for the sudden decline in counts on Stroma are not readily apparent, but this is quite different from the general situation in Scotland. It is therefore important to consider growth rates at larger temporal and spatial scales as individual colony demographic parameters may not reflect regional/national trends.

While the data at the Scottish and UK levels showed annual population growth rates higher than those from the models, many were quite similar. At the UK level across the whole data set the difference in the annual population growth rate was only 0.0342 – 0.0345 (for the deterministic and stochastic models respectively) and at the Scottish level the difference was slightly larger (0.0366 - 0.0369). The trends in the Scottish population are very similar to that at the UK level, mainly due to the vast majority of the UK population occurring in Scotland (Figure 2).

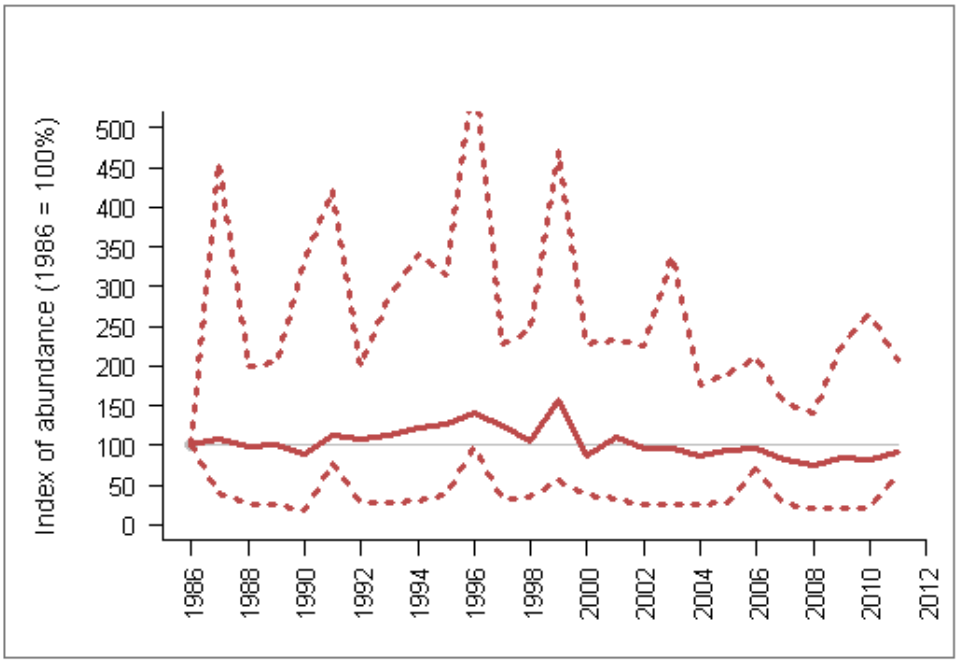


Figure 2. Trend in abundance index (solid line) of fulmar in Scotland, 1986-2011 with 95% confidence limits (dotted lines; drawing of upper limit restricted to preserve detail in the abundance index). Based on SMP data; from http://jncc.defra.gov.uk/page-2868 on 21/05/2013.

The demographic parameters used in these models came from several sources; most from colonies in the north of Scotland. The annual population growth rates predicted by the models were both less than 1. This is partly due to the low productivity value used in the model (0.08 (±0.005) fledglings per nest). This is much lower than the mean UK value (0.39) derived from the SMP by Cook & Robinson (2010).

While the annual population growth rate derived from these models is lower than the UK and Scottish data it appears that this is due to low levels of productivity in local populations, which may now be increasing. It would be technically feasible to adjust the models to produce a population growth rate that matched one of the known population trends. If this was attempted questions would remain as to which population trend the model should follow and which parameters should be reduced by which amount. With no robust data available to inform this, the model would provide an apparently correct output by using input values not based on empirical data, thus any inferences drawn from the model would be weak.

The models used to understand the effects of impacts on the populations relevant to the three proposed wind farms are necessarily approximations of reality. It appears that while the predicted population growth rates are lower than recent population trends they are likely conservative for the purposes of impact assessment. As such the models should be considered robust for use as a comparative tool to understand the significance of effects.

5.2 Gannet

5.2.1 Demographic parameters

Demographic parameters used for modelling the gannet population are shown in Table 20.

Table 20. Demographic parameters used for gannet PVAs

Population parameter	Rate (variance)	Reference	Reason for selection
Adult survival	0.922 (0.0001)	Wanless *et al.*, 2006	Based on recoveries of ringed birds from 10 colonies across Britain and Ireland between 1959 and 2002. Selected due to detail of study and availability of variance rates.
First year survival	0.420 (0.0062)	Wanless *et al.*, 2006	Based on recoveries of ringed birds from 10 colonies across Britain and Ireland between 1959 and 2002. Selected due to detail of study and availability of variance rates
Second year survival	0.852 (0.0010)	Wanless *et al.*, 2006	Based on recoveries of ringed birds from 10 colonies across Britain and Ireland between 1959 and 2002. Selected due to detail of study and availability of variance rates
Third year survival	0.908 (0)	Wanless *et al.*, 2006	Based on recoveries of ringed birds from 10 colonies across Britain and Ireland between 1959 and 2002. Selected due to detail of study and availability of variance rates
Fourth year survival	0.910 (0)	Wanless *et al.*, 2006	Based on recoveries of ringed birds from 10 colonies across Britain and Ireland between 1959 and 2002. Selected due to detail of study and availability of variance rates
Average breeding age	5 years	Nelson, 2002	Accepted value.
Number of eggs per clutch	1	Nelson, 2002	Accepted value.
Number of fledglings per nest	0.69 (0.002)	Mavor *et al.*, 2008	Mean value for colonies in SW Scotland, Shetland, Orkney and Wales between 1986 and 2005. Selected based on duration of study. This value is representative of figures provided for individual colonies in Scotland (ranging between means of 0.66 and 0.70)

5.2.2 Growth Rates

Available growth rates for gannet at multiple spatial and temporal scales are presented in Table 21.

Table 21. Estimated annual population growth rate of gannet at multiple spatial and temporal scales.

Spatial scale	Temporal scale	Lambda
UK	1969/70 to 1985/88	1.0180
	1985/88 to 1994/95	1.0219
	1994/95 to 2004/05	0.9942
	1969/70 to 2004/05	1.0133
Scotland	1969/70 to 1985/88	1.0165
	1985/88 to 1994/95	1.0362
	1994/95 to 2004/05	1.0087
	1969/70 to 2004/05	1.0183

Spatial scale	Temporal scale	Lambda
Deterministic growth rate - mean		1.0118
Stochastic growth rate – mean		1.0116
Stochastic growth rate – lower 95% CI		1.0058
Stochastic growth rate – upper 95% CI		1.0175

5.2.3 UK growth rates

Unlike other seabirds, surveys of gannets have been carried out specifically for this species every ten years since 1994/95. This is due to the need to count large and remote colonies from an aerial survey platform. Based on four data points from two national seabird surveys and two national gannet surveys (in 1994/95 and 2004/05) it appears that the UK annual population growth rate increased very slightly from 1.0180 between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) to 1.0219 between the Seabird Colony Register (1985/88) and the National gannet survey in 1994/95, before declining slightly between the last two national surveys to 0.9942 (Table 21). However, the absolute population size has increased by a factor of 1.9 from 1969/70 to 2004/05, with an annual growth rate of 1.0133. The annual population growth rates from both the deterministic and stochastic population models (1.0118 and 1.0116 respectively) are lower than these estimates, although the difference is not signficant.

5.2.4 Scottish growth rates

In general the growth rates for Scotland are similar, but slightly higher, to that of the whole of the UK, which is unsurprising given that the majority of the UK gannet population is in Scotland (84%). The overall annual population growth rate across all the counts was 1.0183. Again the model predictions were slightly lower than empirical data but the differences are not significant

5.2.5 Site specific growth rates

Site-specific population data were available for the Troup Head colony. This colony has grown in size markedly since in mid-1980's, when the colony was established to a population size of 1,547 pairs at the last National gannet survey. Since the initial growth was due to immigration rather than intrinsic growth, due to the colony being established as a new breeding population, it is not reasonable to compare its apparent growth rate over this period with the closed population modelled in the PVA.

5.2.6 Discussion

The annual population growth rates for gannet from both the deterministic and stochastic models were very similar. The model rates were within the variation of the UK and Scottish population rates across the period considered.

At the UK level across the whole data set the difference in the annual population growth rate was very small (0.0015 – 0.0017 for the deterministic and stochastic models respectively) and at the Scottish level the difference was slightly greater though still very small (0.0065 - 0.0067). The trend plots for the Scottish population only shows three points but does clearly show an increase in

numbers (Figure 3). In addition the total number of colonies has increased since the 1969/70 to the last national census from 8 to 14 in Scotland and from 10 to 17 for the UK.

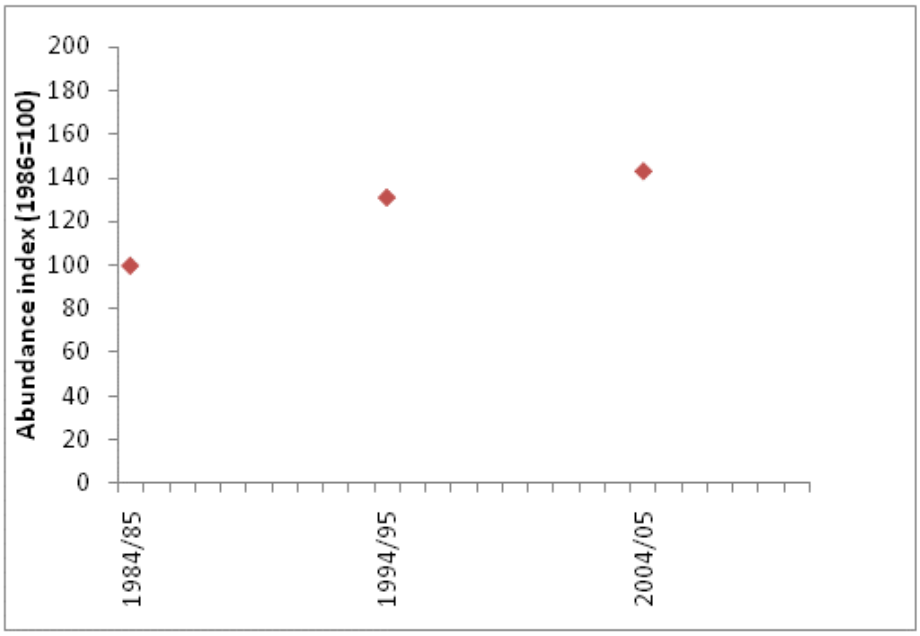


Figure 3. Plot of abundance index of gannet in Scotland, 1986-2011. Based on SMP data, from http://jncc.defra.gov.uk/page-2874 on 21/05/2013.

The demographic parameters used in the model were based on data from across the UK and as such reflect the empirical growth rates at the UK and Scottish level well. The whole gannet population in the North Atlantic has shown very steady 2% per annum growth since the early 1900s, however there are now indications that there may be density dependent processes limiting growth in some colonies at least (Lewis *et al*. 2001).

The UK and Scottish population of gannet has shown very consistent levels of productivity since 1986 between 0.6 and 0.8 chicks per pair (JNCC 2012). The parameter value used in the model was from a similarly long time series (1986 to 2005).

The annual population growth rates derived from these models were very similar to the UK and Scottish values. As such the models should be considered robust for use as a comparative tool to understand the significance of effects.

5.3 Kittiwake

5.3.1 Demographic parameters

Demographic parameters used for modelling the kittiwake populations are shown in Table 22.

Table 22. Demographic parameters used for kittiwake PVAs.

Population parameter	Rate (variance)	Reference	Reason for selection
Adult survival	0.882 (0.0003)	Harris et al., 2000	Rate based on data collected between 1986 and 1996 in the Isle of May. Selected based on duration of study and proximity to site.
Juvenile survival	0.790 (0.0441)	Coulson and White, 1959	Based on two years of data collected at the Farne Islands and North Sheilds in the mid-1950s. Selected based on proximity to site and poor data availability for this rate.
Average breeding age	5 years	Robinson, 2005	Number based on literature reviews carried out by the BTO.
Number of eggs per clutch	2	Snow and Perrins, 1998	Number from widely accepted source.
Number of fledglings per nest	0.560 (0.1280)	Mavor et al., 2008	Mean value for Isle of May between 1986 and 2005. Selected based on duration of study, proximity to site and compatibility with adult survival rate used.

5.3.2 Growth Rates

Available growth rates for kittiwake at multiple spatial and temporal scales are presented in Table 23.

Table 23. Estimated annual population growth rate of kittiwake at multiple spatial and temporal scales.

Spatial scale	Temporal scale	Lambda
UK	1969/70 to 1985/88	1.0126
	1985/88 to 1998/02	0.9798
	2000 to 2011	0.9532
	1969/70 to 2011	0.9861
Scotland	1969/70 to 1985/88	1.0022
	1985/88 to 1998/02	0.9829
	2000 to 2011	no data
	1969/70 to 1998/02	0.9940
Deterministic growth rate - mean		0.9844
Stochastic growth rate – mean		0.9827
Stochastic growth rate – lower 95% CI		0.9571
Stochastic growth rate – upper 95% CI		1.0089

5.3.3 UK growth rates

Based on only three data points from the three national seabird surveys it appears that the UK annual population growth rate declined from 1.0126 between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) to 0.9798 between the Seabird Colony Register and Seabird 2000 (1998 – 2000), and further still across the period 2000 to 2011 to 0.9532 (Table 23). The absolute population size has decreased over this period and is now 93% of its size in 1969/70, with an annual growth rate of 0.9861. The annual population growth rates from both the deterministic and stochastic population models (0.9844 and 0.9827 respectively) are similar to the overall UK estimate

across the whole period, but slightly higher than the most recent population growth rate (from 2000 to 2011).

5.3.4 Scottish growth rates

The annual population growth rate in Scotland was smaller between the Seabird Colony Register (1985-88) and Seabirds 2000 (1998-2002) counts than between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) counts (0.9829 and 1.0022 respectively). The overall annual population growth rate across all three counts was 0.9940. Again the difference between this value and the deterministic and stochastic model predictions are not significant; 0.0096 and 0.0114 respectively.

5.3.5 Discussion

The annual population growth rates for kittiwake from both the deterministic and stochastic models were very similar. The model rates were similar to most of the empirically derived rates, and while higher than the most recent (2001 – 2011) derived rate for the UK they were only about 3% higher. The models did result in growth rates less than 1, indicating a declining population, matching the UK and Scottish population trends.

It is unfortunate that the SMP has not published a percentage change in population size for the Scottish population as it has for the UK population. The trend plot for the Scottish population does show a decline since the late 1980s (Figure 4), but it is important to consider the influences of different regional populations, with different foraging areas, when using this trend given that there have been dramatic declines in kittiwake numbers at colonies in the Northern Isles, Shetland in particular. The growth rates from the models are within the confidence limits shown in this trend plot since c2000.

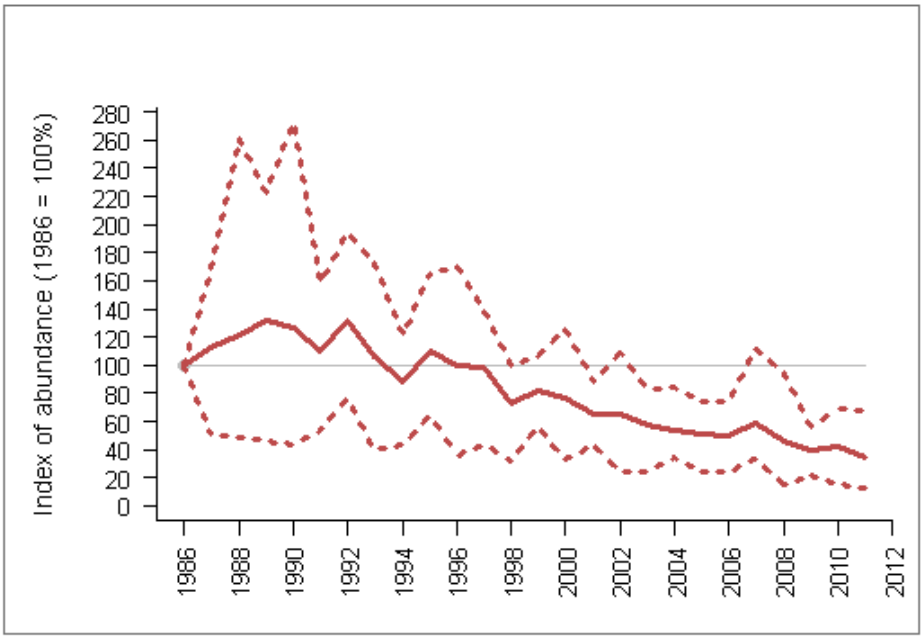


Figure 4. Trend in abundance index (solid line) of kittiwake in Scotland, 1986-2011 with 95% confidence limits (dotted lines; drawing of upper limit restricted to preserve detail in the abundance index). Based on SMP data, from http://jncc.defra.gov.uk/page-2889 on 21/05/2013.

It is important to consider that the demographic parameters used in these models mostly come from single colony studies (mostly from studies of the colony on the Isle of May). While these are the most robust values available, and the models account for the variability in the data, they are unlikely to exactly reflect the entire UK or Scottish population, and were not designed to do this. The kittiwake colony on the Isle of May had particularly low productivity and adult survival during the period 1990 to 2000 due to the commercial sandeel fishery on the Wee Bankie (Frederiksen *et al*. 2004). As such the use of values of adult survival which include part of this period may be reflected in the differences between the models annual population growth rate predictions and at least some of the empirical data.

The UK and Scottish populations of kittiwake have shown declines in productivity over the period 1986 to present, though inter-annual fluctuations are typical (JNCC 2012). The average across this period was 0.68 chicks fledged per pair for the whole of the UK (Cook & Robinson, 2010), which is larger than the value used in the models. The values used in the model were again derived from the Isle of May and included part of the period during which the sandeel fishery was impacting the population (1986 to 2005). The annual productivity often varies not only temporally, but spatially. In 2011 there was very low productivity in the north of Scotland (Orkney and Shetland in particular) but high productivity in the south and west (up to 0.9 fledglings per pair) (JNCC 2012).

The annual population growth rate derived from these models was overall similar to the empirical data across a wide range of population scales. While some values were lower than the model values this is to be expected with species with frequent large fluctuations in productivity. The models should therefore be considered robust for use as a comparative tool to understand the significance of effects.

5.4 Herring gull

5.4.1 Demographic parameters

Demographic parameters used for modelling the herring gull population are shown in Table 24.

Table 24. Demographic parameters used for herring gull PVAs.

Population parameter	Rate (variance)	Reference	Reason for selection
Adult survival	0.880 (0.0002)	Wanless et al., 1996	Overall survival based on birds ringed on the Isle of May between 1989 and 1993 and recaptured between 1990 and 1994. Selected based on proximity to site and depth of study.
Juvenile survival	0.819 (0.0022)	Wanless et al., 1996	Rate of survival of fledged young to breeding age (age 4) estimated from a population model based on the dataset described above.
Average breeding age	4	Robinson, 2005	Number based on literature reviews carried out by the BTO.
Population parameter	**Rate (variance)**	**Reference**	**Reason for selection**
Number of eggs per clutch	3	Snow and Perrins, 1998	Number from widely accepted source.
Number of fledglings per nest	0.74 (0.4096)	Mavor et al., 2008	Based on data collected on Canna between 1986 and 2005. Selected due to proximity to site.

5.4.2 Growth Rates

Available growth rates for herring gull at multiple spatial and temporal scales are presented in Table 25.

Table 25. Estimated annual population growth rate of herring gull at multiple spatial and temporal scales.

Spatial scale	Temporal scale	Lambda
UK	1969/70 to 1985/88	0.9625
	1985/88 to 1998/02	0.9903
	2000 to 2011	0.9642
	1969/70 to 2011	0.9721
Scotland	1969/70 to 1985/88	0.9688
	1985/88 to 1998/02	0.9816
	2000 to 2011	no data
	1969/70 to 1998/02	0.9746
Deterministic growth rate - mean		1.0393
Stochastic growth rate – mean		1.0344
Stochastic growth rate – lower 95% CI		0.9977
Stochastic growth rate – upper 95% CI		1.0727

5.4.3 UK growth rates

Based on only three data points from the three national seabird surveys it appears that the UK annual population growth rate increased from 0.9625 between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) to 0.9903 between the Seabird Colony Register and Seabird 2000 (1998 to 2002), but then declined again to 0.9642 across the period 2000 to 2011 (Table 25). The absolute population size has decreased by a factor of 3.3 from 1969/70 to 2011, with an annual growth rate of 0.9721. The annual population growth rates from both the deterministic and stochastic population models (1.0393 and 1.0344 respectively) are slightly larger than these estimates.

5.4.4 Scottish growth rates

In general the growth rates for Scotland are similar to those of the whole of the UK. The annual population growth rate was slightly lower between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) counts than between the Seabird Colony Register (1985-88) and Seabird 2000 (1998 – 2002) counts (0.9688 and 0.9816 respectively). The overall annual population growth rate across all three counts was 0.9746. Since this is similar to the UK values the difference between this value and the model predictions are not importantly different.

5.4.5 Discussion

The annual population growth rates for herring gull from both the deterministic and stochastic models were very similar. The model rates were not dissimilar to many of the rates available from currently available sources but they predicted a slightly increasing population whereas the Scottish and UK trends are for slight population declines.

At the UK level across the whole data set the difference in the annual population growth rate was 0.0672 – 0.0623 (for the deterministic and stochastic models respectively) and at the Scottish level the difference was smaller (0.0648 - 0.00599). It is unfortunate that the SMP has not published a percentage change in population size for the Scottish population as it has for the UK population. The trend plots for the Scottish population shows a decline over the last 10 years, but due to uncertainty over the trends (to which between-colony variation will contribute), the model growth rates are within the confidence limits of recent (e.g. 10 years) population changes (Figure 5).

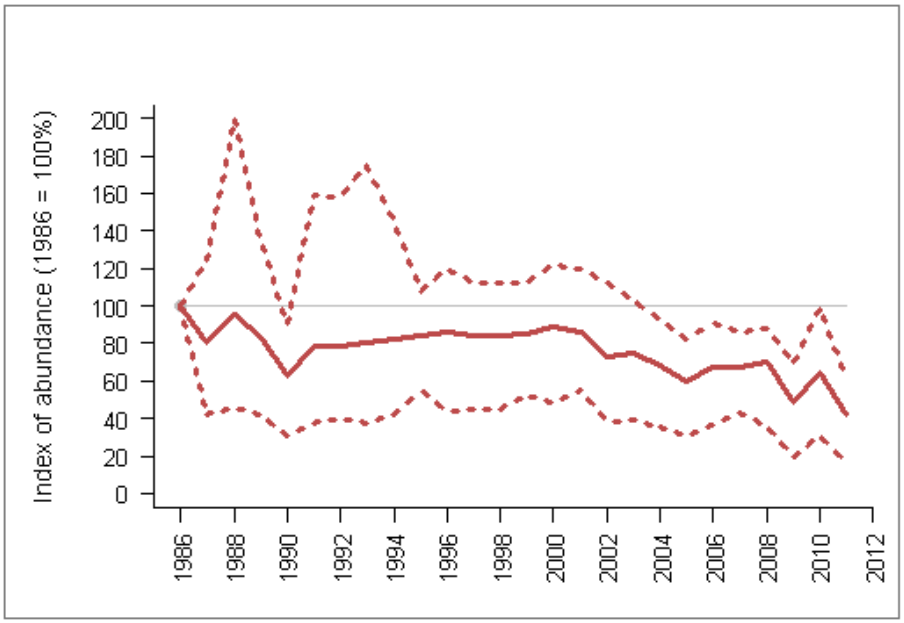


Figure 5. Trend in abundance index (solid line) of herring gull in Scotland, 1986-2011 with 95% confidence limits (dotted lines; drawing of upper limit restricted to preserve detail in the abundance index). Based on SMP data, from http://jncc.defra.gov.uk/page-2887 on 21/05/2013.

The demographic parameters used in these models came from two colony studies; the Isle of May (survival parameters) and Canna (productivity parameter). While these are the most robust values available, and the models account for the variability in the data, they are unlikely to exactly reflect the entire UK or Scottish population.

The Scottish population of herring gull has shown a decline in productivity from 1986 to 1999, with an increase in recent years, perhaps due to mink trapping on the west coast (JNCC 2012). The parameter value used in the model was from a long time series (1986 to 2005), so while it partly covered the period when productivity in Scotland was low due to mink predation, the seabirds on Canna, Rum and Eigg are considered not have been vulnerable to mink predation (Craik, 1997). In addition the study by Cook & Robinson (2010) found the productivity of the population across the UK to be 0.75 fledglings per pair. It is therefore considered to be a robust parameter and suitable for this study.

The population of herring gulls across the UK has shown a slight decline in spite of recent increases in town nesting populations. The declines have been noted from coastal breeding colonies in natural habitat although the reasons for these remain largely unknown. Although the model growth rates are slightly higher than the mean rates shown by the UK and Scottish trends, they are within the variation shown by the Scottish trends. As such the models should be considered robust for use as a comparative tool to understand the significance of effects.

5.5 Great black-backed gull

5.5.1 Demographic parameters

Demographic parameters used for modelling the great black-backed gull population are shown in Table 26.

Table 26: Demographic parameters used for great black-backed gull PVAs.

Population parameter	Rate (variance)	Reference	Reason for selection
Adult survival	0.930 (0)	Garthe and Huppop, 2004	Based on a rate provided in Glutz von Blotzheim & Bauer, 1982 (in German). Selected because this was the only rate found during data searching.
Juvenile survival	0.930 (0)	Garthe and Huppop, 2004	As above as no suitable data available for juvenile survival.
Average breeding age	4 years	Robinson 2005	Number based on literature reviews carried out by the BTO.
Number of eggs per clutch	2	Snow and Perrins, 1998	Number from widely accepted source.
Number of fledglings per nest	0.65 (0.072)	Mavor et al., 2008	Chicks fledged per pair for great black-backed gulls in Shetland, collected over 5 years between 1986 and 2005. Selected due to proximity of site and duration of study.

5.5.2 Growth Rates

Available growth rates for great black-backed gull at multiple spatial and temporal scales are presented in Table 27.

Table 27. Estimated annual population growth rate of great black-backed gull at multiple spatial and temporal scales. Shading highlights the value calculated across the whole period measured.

Spatial scale	Temporal scale	Lambda
UK	1969/70 to 1985/88	0.9956
	1985/88 to 1998/02	0.9972
	2000 to 2011	0.9589
	1969/70 to 2011	0.9864
Scotland	1969/70 to 1985/88	0.9976
	1985/88 to 1998/02	0.9974
	2000 to 2011	no data
	1969/70 to 1998/02	0.9975
Deterministic growth rate - mean		1.1084
Stochastic growth rate – mean		1.1070
Stochastic growth rate – lower 95% CI		1.0744
Stochastic growth rate – upper 95% CI		1.1405

5.5.3 UK growth rates

Based on only three data points from the three national seabird surveys it appeared that the UK annual population growth rate changed little from 0.9956 between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) to 0.9972 between the Seabird Colony Register and Seabird 2000 (1998 – 2002) but declined to 0.9589 across the period 2000 to 2011 (Table 27). The absolute population size has declined by about 11% from 1969/70 to 2011, with an annual growth rate of 0.9864. The annual population growth rates from both the deterministic and stochastic population models (1.1084 and 1.1070 respectively) are larger than these estimates.

5.5.4 Scottish growth rates

In general the growth rates for Scotland are slightly higher than the whole of the UK. The annual population growth rate was very similar across all period, including 1969/70 to 2011 (0.9975).

5.5.5 Discussion

The annual population growth rates for great black-backed gulls from both the deterministic and stochastic models were very similar. The model rates were higher than the rates from the Scottish and UK tends. At the UK level across the whole data set the difference in the annual population growth rate was 0.1221 – 0.1207 (for the deterministic and stochastic models respectively) and at the Scottish level the difference was slightly smaller (0.1109 - 0.1095). It is unfortunate that the SMP has not published a percentage change in population size for the Scottish population as it has for the UK population. The trend plot for the Scottish population shows a largely stable population from 1986 to 2003 and a general decline over the last 10 years (Figure 6); the growth rates from the models are within the confidence limits shown for recent (e.g. years) population changes, with this variation likely to be coming in part from between-colony variation.

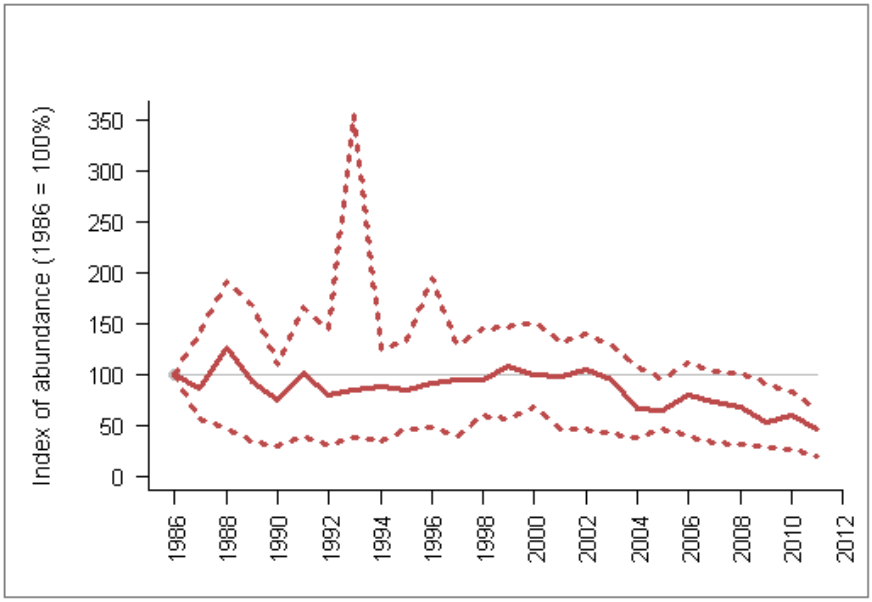


Figure 6. Trend in abundance index (solid line) of great black-backed gull in Scotland, 1986-2011 with 95% confidence limits (dotted lines; drawing of upper limit restricted to preserve detail in the abundance index). Based on SMP data, from http://jncc.defra.gov.uk/page-2888 on 21/05/2013.

There were very few sources for demographic parameters to use in these models. There was only a single source found for adult survival and no data for juvenile survival. The data used for productivity was from the Shetland population and at 0.65 fledglings per pair was lower than the data from Scotland as a whole in all but 3 years (Figure 7).

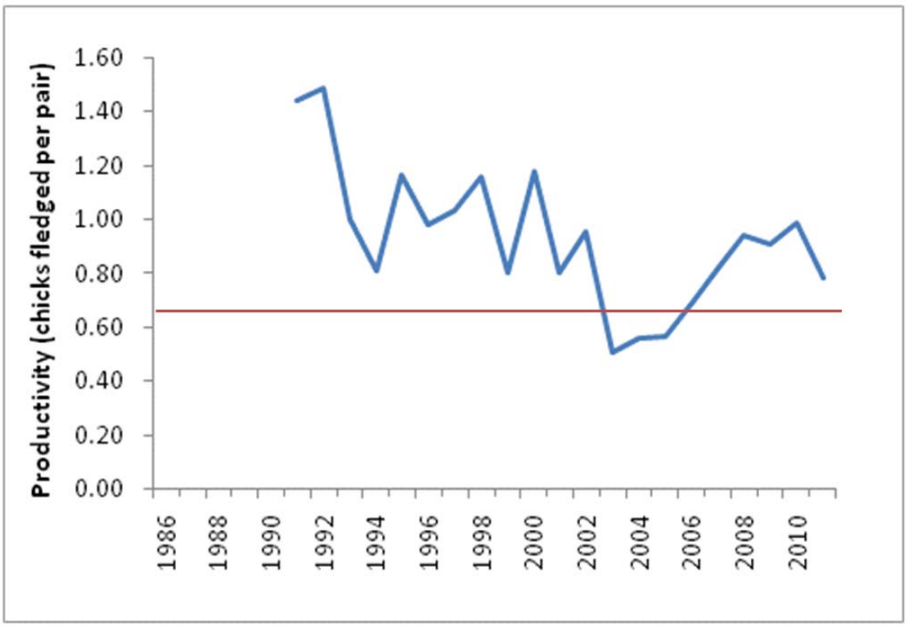


Figure 7. Trend in productivity (no. of chicks fledged per pair) of great black-backed gull in Scotland, 1986-2011 (blue line) from SMP data (JNCC, 2012). The parameter value used in the model was 0.65 (red line).

Population models of k-selected species such as great black-backed gull are typically much more sensitive to changes in adult survival rates than they are to other parameters. Given the apparently low productivity used in the model, and the higher population growth rate it may be that the only available data source for adult survival was higher than the mean for the UK population. It may also be a function of the relatively high juvenile survival value used. Adult survival was used as a proxy as there was no empirical data on juvenile survival. It is likely that this was lower than adult survival, but given the model is likely to be more sensitive to differences in adult survival this should have made relatively little difference.

Although the model growth rates are slightly higher than the mean rates shown by the UK and Scottish trends, they are within the variation shown by the Scottish trends. As such the models should be considered robust for use as a comparative tool to understand the significance of effects.

5.6 Guillemot

5.6.1 Demographic parameters

Demographic parameters used for modelling the guillemot populations are shown in Table 28.

Table 28. Demographic parameters used for guillemot PVAs.

Population parameter	Rate (variance)	Reference	Reason for selection
Adult survival	0.965 (0.0001)	Harris *et al.*, 2007	Rate calculated for the Isle of May based on data collected between 1984 and 2005 for chicks ringed between 1983 and 2002. Selected based on length of study, proximity to site and relatively recent date of study.
First year survival	0.560 (0.0002)	Harris *et al.*, 2007	Rate calculated for the Isle of May based on data collected between 1984 and 2005 for chicks ringed between 1983 and 2002. Selected based on length of study, proximity to site and relatively recent date of study.
Second year survival	0.792 (0.0009)	Harris *et al.*, 2007	Rate calculated for the Isle of May based on data collected between 1984 and 2005 for chicks ringed between 1983 and 2002. Selected based on length of study, proximity to site and relatively recent date of study.
Third year survival	0.917 (0.0003)	Harris *et al.*, 2007	Rate calculated for the Isle of May based on data collected between 1984 and 2005 for chicks ringed between 1983 and 2002. Selected based on length of study, proximity to site and relatively recent date of study.
Fourth year survival	0.938 (0.0003)	Harris *et al.*, 2007	Rate calculated for the Isle of May based on data collected between 1984 and 2005 for chicks ringed between 1983 and 2002. Selected based on length of study, proximity to site and relatively recent date of study.
Average breeding age	5 years	Birkhead & Hudson 1977	Based on a study carried out on Skomer Island, Wales between 1972 and 1975.

Population parameter	Rate (variance)	Reference	Reason for selection
Number of eggs per clutch	1	Snow and Perrins, 1998	Number from widely accepted source.
Number of fledglings per nest	0.63 (0.03)	Mavor *et al.*, 2008	Rate based on data collected over 12 years between 1986 and 2005 at North Sutor. Selected based on proximity to site, length of study and relatively recent date of study.

5.6.2 Growth Rates

Available growth rates for guillemot at multiple spatial and temporal scales are presented in Table 29.

Table 29. Estimated annual population growth rate of guillemot at multiple spatial and temporal scales.

Spatial scale	Temporal scale	Lambda
UK	1969/70 to 1985/88	1.0341
	1985/88 to 1998/02	1.0195
	2000 to 2011	1.0053
	1969/70 to 2011	1.0216
Scotland	1969/70 to 1985/88	1.0357
	1985/88 to 1998/02	1.0154
	2000 to 2011	no data
	1969/70 to 1998/02	1.0265
North Caithness Cliffs SPA - Stroma Island only	1986 to 1993	0.9996
	1993 to 2000	1.0122
	2000 to 2001	1.1324
	1986 to 2001	1.0138
Deterministic growth rate - mean		1.0577
Stochastic growth rate – mean		1.0575
Stochastic growth rate – lower 95% CI		1.0487
Stochastic growth rate – upper 95% CI		1.0665

5.6.3 UK growth rates

Based on only three data points from the three national seabird surveys it appeared that the UK annual population growth rate declined from 1.0341 between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) to 1.0053 across the period 2000 to 2011 (Table 29). The absolute population size has increased by a factor of 2.5 from 1969/70 to 2011, with an annual growth rate of 1.0216. The annual population growth rates from both the deterministic and stochastic population models (1.0577 and 1.0575 respectively) are larger than these estimates, though the differences are small and not significant.

5.6.4 Scottish growth rates

In general the growth rates for Scotland are very similar to that of the whole of the UK, which is unsurprising given that the majority of the UK guillemot population is in Scotland. The annual population growth rate was smaller between the Seabird Colony Register (1985-88) and Seabirds 2000 (1998-2002) counts than between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) counts (1.0154 and 1.0357 respectively). The overall annual population growth rate across all three counts was 1.0265. Again the differences between this value and the model predictions are small and not significant.

5.6.5 Site specific growth rates

There were only site-specific data available was for the North Caithness Cliffs SPA. The only robust data for the East Caithness Cliffs SPA were from a single count for Seabird 2000. The only multi-year data available for the North Caithness Cliffs SPA was from the island of Stroma, which is only one part of the whole SPA (about 20%), so data should be considered with this in mind.

The population change on Stroma from 1986 to 2001 was relatively modest with the count increasing from 13,600 to 16,714 individuals, thus there has been an overall annual growth rate only slightly above 1 (at 1.013) over the period of the data set.

5.6.6 Discussion

The annual population growth rates for guillemots from both the deterministic and stochastic models were very similar. While the model rates were higher than many of the rates available from currently available sources it is notable that several were higher; Troup, Pennan and Lion's Head SPA 1986 – 1995 and North Caithness Cliffs 2000 – 2001. The latter was due to a change in population size between two years (2000 = 14,760. 2001 = 16,714) and highlights the variability found in these types of count data. It is likely that the difference in the number of individuals between the years 2000-2001 is probably due to normal inter-annual variation and methodology rather than being indicative of a real increase in population size.

While the remaining data showed annual population growth rates lower than that from the models, many were not dissimilar. At the UK level across the whole data set the difference in the annual population growth rate was only 0.0364 – 0.0365 (for the deterministic and stochastic models respectively) and at the Scottish level the difference was slightly smaller (0.0334 - 0.0336). It is unfortunate that the SMP has not published a percentage change in population size for the Scottish population as it has for the UK population. The trend plots for the Scottish population does show a general decline over the last 10 – 12 years (Figure 8), but it is important to consider the influences of different regional populations, with different foraging areas, when using this trend. There have been dramatic declines in guillemot numbers at colonies in the Northern Isles, Shetland in particular, which may be having a strong effect on the Scottish trend due to the number and size of colonies in that area.

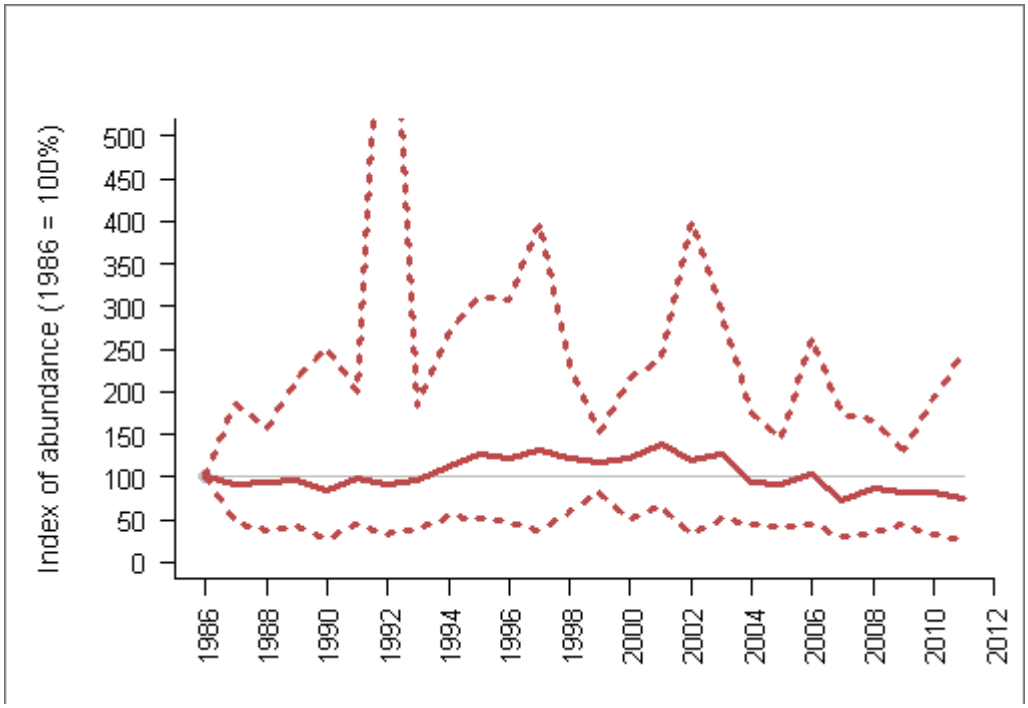


Figure 8: Trend in abundance index (solid line) of guillemot in Scotland, 1986-2011 with 95% confidence limits (dotted lines; drawing of upper limit restricted to preserve detail in the abundance index). Based on SMP data, from http://jncc.defra.gov.uk/page-2898 on 21/05/2013.

It is important to consider that the demographic parameters used in these models all come from single colony studies; most came from studies of the colony on the Isle of May. While these are the most robust values available, and the models account for the variability in the data, they are unlikely to exactly reflect the entire UK or Scottish population. The annual population growth rate predicted by the models is very close to that found in models of the Skomer guillemot population in Wales (1.050; Meade *et al* 2013) which was also found to be very similar to the observed geometric mean of the population (1.051). The geometric mean of the Isle of May population over a similar period was smaller at 1.0183.

Population models of k-selected species such as guillemot are typically much more sensitive to changes in adult survival rates than they are to other parameters. Meade *et al.* (2013) found that a proportional increase in adult survival had 10 times the effect on lambda as any other parameter. As such the use of the data from Harris *et al.* (2007) is likely to be the most appropriate to this location and the most robust data source available.

The Scottish population of guillemot has shown declines in productivity from 2002 to 2007, with an increase in recent years (JNCC 2012). The parameter value used in the model was from a long time series (1986 to 2005), so partly covered the period when Scottish productivity was low, and from a site within the population being modelled. It is therefore also considered to be robust and suitable for this study.

While it may appear that the annual population growth rate derived from these models is slightly higher than for at least some of the local and regional populations it is not clear what demographic

parameters are causing the decline in these populations; though it is apparent that productivity may have been declining until recently. It would be technically feasible to adjust the models to produce a population growth rate that matched one of the known population trends. If this was attempted questions would remain as to which population trend the model should follow and which parameters should be reduced by which amount. With no robust data available to inform this, the model would provide an apparently correct output by using input values not based on empirical data, thus any inferences drawn from the model would be weak.

The models used to understand the effects of impacts on the populations relevant to the three proposed wind farms are necessarily approximations of reality. It appears that while the predicted population growth rates are slightly higher than some recent population trends they are within the known range of population trends. As such the models should be considered robust for use as a comparative tool to understand the significance of effects.

5.7 Razorbill

5.7.1 Demographic parameters

Demographic parameters used for modelling the razorbill population are shown in Table 30.

Table 30. Demographic parameters used for razorbill PVAs.

Population parameter	Rate (variance)	Reference	Reason for selection
Adult survival	0.905 (0.0004)	Harris et al., 2000	Rate based on data collected between 1986 and 1996 in the Isle of May. Selected based on duration of study and proximity to site.
Juvenile survival	0.905 (0.0004)	No data	Based on the above as no suitable data available for juvenile survival.
Average breeding age	4 years	Robinson 2005	Number based on literature reviews carried out by the BTO.
Number of eggs per clutch	1	Snow and Perrins, 1998	Number from widely accepted source.
Number of fledglings per nest	0.66 (0.0080)	Mavor *et al*., 2006	Colony average for Isle of May between 1986 and 2005. Selected based on length of study, proximity to site, recent date of study and compatibility with other rates used (all from Isle of May).

5.7.2 Growth Rates

Available growth rates for razorbill at multiple spatial and temporal scales are presented in Table 31.

Table 31. Estimated annual population growth rate of razorbill at multiple spatial and temporal scales.

Spatial scale	Temporal scale	Lambda
UK	1969/70 to 1985/88	1.0089
	1985/88 to 1998/02	1.0139
	2000 to 2011	1.0120
	1969/70 to 2011	1.0114
Scotland	1969/70 to 1985/88	1.0073
	1985/88 to 1998/02	1.0074
	2000 to 2011	no data
	1969/70 to 1998/02	1.0073
Deterministic growth rate - mean		1.0805
Stochastic growth rate – mean		1.0801
Stochastic growth rate – lower 95% CI		1.0710
Stochastic growth rate – upper 95% CI		1.0892

5.7.3 UK growth rates

Based on only three data points from the three national seabird surveys it appears that the UK annual population growth rate increased from 1.0089 between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) to 1.0139 between the Seabird Colony Register and Seabird 2000 (1998 – 2002) across the period 2000 to 2011 (Table 31). The absolute population size has increased by 61% from 1969/70 to 2011, with an annual growth rate of 1.0114. The annual population growth rates from both the deterministic and stochastic population models (1.0805 and 1.0801 respectively) are larger than these estimates, though the difference is not significant (0.0691 – 0.0687).

5.7.4 Scottish growth rates

In general growth rates for Scotland are slightly lower than those of the whole of the UK. The annual population growth rate has been essentially stable since Operation Seafarer (1969-70) at about 1.0073 – 1.0074. The difference between this value and the model predictions are also not significant.

5.7.5 Site specific growth rates

The only robust data for the East Caithness Cliffs SPA were from a single count for Seabird 2000, however a recent SCM report (Swann 2012) found increases in all 4 plots monitored, with some increases being substantial. Since these plots were only a very small proportion of the overall population they were not considered robust enough for comparisons with other empirical data or model results. They do however illustrate that changes in population size can vary substantially at small spatial scales.

5.7.6 Discussion

The annual population growth rates for razorbill from both the deterministic and stochastic models were very similar. The model rates were slightly higher than the Scottish and UK population trends.

At the UK level across the whole data set the difference in the annual population growth rate was 0.0691 – 0.0687 (for the deterministic and stochastic models respectively) and at the Scottish level the difference was slightly larger (0.0732 - 0.0728). It is unfortunate that the SMP has not published a percentage change in population size for the Scottish population as it has for the UK population. The trend plots for the Scottish population shows an increase during the mid-1990s followed by a period of relative stability until 2007 and then a decline over the last 4 years (Figure 9). This pattern is reflected in the counts from several large colonies (such as Handa and Mingulay) (JNCC 2012).

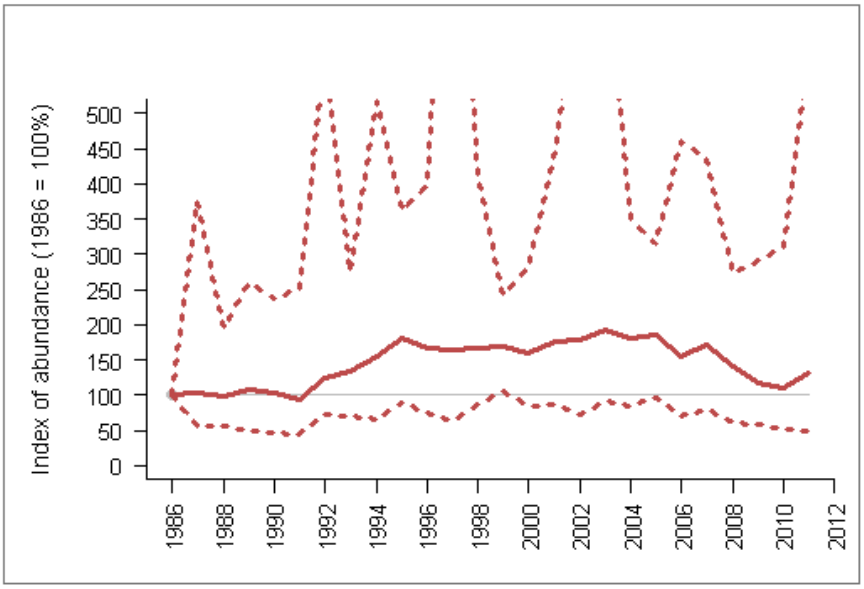


Figure 9. Trend in abundance index (solid line) of razorbill in Scotland, 1986-2011 with 95% confidence limits (dotted lines; drawing of upper limit restricted to preserve detail in the abundance index). Based on SMP data, from http://jncc.defra.gov.uk/page-2899 on 21/05/2013.

It is important to consider that the demographic parameters used in these models all come from single colony studies; from studies of the colony on the Isle of May. While these are the most robust values available, and the models account for the variability in the data, they are unlikely to exactly reflect the entire UK or Scottish population. The main difference appears to be in the productivity value used to parameterise the model. While this was taken from a long time series on the Isle of May it is similar to the productivity in Scotland during the late 1980s and early 1990s but higher than the productivity in the 2000s (Figure 10).

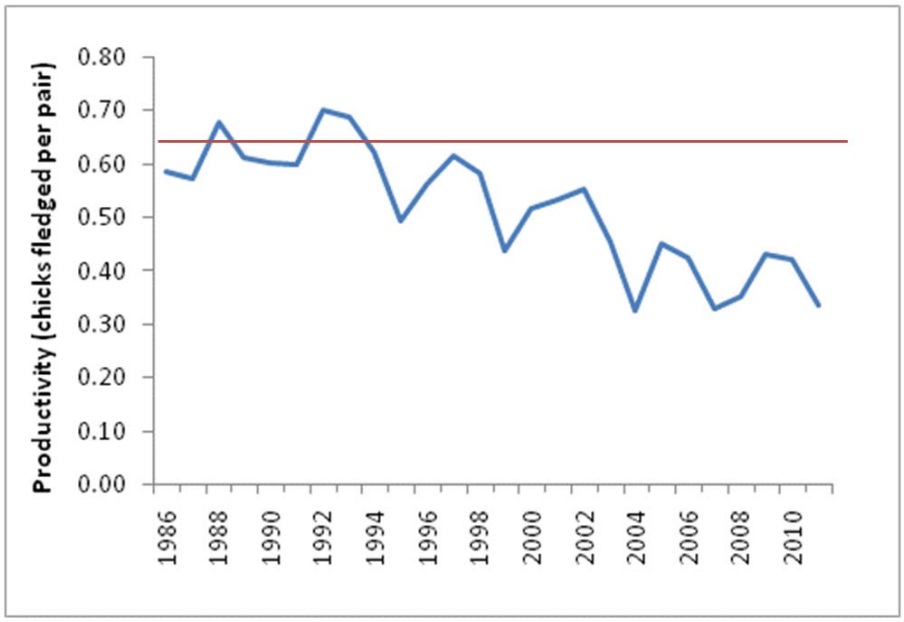


Figure 10. Trend in productivity (no. of chicks fledged per pair) of razorbill at Scottish colonies, 1986-2011 (blue line) from SMP data (JNCC, 2012) and the productivity parameter used in the model (red line).

Population models of k-selected species such as razorbill are typically much more sensitive to changes in adult survival rates than they are to other parameters. However, the value from the Isle of May used in the model is very similar to the long time series from Skomer (JNCC 2012). Due to a lack of empirical data for juvenile survival the value for adult survival had to be used. This combined with the higher productivity in the model than in recent years may explain the difference in the annual growth rates.

While the annual population growth rate derived from these models is higher than the local and regional populations it is not clear what demographic parameters are causing the decline in these populations; though it is apparent that productivity may have been declining recently. It would be technically feasible to adjust the models to produce a population growth rate that matched one of the known population trends. If this was attempted questions would remain as to which population trend the model should follow and which parameters should be reduced by which amount. With no robust data available to inform this, the model would provide an apparently correct output by using input values not based on empirical data, thus any inferences drawn from the model would be weak.

The models used to understand the effects of impacts on the populations relevant to the three proposed wind farms are necessarily approximations of reality. It appears that while the predicted population growth rates are higher than some recent population trends they are within the known range of population trends. As such the models should be considered robust for use as a comparative tool to understand the importance of impacts.

5.8 Puffin

5.8.1 Demographic parameters

Demographic parameters used for modelling the puffin populations are shown in Table 32.

Table 32. Demographic parameters used for puffin PVAs.

Population parameter	Rate (variance)	Reference	Reason for selection
Adult survival	0.916 (0.0002)	Harris *et al*., 2000	Rate based on data collected between 1986 and 1996 in the Isle of May. Selected based on duration of study and proximity to site.
Juvenile survival	0.916 (0.0002)	As above	As above as no suitable data available for juvenile survival.
Average breeding age	5 years	Robinson 2005	Number based on literature reviews carried out by the BTO.
Number of eggs per clutch	1	Snow and Perrins, 1998	Number from widely accepted source.
Number of fledglings per nest	0.69 (0.0245)	Mavor *et al*., 2008	Average across five colonies in Fair Isle, St. Kilda, Isle of May, Farne Islands and Skomer in 2006. Selected due to proximity to site and recent date.

5.8.2 Growth Rates

Available growth rates for puffin at multiple spatial and temporal scales are presented in Table 33.

Table 33. Estimated annual population growth rate of puffin at multiple spatial and temporal scales.

Spatial scale	Temporal scale	Lambda
UK	1969/70 to 1985/88	1.0084
	1985/88 to 1998/02	1.0124
	2000 to 2011	no data
	1969/70 to 1998/2002	1.0102
Scotland	1969/70 to 1985/88	1.0039
	1985/88 to 1998/02	1.0085
	2000 to 2011	no data
	1969/70 to 1998/02	1.0060
Deterministic growth rate - mean		1.0797
Stochastic growth rate – mean		1.0796
Stochastic growth rate – lower 95% CI		1.0694
Stochastic growth rate – upper 95% CI		1.0899

5.8.3 UK growth rates

Due to its burrow nesting behaviour it is very difficult to monitor puffin populations and the only data available were from the from the three national seabird surveys. It appears that the UK annual population growth rate increased slightly from 1.0084 between Operation Seafarer (1969-70) and the Seabird Colony Register (1985-88) to 1.0124 between the Seabird Colony Register and Seabird

2000 (1998 – 2002) (Table 33). However, the absolute population size has increased by 37% from 1969/70 to 1998/2002, with an annual growth rate of 1.0102. The annual population growth rates from both the deterministic and stochastic population models (1.0797 and 1.0796 respectively) are larger than these estimates, though the difference is not significant.

5.8.4 Scottish growth rates

In general growth rates for Scotland are similar to those of the whole of the UK. The annual population growth rate was similar between Operation Seafarer and the Seabird Colony Register (1.0039) and the Seabird Colony Register and Seabird 2000 counts (1.0085). The overall annual population growth rate across all three counts was 1.0060. Again the difference between this value and the model predictions are not significant.

5.8.5 Discussion

The annual population growth rates for puffin from both the deterministic and stochastic models were very similar. The model rates were slightly higher than all of the rates from currently available sources. Given the paucity of empirical estimates of population parameters on this species it is hard to assess what the sources of these differences are. It may be due to the juvenile survival rate being too high, as the adult survival rate was used in the absence of any empirical data to inform this.

Although the model growth rates are slightly higher than the mean rates shown by the UK and Scottish trends, the models should be considered robust for use as a comparative tool to understand the significance of effects.

6 PVA outputs

The re-presentation of stochastic PVA outputs used are provided in this section. The aim of the PVA outputs is to provide a comparative tool so that an analysis can be made for various scenarios of impact, i.e. it is not being used here to predict absolute numbers under different scenarios. The outputs provided for each species – SPA combination are:

- A table showing the initial population structure of the population by age. This was derived from the known number of breeding individuals and the stable population structure predicted by the model. Beginning with a stable population structure means that a burn in is not required; which means that the model can be run from year 0 rather than running the model for a number of years first.
- A graph showing the projected population size of the population over a 35 year period, providing the baseline situation (i.e. no wind farms present) and at different displacement or collision rates (with this being species-specific). Where the assessments are based on displacement, the maximum level of displacement presented in the graphs is based on that predicted at the higher end of the range investigated for that species (see Table 5), for the cumulative situation. Where the assessments are based on collision, the maximum level presented within the graphs is based on that predicted at the 98% avoidance rate for the cumulative situation (the levels shown in the graphs are rounded up to the nearest factor of four so that quartiles could be calculated). The remaining levels shown in the graphs are quartiles, in order to provide an indication of population projections at different ranges of displacement or collision.
- A table and graph showing the probabilities of the population dropping below the current population size, during the 25-year period of the project, at different displacement and/or collision rates (with this being species-specific), and a second graph showing the change in probabilities compared to the baseline situation.
- A table and graph showing the probabilities of the population dropping below the current population size, during the 25-year period of the project and a 10-year recovery period, at different displacement and/or collision rates (with this being species-specific), and a second graph showing the change in probabilities compared to the baseline situation.

Each of the probability graphs show the likelihood of the population dropping below a certain threshold. This threshold is known as the quasi-extinction threshold (QET), which in this case is taken to be a range of different levels of concern ranging from 50% to 5% population reductions from baseline. The QET is not an indication of extinction risk, but rather arbitrary thresholds to provide of possible scenarios since the likely extinction threshold is not known.

The assessments in Section 7 have focussed on these PVA outputs since they make comparisons with the current population estimates. Additional outputs requested by JNCC and SNH that make comparisons with the projected population estimates are provided in Appendices C to M. These have not been used to inform the assessments as it is considered that there is too much uncertainty over the population predictions for 25 to 35 years in the future for them to be used for this purpose.

As for the ES both the primary and secondary assessments are shown. For the secondary assessments the sum of the collision risk for the three sites individually is greater than actual collision risk of the combined sites. This is due to each of the individual site assessments being made based on using 3.6 MW turbines, whilst a maximum of one of the sites would be built with these turbines. This

therefore means that whilst the worst case scenario is shown in the "whole site" scenario, the sum of the three proposed wind farm sites will be greater than this but would not occur in practice.

6.1 Fulmar – East Caithness Cliffs SPA

The initial population structure for the fulmar population at East Caithness Cliffs SPA is provided in Table 34. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 11. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different collision rates are shown in Table 35 and Figure 12 (only the cumulative situation is shown in Table 35 as no collisions are predicted from the three proposed wind farm sites). The change in probabilities compared to the baseline situation is provided in Figure 13. This information is then repeated in Table 36 and Figures 14-15, but for the 25-year period of the projects (three proposed wind farms plus BOWL) plus a 10-year recovery period.

Table 34. Initial population structure of the fulmar population at East Caithness Cliffs.

Age Class	Number of Individuals
First year	1102
Second year	1068
Third year	1036
Fourth year	1005
Fifth year	974
Sixth year	945
Seventh year	916
Eighth year	888
Breeding adults (9 years and greater)	28404

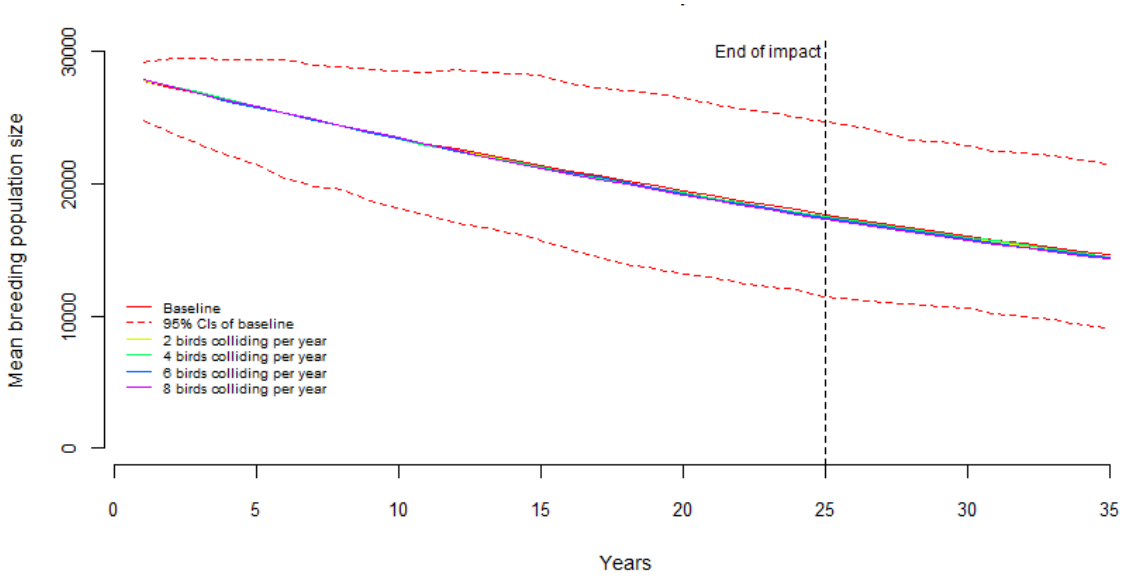


Figure 11. Population projections for the fulmar population at East Caithness Cliffs at different levels of collision at the realistic level of displacement.

Table 35. Modelled probabilities of dropping below current population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.182	0.512	0.813	0.908	0.956	0.982	0.993	0.998	1.000	17479
BOWL and MORL	50%	177	95.0%	7	0.188	0.523	0.820	0.911	0.959	0.983	0.994	0.999	1.000	17392
BOWL and MORL	50%	177	98.0%	3	0.184	0.516	0.816	0.909	0.957	0.982	0.994	0.998	1.000	17442
BOWL and MORL	50%	177	98.5%	2	0.184	0.515	0.815	0.909	0.957	0.982	0.993	0.998	1.000	17454
BOWL and MORL	50%	177	99.0%	1	0.183	0.513	0.814	0.908	0.956	0.982	0.993	0.998	1.000	17467
BOWL and MORL	50%	177	99.5%	1	0.183	0.513	0.814	0.908	0.956	0.982	0.993	0.998	1.000	17467

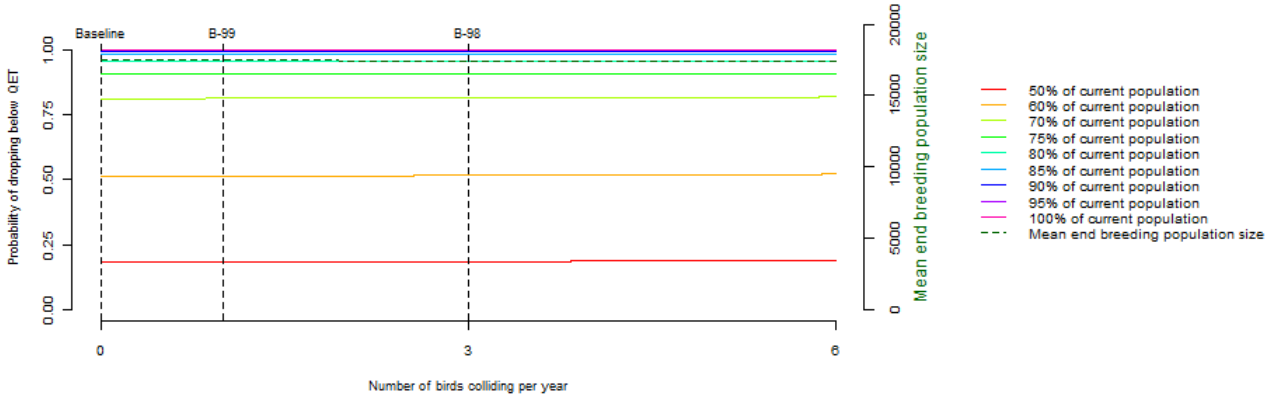


Figure 12. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

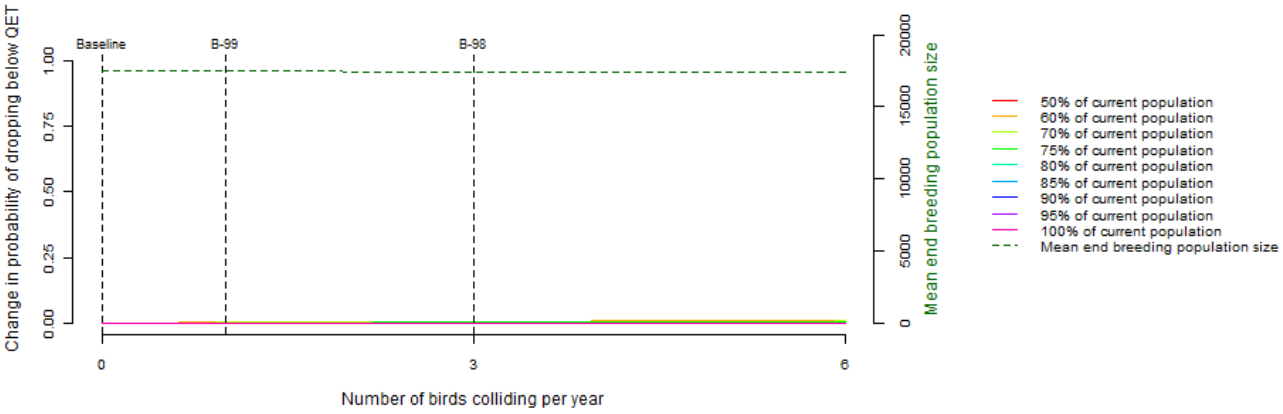


Figure 13. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

Table 36. Modelled probabilities of dropping below current population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance Rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.542	0.834	0.960	0.980	0.993	0.997	0.999	1.000	1.000	14400
BOWL and MORL	50%	177	95.0%	7	0.553	0.839	0.962	0.981	0.993	0.997	0.999	1.000	1.000	14325
BOWL and MORL	50%	177	98.0%	3	0.547	0.837	0.961	0.980	0.993	0.997	0.999	1.000	1.000	14368
BOWL and MORL	50%	177	98.5%	2	0.545	0.836	0.961	0.980	0.993	0.997	0.999	1.000	1.000	14379
BOWL and MORL	50%	177	99.0%	1	0.544	0.835	0.960	0.980	0.993	0.997	0.999	1.000	1.000	14390
BOWL and MORL	50%	177	99.5%	1	0.544	0.835	0.960	0.980	0.993	0.997	0.999	1.000	1.000	14390

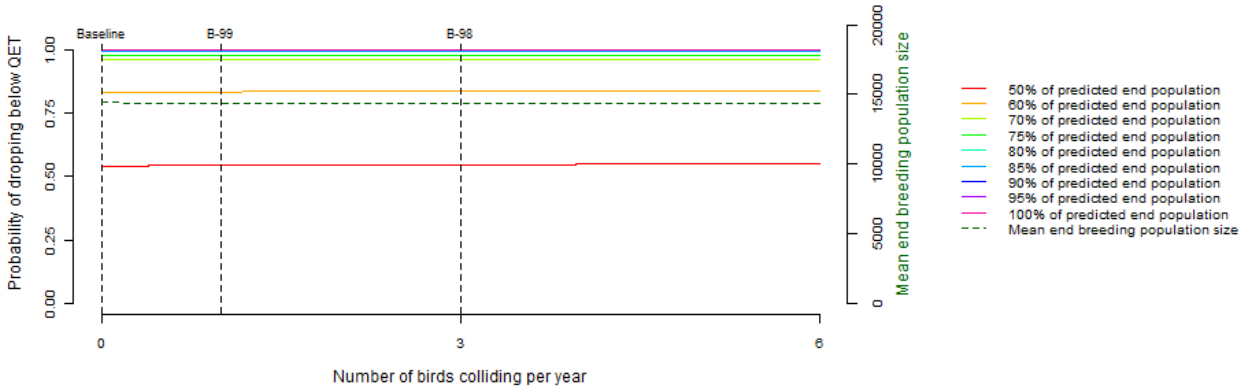


Figure 14. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

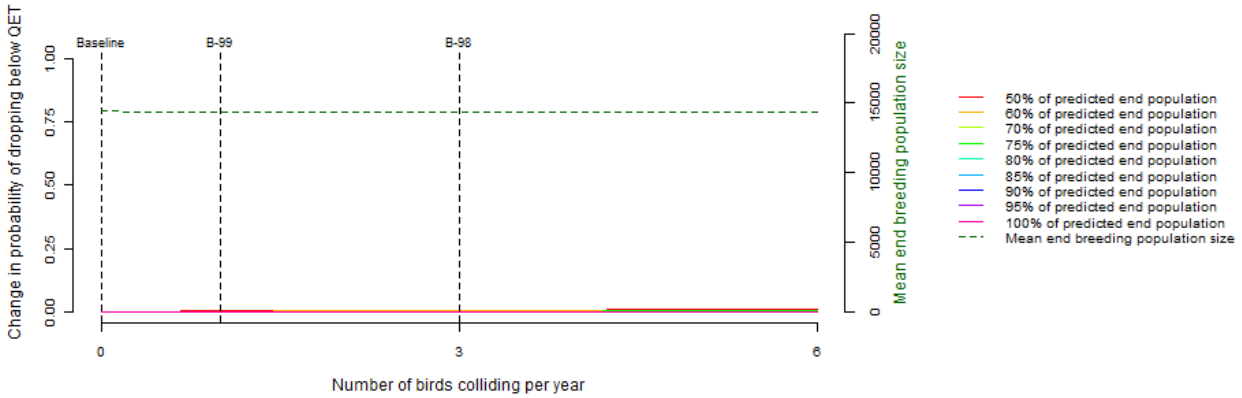


Figure 15. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

6.2 Fulmar – North Caithness Cliffs SPA

The initial population structure for the fulmar population at North Caithness Cliffs SPA is provided in Table 37. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 16. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different collision rates are shown in Table 38 and Figure 17 (the cumulative situation only is shown in Table 38 as no collisions are predicted from the three proposed wind farm sites). The change in probabilities compared to the baseline situation is provided in Figure 18. This information is then repeated in Table 39 and Figures 19-20, but for the 25-year period of the project plus a 10-year recovery period.

Table 37. Initial population structure of the fulmar population at North Caithness Cliffs.

Age Class	Number of Individuals
First year	1099
Second year	1066
Third year	1033
Fourth Year	1002
Fifth Year	972
Sixth Year	942
Seventh Year	914
Eighth Year	886
Breeding adult (9 years and greater)	28336

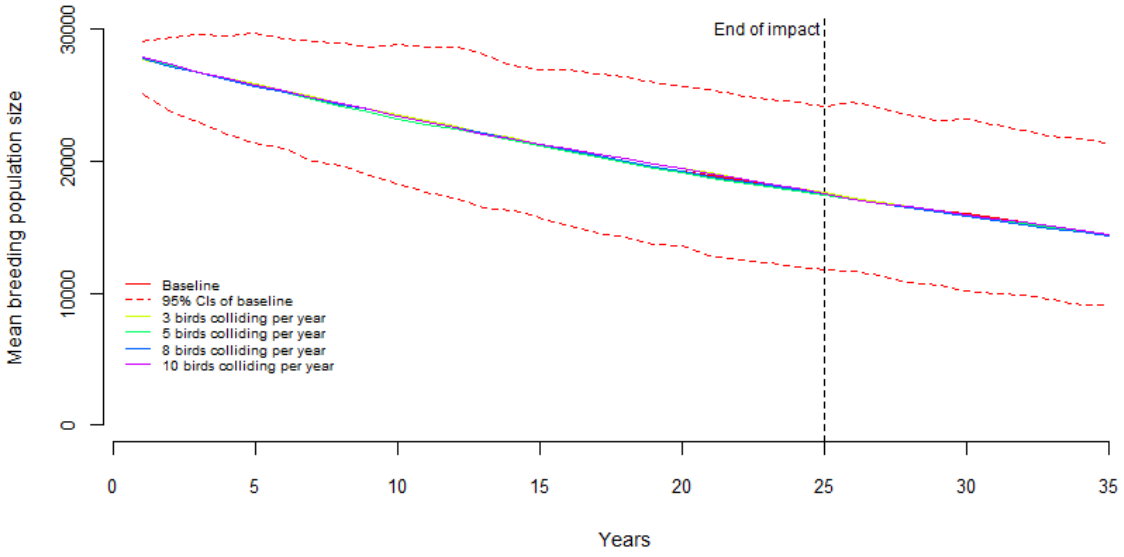


Figure 16. Population projections for the fulmar population at North Caithness Cliffs at different levels of collision at the realistic level of displacement.

Table 38. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.184	0.507	0.805	0.896	0.950	0.979	0.992	0.998	1.000	17540
BOWL and MORL	50%	49	95.0%	25	0.203	0.546	0.834	0.915	0.961	0.984	0.994	0.998	1.000	17203
BOWL and MORL	50%	49	98.0%	10	0.191	0.523	0.817	0.904	0.955	0.981	0.993	0.998	1.000	17405
BOWL and MORL	50%	49	98.5%	7	0.189	0.518	0.814	0.902	0.953	0.980	0.993	0.998	1.000	17445
BOWL and MORL	50%	49	99.0%	5	0.187	0.515	0.811	0.900	0.953	0.980	0.993	0.998	1.000	17472
BOWL and MORL	50%	49	99.5%	2	0.185	0.511	0.808	0.898	0.951	0.979	0.992	0.998	1.000	17513

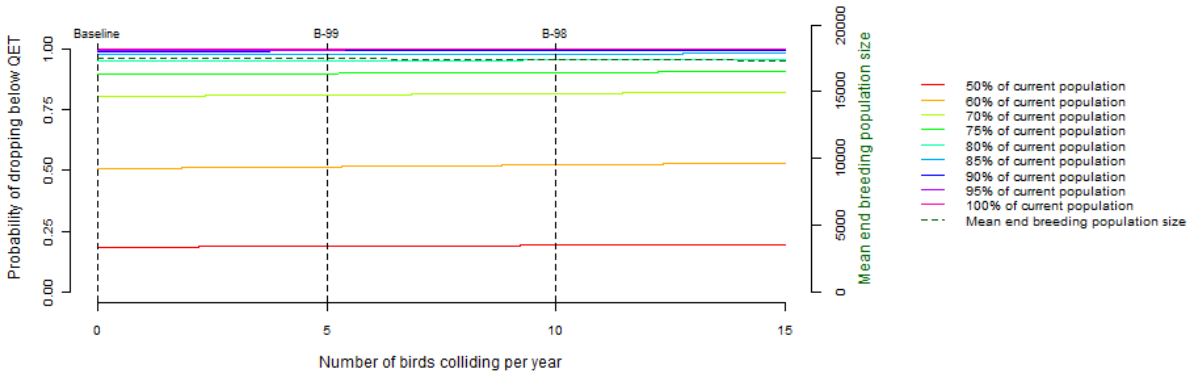


Figure 17. Probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

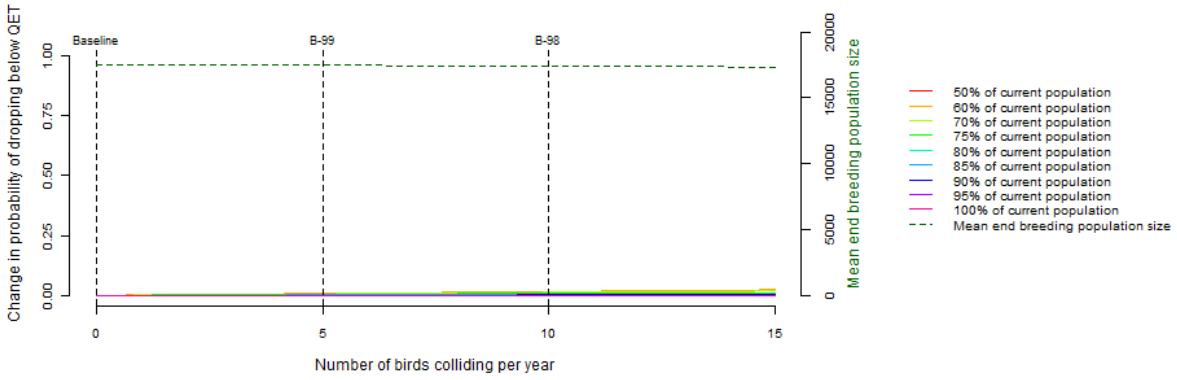


Figure 18. Change in probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

Table 39. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.539	0.821	0.953	0.981	0.991	0.995	0.998	0.999	1.000	14439
BOWL and MORL	50%	49	95.0%	25	0.570	0.846	0.961	0.985	0.994	0.998	0.999	1.000	1.000	14158
BOWL and MORL	50%	49	98.0%	10	0.552	0.832	0.957	0.983	0.993	0.996	0.998	1.000	1.000	14326
BOWL and MORL	50%	49	98.5%	7	0.548	0.828	0.956	0.982	0.992	0.996	0.998	1.000	1.000	14360
BOWL and MORL	50%	49	99.0%	5	0.546	0.826	0.955	0.982	0.992	0.996	0.998	1.000	1.000	14383
BOWL and MORL	50%	49	99.5%	2	0.542	0.823	0.954	0.981	0.991	0.995	0.998	0.999	1.000	14416

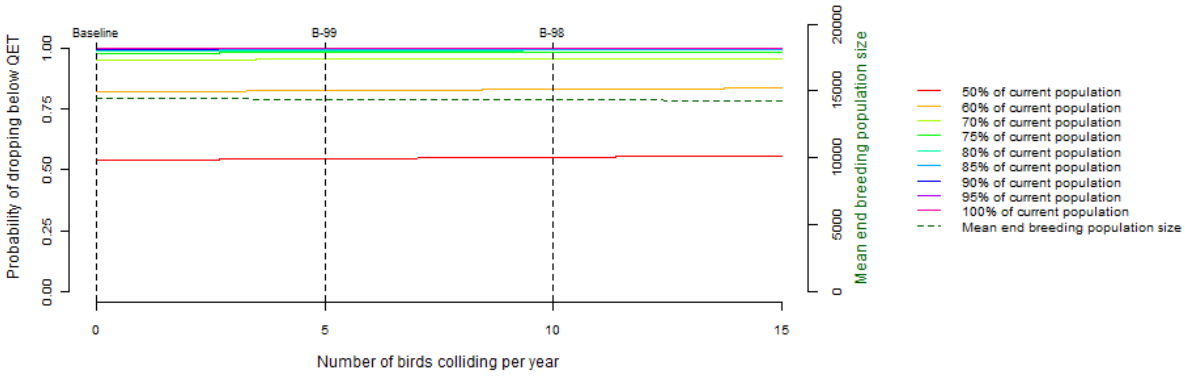


Figure 19. Probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

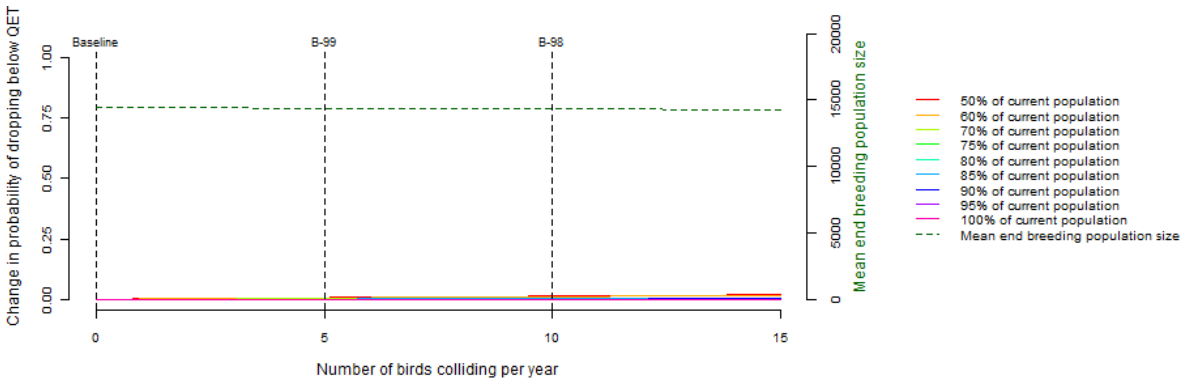


Figure 20. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

6.3 Gannet – Troup Head

The initial population structure for the gannet population at Troup Head is provided in Table 40. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 21. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different collision rates are shown in Table 41 and Figure 22. The change in probabilities compared to the baseline situation is provided in Figure 23. This information is then repeated in Table 42 and Figures 24-25, but for the 25-year period of the project plus a 10-year recovery period.

Table 40. Initial population structure of the gannet population at Troup Head.

Age Class	Number of Individuals
First year	973
Second year	404
Third year	340
Fourth year	305
Breeding adult (5 years and greater)	3094

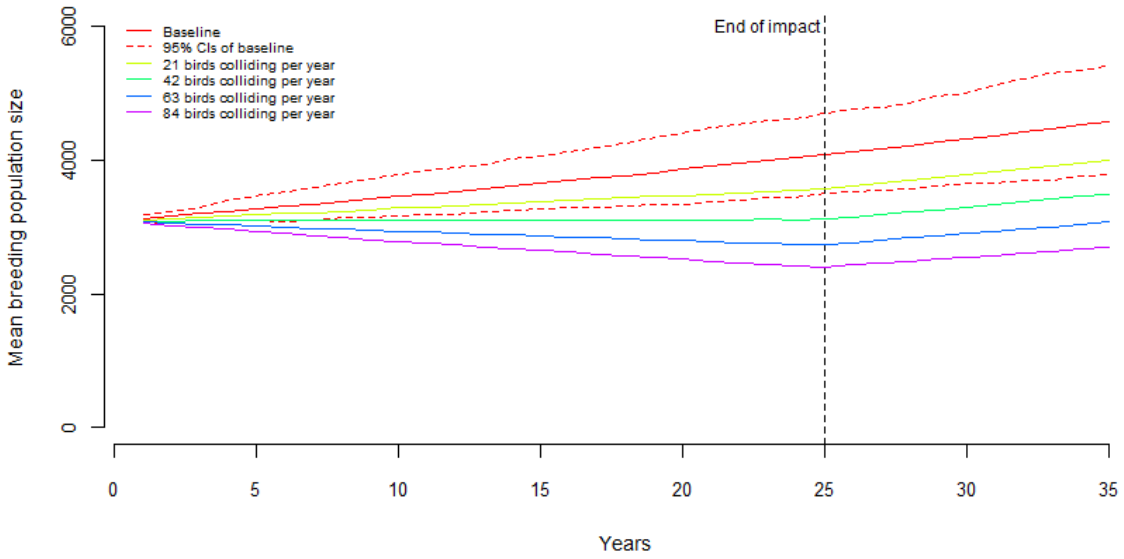


Figure 21. Population projections for the gannet population at Troup Head at different levels of collision at the realistic level of displacement.

Table 41. Modelled probabilities of dropping below current population size for the gannet population at Troup Head with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.009	0.438	4160
Whole site	50%	30	95.0%	131	0.055	0.779	0.994	0.999	1.000	1.000	1.000	1.000	1.000	1752
Whole site	50%	30	98.0%	53	0.000	0.000	0.001	0.006	0.029	0.125	0.403	0.779	0.964	2943
Whole site	50%	30	98.5%	39	0.000	0.000	0.000	0.001	0.004	0.021	0.103	0.440	0.916	3209
Whole site	50%	30	99.0%	26	0.000	0.000	0.000	0.000	0.001	0.003	0.019	0.149	0.820	3499
Whole site	50%	30	99.5%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.038	0.653	3815
Sum of MacColl, Telford & Stevenson	50%	30	95.0%	157	0.698	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1478
Sum of MacColl, Telford & Stevenson	50%	30	98.0%	63	0.000	0.000	0.004	0.026	0.119	0.386	0.731	0.920	0.981	2750
Sum of MacColl, Telford & Stevenson	50%	30	98.5%	47	0.000	0.000	0.000	0.003	0.013	0.061	0.245	0.655	0.949	3050
Sum of MacColl, Telford & Stevenson	50%	30	99.0%	31	0.000	0.000	0.000	0.000	0.001	0.007	0.038	0.240	0.865	3382
Sum of MacColl, Telford & Stevenson	50%	30	99.5%	16	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.050	0.691	3751
MacColl	50%	30	95.0%	89	0.000	0.006	0.182	0.560	0.857	0.964	0.989	0.996	0.997	2318
MacColl	50%	30	98.0%	36	0.000	0.000	0.000	0.000	0.002	0.012	0.064	0.336	0.894	3292
MacColl	50%	30	98.5%	27	0.000	0.000	0.000	0.000	0.001	0.003	0.020	0.155	0.823	3490
MacColl	50%	30	99.0%	18	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.062	0.720	3701
MacColl	50%	30	99.5%	9	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.024	0.586	3924
Stevenson	50%	30	95.0%	33	0.000	0.000	0.000	0.000	0.002	0.009	0.047	0.280	0.879	3342
Stevenson	50%	30	98.0%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.038	0.655	3811
Stevenson	50%	30	98.5%	10	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.027	0.604	3896
Stevenson	50%	30	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.018	0.549	3982
Stevenson	50%	30	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.013	0.494	4070
Telford	50%	30	95.0%	35	0.000	0.000	0.000	0.000	0.002	0.011	0.060	0.323	0.891	3303
Telford	50%	30	98.0%	14	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.042	0.666	3793
Telford	50%	30	98.5%	11	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.028	0.612	3882
Telford	50%	30	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.019	0.555	3972
Telford	50%	30	99.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.013	0.497	4065
MacColl and Stevenson	50%	30	95.0%	122	0.015	0.467	0.974	0.995	0.999	1.000	1.000	1.000	1.000	1862
MacColl and Stevenson	50%	30	98.0%	49	0.000	0.000	0.000	0.003	0.017	0.077	0.290	0.697	0.954	3016
MacColl and Stevenson	50%	30	98.5%	37	0.000	0.000	0.000	0.001	0.003	0.014	0.073	0.364	0.901	3269
MacColl and Stevenson	50%	30	99.0%	24	0.000	0.000	0.000	0.000	0.000	0.002	0.015	0.124	0.800	3542
MacColl and Stevenson	50%	30	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.034	0.639	3839
Telford and MacColl	50%	30	95.0%	124	0.020	0.535	0.980	0.996	0.999	1.000	1.000	1.000	1.000	1840
Telford and MacColl	50%	30	98.0%	50	0.000	0.000	0.001	0.004	0.019	0.085	0.311	0.715	0.956	3002
Telford and MacColl	50%	30	98.5%	37	0.000	0.000	0.000	0.001	0.003	0.015	0.078	0.378	0.904	3257
Telford and MacColl	50%	30	99.0%	25	0.000	0.000	0.000	0.000	0.001	0.003	0.016	0.129	0.804	3534
Telford and MacColl	50%	30	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.035	0.642	3834
Stevenson and Telford	50%	30	95.0%	68	0.000	0.000	0.009	0.056	0.230	0.579	0.850	0.955	0.987	2653
Stevenson and Telford	50%	30	98.0%	27	0.000	0.000	0.000	0.000	0.001	0.004	0.022	0.165	0.830	3475
Stevenson and Telford	50%	30	98.5%	20	0.000	0.000	0.000	0.000	0.000	0.001	0.009	0.083	0.755	3635
Stevenson and Telford	50%	30	99.0%	14	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.040	0.661	3802
Stevenson and Telford	50%	30	99.5%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.019	0.552	3977
BOWL	50%	30	95.0%	63	0.000	0.000	0.004	0.026	0.121	0.392	0.735	0.921	0.982	2747
BOWL	50%	30	98.0%	25	0.000	0.000	0.000	0.000	0.001	0.003	0.016	0.132	0.807	3528
BOWL	50%	30	98.5%	19	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.071	0.736	3671
BOWL	50%	30	99.0%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.037	0.651	3819
BOWL	50%	30	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.017	0.538	3999
BOWL and MORL	50%	30	95.0%	194	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1157
BOWL and MORL	50%	30	98.0%	78	0.000	0.001	0.039	0.196	0.543	0.844	0.953	0.984	0.993	2493
BOWL and MORL	50%	30	98.5%	58	0.000	0.000	0.002	0.013	0.065	0.246	0.595	0.872	0.975	2834
BOWL and MORL	50%	30	99.0%	39	0.000	0.000	0.000	0.001	0.004	0.019	0.096	0.425	0.914	3220
BOWL and MORL	50%	30	99.5%	19	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.074	0.742	3660

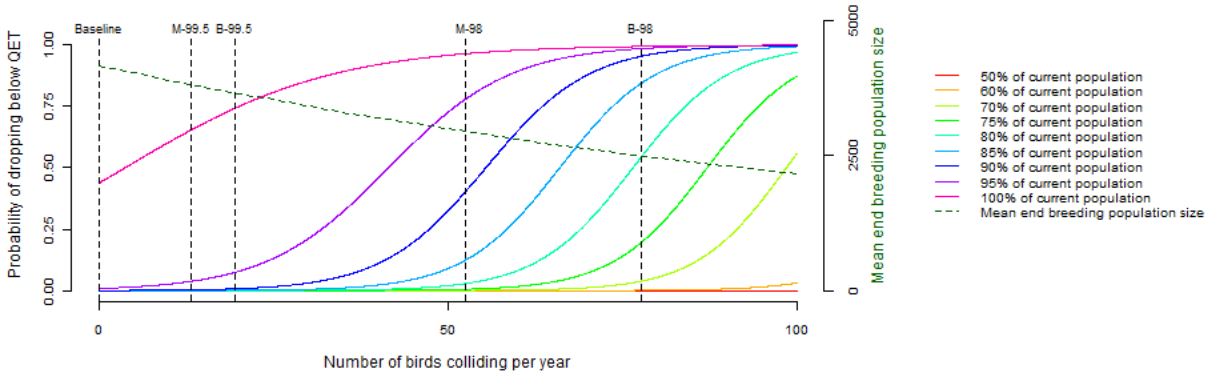


Figure 22. Probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (up to end of impact). M98 and M99.5 highlight the collision rates for the three wind farm sites at 98 and 99.5% avoidance rates, respectively. B98 and B99.5 highlight the cumulative collision rates at 98 and 99.5% avoidance rates, respectively.

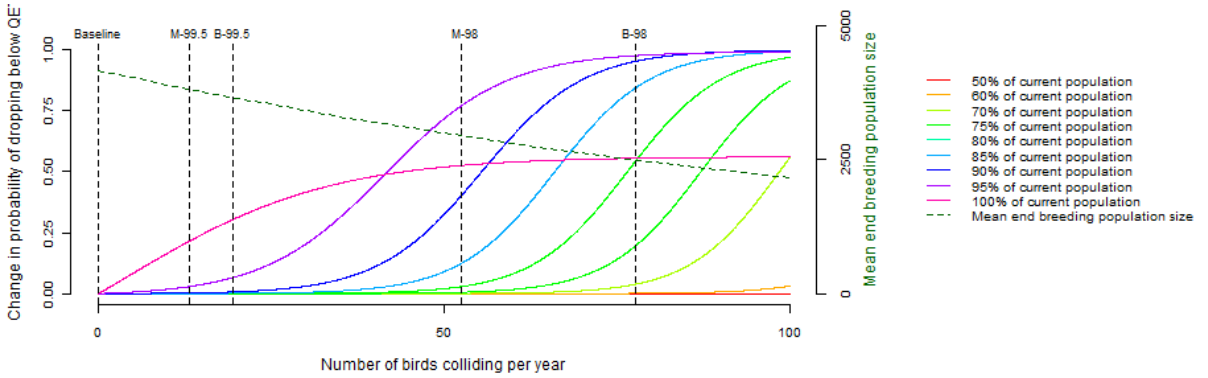


Figure 23. Change in probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (up to end of impact). M98 and M99.5 highlight the collision rates for the three wind farm sites at 98 and 99.5% avoidance rates, respectively. B98 and B99.5 highlight the cumulative collision rates at 98 and 99.5% avoidance rates, respectively.

Table 42. Modelled probabilities of dropping below current population size for the gannet population at Troup Head with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.009	0.438	4665
Whole site	50%	30	95.0%	131	0.061	0.795	0.994	0.999	1.000	1.000	1.000	1.000	1.000	1977
Whole site	50%	30	98.0%	53	0.000	0.000	0.001	0.006	0.031	0.131	0.416	0.783	0.964	3309
Whole site	50%	30	98.5%	39	0.000	0.000	0.000	0.001	0.005	0.022	0.108	0.445	0.918	3606
Whole site	50%	30	99.0%	26	0.000	0.000	0.000	0.000	0.001	0.003	0.020	0.152	0.821	3929
Whole site	50%	30	99.5%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.038	0.655	4281
Sum of MacColl, Telford & Stevenson	50%	30	95.0%	157	0.727	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1670
Sum of MacColl, Telford & Stevenson	50%	30	98.0%	63	0.000	0.000	0.004	0.029	0.128	0.403	0.742	0.921	0.982	3093
Sum of MacColl, Telford & Stevenson	50%	30	98.5%	47	0.000	0.000	0.000	0.003	0.014	0.065	0.255	0.660	0.950	3428
Sum of MacColl, Telford & Stevenson	50%	30	99.0%	31	0.000	0.000	0.000	0.000	0.001	0.007	0.039	0.244	0.867	3799
Sum of MacColl, Telford & Stevenson	50%	30	99.5%	16	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.051	0.693	4209
MacColl	50%	30	95.0%	89	0.000	0.007	0.194	0.584	0.870	0.967	0.990	0.996	0.997	2610
MacColl	50%	30	98.0%	36	0.000	0.000	0.000	0.001	0.003	0.013	0.067	0.340	0.896	3698
MacColl	50%	30	98.5%	27	0.000	0.000	0.000	0.000	0.001	0.004	0.021	0.157	0.825	3919
MacColl	50%	30	99.0%	18	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.063	0.721	4153
MacColl	50%	30	99.5%	9	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.024	0.587	4402
Stevenson	50%	30	95.0%	33	0.000	0.000	0.000	0.000	0.002	0.009	0.050	0.284	0.880	3754
Stevenson	50%	30	98.0%	13	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.039	0.657	4277
Stevenson	50%	30	98.5%	10	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.027	0.605	4370
Stevenson	50%	30	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.019	0.550	4466
Stevenson	50%	30	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.013	0.494	4565
Telford	50%	30	95.0%	35	0.000	0.000	0.000	0.000	0.002	0.012	0.063	0.328	0.893	3710
Telford	50%	30	98.0%	14	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.042	0.668	4256
Telford	50%	30	98.5%	11	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.029	0.613	4355
Telford	50%	30	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.019	0.556	4456
Telford	50%	30	99.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.013	0.497	4559
MacColl and Stevenson	50%	30	95.0%	122	0.017	0.494	0.977	0.995	0.999	1.000	1.000	1.000	1.000	2100
MacColl and Stevenson	50%	30	98.0%	49	0.000	0.000	0.000	0.004	0.018	0.081	0.301	0.702	0.955	3390
MacColl and Stevenson	50%	30	98.5%	37	0.000	0.000	0.000	0.001	0.003	0.015	0.076	0.369	0.902	3672
MacColl and Stevenson	50%	30	99.0%	24	0.000	0.000	0.000	0.000	0.001	0.003	0.016	0.126	0.802	3977
MacColl and Stevenson	50%	30	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.034	0.640	4307
Telford and MacColl	50%	30	95.0%	124	0.022	0.561	0.982	0.996	0.999	1.000	1.000	1.000	1.000	2076
Telford and MacColl	50%	30	98.0%	50	0.000	0.000	0.001	0.004	0.020	0.089	0.322	0.719	0.957	3374
Telford and MacColl	50%	30	98.5%	37	0.000	0.000	0.000	0.001	0.003	0.016	0.082	0.383	0.906	3659
Telford and MacColl	50%	30	99.0%	25	0.000	0.000	0.000	0.000	0.001	0.003	0.016	0.131	0.806	3967
Telford and MacColl	50%	30	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.035	0.643	4302
Stevenson and Telford	50%	30	95.0%	68	0.000	0.000	0.010	0.062	0.246	0.598	0.857	0.956	0.987	2985
Stevenson and Telford	50%	30	98.0%	27	0.000	0.000	0.000	0.000	0.001	0.004	0.023	0.168	0.832	3902
Stevenson and Telford	50%	30	98.5%	20	0.000	0.000	0.000	0.000	0.000	0.001	0.009	0.084	0.757	4080
Stevenson and Telford	50%	30	99.0%	14	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.040	0.662	4266
Stevenson and Telford	50%	30	99.5%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.019	0.553	4461
BOWL	50%	30	95.0%	63	0.000	0.000	0.004	0.029	0.130	0.409	0.746	0.923	0.982	3090
BOWL	50%	30	98.0%	25	0.000	0.000	0.000	0.000	0.001	0.003	0.017	0.134	0.809	3961
BOWL	50%	30	98.5%	19	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.072	0.738	4120
BOWL	50%	30	99.0%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.038	0.652	4285
BOWL	50%	30	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.017	0.539	4485
BOWL and MORL	50%	30	95.0%	194	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1309
BOWL and MORL	50%	30	98.0%	78	0.000	0.001	0.042	0.213	0.567	0.855	0.956	0.985	0.993	2806
BOWL and MORL	50%	30	98.5%	58	0.000	0.000	0.002	0.015	0.070	0.259	0.608	0.875	0.976	3186
BOWL and MORL	50%	30	99.0%	39	0.000	0.000	0.000	0.001	0.004	0.020	0.101	0.430	0.915	3618
BOWL and MORL	50%	30	99.5%	19	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.076	0.744	4108

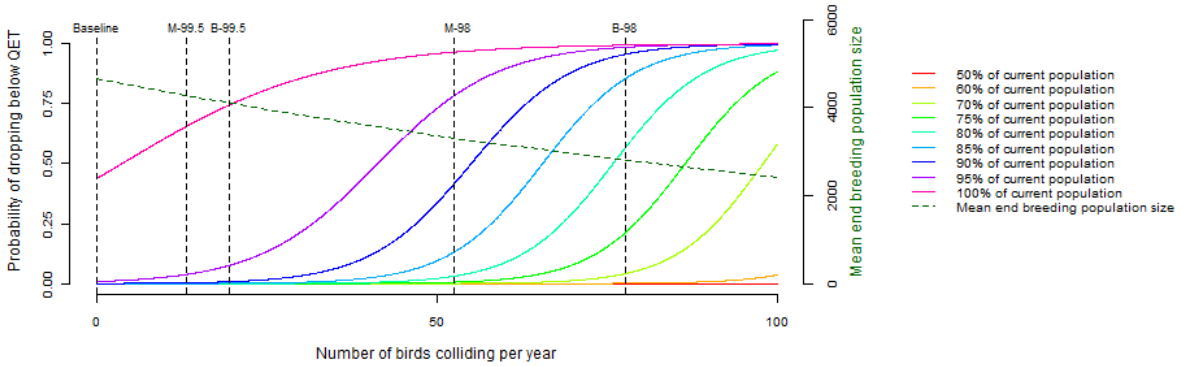


Figure 24. Probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M99.5 highlight the collision rates for the three wind farm sites at 98 and 99.5% avoidance rates, respectively. B98 and B99.5 highlight the cumulative collision rates at 98 and 99.5% avoidance rates, respectively.

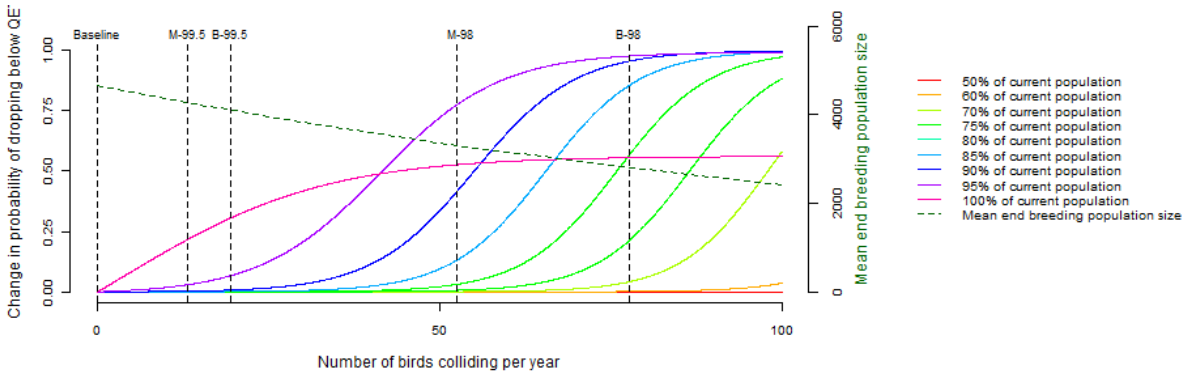


Figure 25. Change in probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M99.5 highlight the collision rates for the three wind farm sites at 98 and 99.5% avoidance rates, respectively. B98 and B99.5 highlight the cumulative collision rates at 98 and 99.5% avoidance rates, respectively.

6.4 Kittiwake – East Caithness Cliffs SPA

The initial population structure for the kittiwake population at East Caithness Cliffs SPA is provided in Table 43. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 26. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different collision rates are shown in Table 44 and Figure 27. The change in probabilities compared to the baseline situation is provided in Figure 28. This information is then repeated in Table 45 and Figures 29-30, but for the 25-year period of the project plus a 10-year recovery period.

Table 43. Initial population structure of the kittiwake population at East Caithness Cliffs.

Age Class	Number of Individuals
First year	20275
Second year	16271
Third year	13057
Fourth year	10478
Breeding adult (5 years and greater)	80820

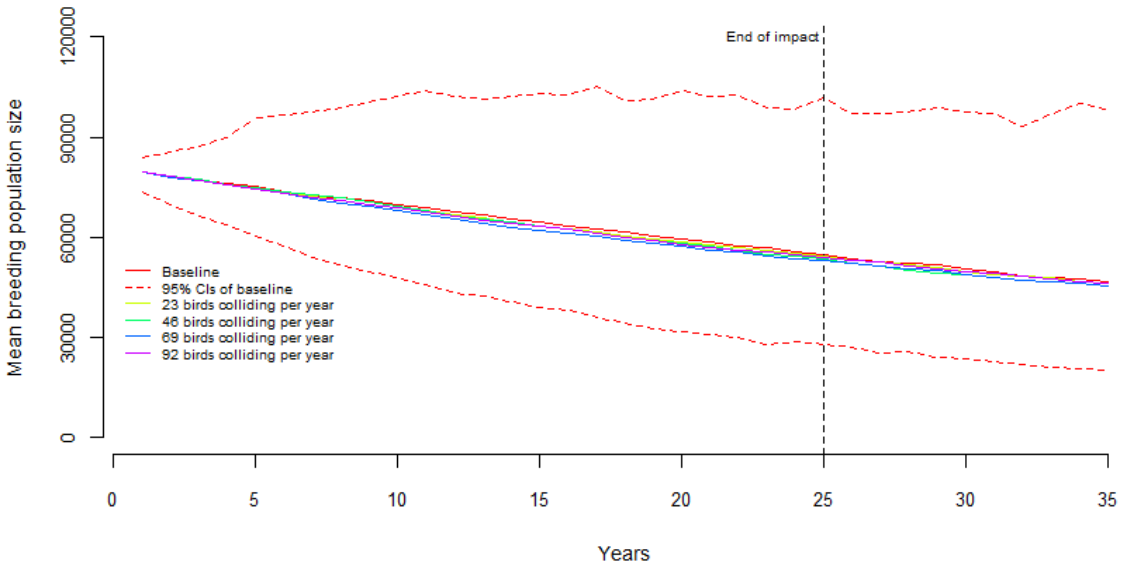


Figure 26. Population projections for the kittiwake population at East Caithness Cliffs at different levels of collision at the realistic level of displacement.

Table 44. Modelled probabilities of dropping below current population size for the kittiwake population at East Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.361	0.593	0.779	0.845	0.901	0.939	0.966	0.984	0.993	54435
Whole site	10%	214	95.0%	181	0.403	0.636	0.810	0.871	0.919	0.951	0.972	0.986	0.994	52151
Whole site	10%	214	98.0%	72	0.378	0.610	0.792	0.856	0.909	0.944	0.969	0.985	0.993	53510
Whole site	10%	214	98.5%	54	0.374	0.606	0.789	0.853	0.907	0.943	0.968	0.985	0.993	53740
Whole site	10%	214	99.0%	36	0.369	0.602	0.786	0.851	0.905	0.941	0.967	0.984	0.993	53971
Whole site	10%	214	99.5%	18	0.365	0.597	0.782	0.848	0.903	0.940	0.967	0.984	0.993	54202
Sum of MacColl, Telford & Stevenson	10%	214	95.0%	218	0.412	0.644	0.816	0.876	0.922	0.953	0.973	0.987	0.994	51695
Sum of MacColl, Telford & Stevenson	10%	214	98.0%	87	0.381	0.614	0.794	0.858	0.910	0.945	0.969	0.985	0.993	53322
Sum of MacColl, Telford & Stevenson	10%	214	98.5%	65	0.376	0.609	0.791	0.855	0.908	0.944	0.968	0.985	0.993	53598
Sum of MacColl, Telford & Stevenson	10%	214	99.0%	44	0.371	0.604	0.787	0.852	0.906	0.942	0.968	0.984	0.993	53876
Sum of MacColl, Telford & Stevenson	10%	214	99.5%	22	0.366	0.598	0.783	0.849	0.904	0.940	0.967	0.984	0.993	54155
MacColl	10%	214	95.0%	109	0.386	0.619	0.798	0.861	0.912	0.947	0.970	0.985	0.994	53040
MacColl	10%	214	98.0%	44	0.371	0.604	0.787	0.852	0.906	0.942	0.968	0.984	0.993	53873
MacColl	10%	214	98.5%	33	0.369	0.601	0.785	0.850	0.905	0.941	0.967	0.984	0.993	54013
MacColl	10%	214	99.0%	22	0.366	0.598	0.783	0.849	0.904	0.940	0.967	0.984	0.993	54153
MacColl	10%	214	99.5%	11	0.364	0.596	0.781	0.847	0.903	0.940	0.966	0.984	0.993	54294
Stevenson	10%	214	95.0%	63	0.376	0.608	0.790	0.855	0.908	0.943	0.968	0.985	0.993	53624
Stevenson	10%	214	98.0%	25	0.367	0.599	0.784	0.849	0.904	0.941	0.967	0.984	0.993	54109
Stevenson	10%	214	98.5%	19	0.365	0.598	0.783	0.848	0.903	0.940	0.967	0.984	0.993	54191
Stevenson	10%	214	99.0%	13	0.364	0.596	0.781	0.847	0.903	0.940	0.966	0.984	0.993	54272
Stevenson	10%	214	99.5%	6	0.362	0.595	0.780	0.846	0.902	0.939	0.966	0.984	0.993	54354
Telford	10%	214	95.0%	45	0.371	0.604	0.787	0.852	0.906	0.942	0.968	0.984	0.993	53857
Telford	10%	214	98.0%	18	0.365	0.597	0.782	0.848	0.903	0.940	0.967	0.984	0.993	54203
Telford	10%	214	98.5%	13	0.364	0.596	0.782	0.847	0.903	0.940	0.966	0.984	0.993	54261
Telford	10%	214	99.0%	9	0.363	0.595	0.781	0.847	0.902	0.939	0.966	0.984	0.993	54319
Telford	10%	214	99.5%	4	0.362	0.594	0.780	0.846	0.902	0.939	0.966	0.984	0.993	54377
MacColl and Stevenson	10%	214	95.0%	173	0.401	0.634	0.808	0.870	0.918	0.951	0.972	0.986	0.994	52250
MacColl and Stevenson	10%	214	98.0%	69	0.377	0.610	0.791	0.856	0.908	0.944	0.968	0.985	0.993	53550
MacColl and Stevenson	10%	214	98.5%	52	0.373	0.605	0.788	0.853	0.907	0.943	0.968	0.984	0.993	53770
MacColl and Stevenson	10%	214	99.0%	35	0.369	0.601	0.785	0.851	0.905	0.941	0.967	0.984	0.993	53991
MacColl and Stevenson	10%	214	99.5%	17	0.365	0.597	0.782	0.848	0.903	0.940	0.967	0.984	0.993	54213
Telford and MacColl	10%	214	95.0%	154	0.397	0.630	0.805	0.868	0.916	0.949	0.971	0.986	0.994	52477
Telford and MacColl	10%	214	98.0%	62	0.375	0.608	0.790	0.855	0.908	0.943	0.968	0.985	0.993	53643
Telford and MacColl	10%	214	98.5%	46	0.372	0.604	0.787	0.852	0.906	0.942	0.968	0.984	0.993	53840
Telford and MacColl	10%	214	99.0%	31	0.368	0.601	0.785	0.850	0.905	0.941	0.967	0.984	0.993	54038
Telford and MacColl	10%	214	99.5%	15	0.365	0.597	0.782	0.848	0.903	0.940	0.966	0.984	0.993	54236
Stevenson and Telford	10%	214	95.0%	108	0.386	0.619	0.798	0.861	0.912	0.946	0.970	0.985	0.993	53055
Stevenson and Telford	10%	214	98.0%	43	0.371	0.603	0.787	0.852	0.906	0.942	0.968	0.984	0.993	53879
Stevenson and Telford	10%	214	98.5%	32	0.368	0.601	0.785	0.850	0.905	0.941	0.967	0.984	0.993	54017
Stevenson and Telford	10%	214	99.0%	22	0.366	0.598	0.783	0.849	0.904	0.940	0.967	0.984	0.993	54156
Stevenson and Telford	10%	214	99.5%	11	0.363	0.596	0.781	0.847	0.903	0.940	0.966	0.984	0.993	54296
BOWL	10%	214	95.0%	32	0.368	0.601	0.785	0.850	0.905	0.941	0.967	0.984	0.993	54023
BOWL	10%	214	98.0%	13	0.364	0.596	0.781	0.847	0.903	0.940	0.966	0.984	0.993	54267
BOWL	10%	214	98.5%	9	0.363	0.595	0.781	0.847	0.902	0.939	0.966	0.984	0.993	54319
BOWL	10%	214	99.0%	6	0.362	0.595	0.780	0.846	0.902	0.939	0.966	0.984	0.993	54358
BOWL	10%	214	99.5%	3	0.362	0.594	0.780	0.846	0.902	0.939	0.966	0.984	0.993	54396
BOWL and MORL	10%	214	95.0%	213	0.411	0.643	0.815	0.875	0.921	0.953	0.973	0.987	0.994	51757
BOWL and MORL	10%	214	98.0%	85	0.381	0.613	0.794	0.858	0.910	0.945	0.969	0.985	0.993	53348
BOWL and MORL	10%	214	98.5%	64	0.376	0.608	0.790	0.855	0.908	0.943	0.968	0.985	0.993	53617
BOWL and MORL	10%	214	99.0%	43	0.371	0.603	0.787	0.852	0.906	0.942	0.967	0.984	0.993	53889
BOWL and MORL	10%	214	99.5%	21	0.366	0.598	0.783	0.849	0.904	0.940	0.967	0.984	0.993	54161

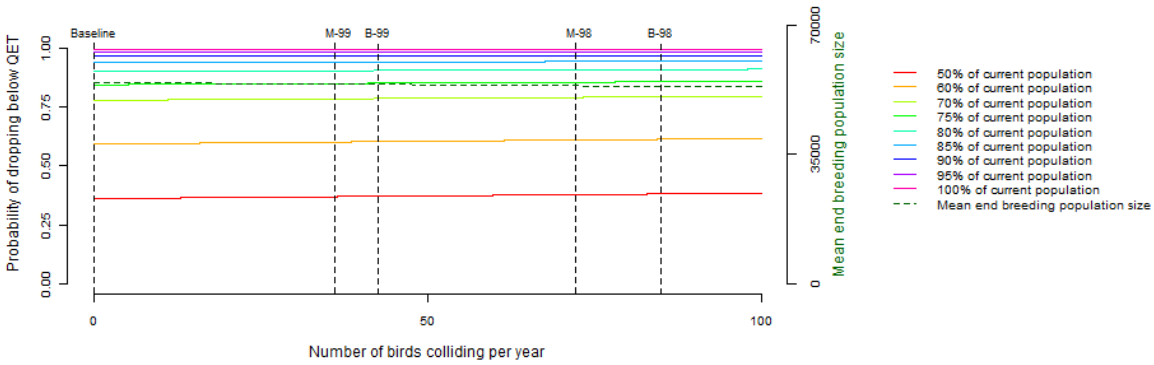


Figure 27. Probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M98 and M99 highlight the collision rates for the three wind farm sites at 98 and 99% avoidance rates, respectively. B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

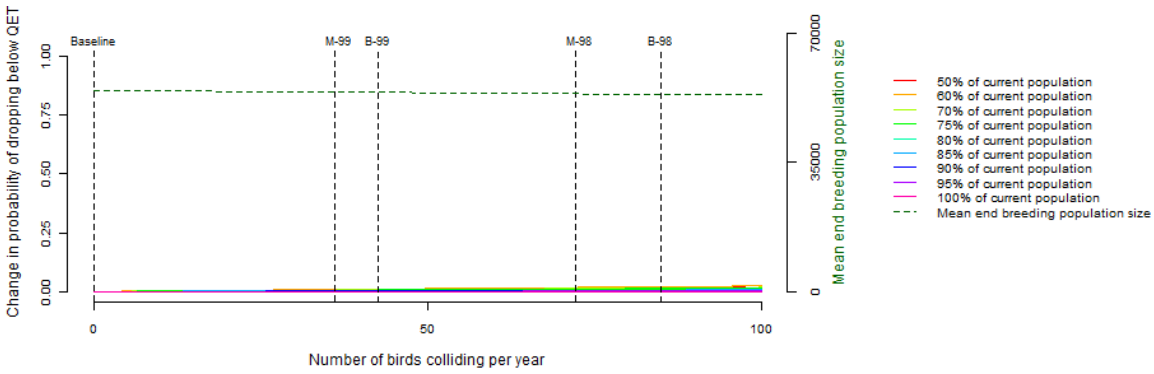


Figure 28. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M98 and M99 highlight the collision rates for the three wind farm sites at 98 and 99% avoidance rates, respectively. B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

Table 45. Modelled probabilities of dropping below current population size for the kittiwake population at East Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.583	0.753	0.884	0.921	0.949	0.969	0.982	0.992	0.996	46456
Whole site	10%	214	95.0%	181	0.624	0.792	0.904	0.936	0.959	0.977	0.987	0.994	0.997	44560
Whole site	10%	214	98.0%	72	0.600	0.769	0.892	0.927	0.953	0.972	0.984	0.993	0.997	45688
Whole site	10%	214	98.5%	54	0.595	0.765	0.890	0.926	0.952	0.972	0.983	0.992	0.997	45879
Whole site	10%	214	99.0%	36	0.591	0.761	0.888	0.924	0.951	0.971	0.983	0.992	0.997	46071
Whole site	10%	214	99.5%	18	0.587	0.757	0.886	0.922	0.950	0.970	0.982	0.992	0.997	46263
Sum of MacColl, Telford & Stevenson	10%	214	95.0%	218	0.632	0.800	0.908	0.939	0.961	0.978	0.987	0.994	0.997	44181
Sum of MacColl, Telford & Stevenson	10%	214	98.0%	87	0.603	0.772	0.894	0.928	0.954	0.973	0.984	0.993	0.997	45532
Sum of MacColl, Telford & Stevenson	10%	214	98.5%	65	0.598	0.768	0.891	0.927	0.953	0.972	0.984	0.992	0.997	45762
Sum of MacColl, Telford & Stevenson	10%	214	99.0%	44	0.593	0.763	0.889	0.925	0.952	0.971	0.983	0.992	0.997	45992
Sum of MacColl, Telford & Stevenson	10%	214	99.5%	22	0.588	0.758	0.886	0.923	0.950	0.970	0.982	0.992	0.997	46223
MacColl	10%	214	95.0%	109	0.608	0.777	0.896	0.930	0.955	0.974	0.985	0.993	0.997	45298
MacColl	10%	214	98.0%	44	0.593	0.763	0.889	0.925	0.952	0.971	0.983	0.992	0.997	45989
MacColl	10%	214	98.5%	33	0.591	0.760	0.888	0.924	0.951	0.971	0.983	0.992	0.997	46106
MacColl	10%	214	99.0%	22	0.588	0.758	0.886	0.923	0.950	0.970	0.982	0.992	0.997	46222
MacColl	10%	214	99.5%	11	0.586	0.755	0.885	0.922	0.949	0.970	0.982	0.992	0.997	46339
Stevenson	10%	214	95.0%	63	0.597	0.767	0.891	0.926	0.953	0.972	0.983	0.992	0.997	45783
Stevenson	10%	214	98.0%	25	0.589	0.759	0.887	0.923	0.950	0.970	0.982	0.992	0.997	46186
Stevenson	10%	214	98.5%	19	0.587	0.757	0.886	0.922	0.950	0.970	0.982	0.992	0.997	46253
Stevenson	10%	214	99.0%	13	0.586	0.756	0.885	0.922	0.950	0.970	0.982	0.992	0.997	46321
Stevenson	10%	214	99.5%	6	0.584	0.754	0.884	0.921	0.949	0.969	0.982	0.992	0.997	46388
Telford	10%	214	95.0%	45	0.593	0.763	0.889	0.925	0.952	0.971	0.983	0.992	0.997	45976
Telford	10%	214	98.0%	18	0.587	0.757	0.886	0.922	0.950	0.970	0.982	0.992	0.997	46264
Telford	10%	214	98.5%	13	0.586	0.756	0.885	0.922	0.950	0.970	0.982	0.992	0.997	46312
Telford	10%	214	99.0%	9	0.585	0.755	0.885	0.921	0.949	0.970	0.982	0.992	0.997	46360
Telford	10%	214	99.5%	4	0.584	0.754	0.884	0.921	0.949	0.969	0.982	0.992	0.997	46408
MacColl and Stevenson	10%	214	95.0%	173	0.622	0.791	0.903	0.935	0.959	0.976	0.986	0.994	0.997	44642
MacColl and Stevenson	10%	214	98.0%	69	0.599	0.768	0.892	0.927	0.953	0.972	0.984	0.993	0.997	45722
MacColl and Stevenson	10%	214	98.5%	52	0.595	0.765	0.890	0.925	0.952	0.972	0.983	0.992	0.997	45904
MacColl and Stevenson	10%	214	99.0%	35	0.591	0.761	0.888	0.924	0.951	0.971	0.983	0.992	0.997	46088
MacColl and Stevenson	10%	214	99.5%	17	0.587	0.757	0.886	0.922	0.950	0.970	0.982	0.992	0.997	46272
Telford and MacColl	10%	214	95.0%	154	0.618	0.787	0.901	0.934	0.958	0.976	0.986	0.993	0.997	44830
Telford and MacColl	10%	214	98.0%	62	0.597	0.767	0.891	0.926	0.953	0.972	0.983	0.992	0.997	45799
Telford and MacColl	10%	214	98.5%	46	0.594	0.763	0.889	0.925	0.952	0.971	0.983	0.992	0.997	45962
Telford and MacColl	10%	214	99.0%	31	0.590	0.760	0.887	0.923	0.951	0.971	0.983	0.992	0.997	46126
Telford and MacColl	10%	214	99.5%	15	0.587	0.756	0.886	0.922	0.950	0.970	0.982	0.992	0.997	46291
Stevenson and Telford	10%	214	95.0%	108	0.608	0.777	0.896	0.930	0.955	0.974	0.985	0.993	0.997	45310
Stevenson and Telford	10%	214	98.0%	43	0.593	0.763	0.889	0.925	0.951	0.971	0.983	0.992	0.997	45994
Stevenson and Telford	10%	214	98.5%	32	0.590	0.760	0.888	0.924	0.951	0.971	0.983	0.992	0.997	46109
Stevenson and Telford	10%	214	99.0%	22	0.588	0.758	0.886	0.923	0.950	0.970	0.982	0.992	0.997	46225
Stevenson and Telford	10%	214	99.5%	11	0.586	0.755	0.885	0.922	0.949	0.970	0.982	0.992	0.997	46340
BOWL	10%	214	95.0%	32	0.590	0.760	0.887	0.924	0.951	0.971	0.983	0.992	0.997	46114
BOWL	10%	214	98.0%	13	0.586	0.756	0.885	0.922	0.950	0.970	0.982	0.992	0.997	46317
BOWL	10%	214	98.5%	9	0.585	0.755	0.885	0.921	0.949	0.970	0.982	0.992	0.997	46360
BOWL	10%	214	99.0%	6	0.584	0.754	0.884	0.921	0.949	0.969	0.982	0.992	0.997	46392
BOWL	10%	214	99.5%	3	0.584	0.753	0.884	0.921	0.949	0.969	0.982	0.992	0.996	46424
BOWL and MORL	10%	214	95.0%	213	0.631	0.799	0.907	0.938	0.961	0.978	0.987	0.994	0.997	44232
BOWL and MORL	10%	214	98.0%	85	0.602	0.772	0.894	0.928	0.954	0.973	0.984	0.993	0.997	45553
BOWL and MORL	10%	214	98.5%	64	0.598	0.767	0.891	0.926	0.953	0.972	0.983	0.992	0.997	45777
BOWL and MORL	10%	214	99.0%	43	0.593	0.763	0.889	0.924	0.951	0.971	0.983	0.992	0.997	46003
BOWL and MORL	10%	214	99.5%	21	0.588	0.758	0.886	0.923	0.950	0.970	0.982	0.992	0.997	46229

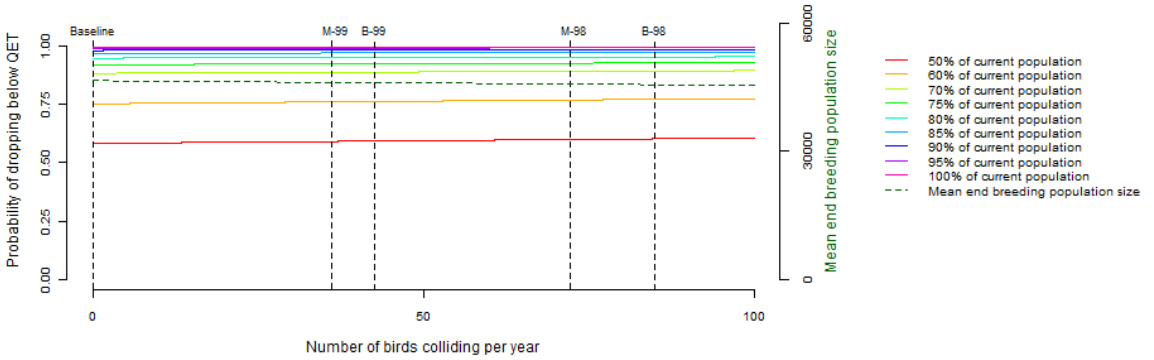


Figure 29. Probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M99 highlight the collision rates for the three wind farm sites at 98 and 99% avoidance rates, respectively. B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

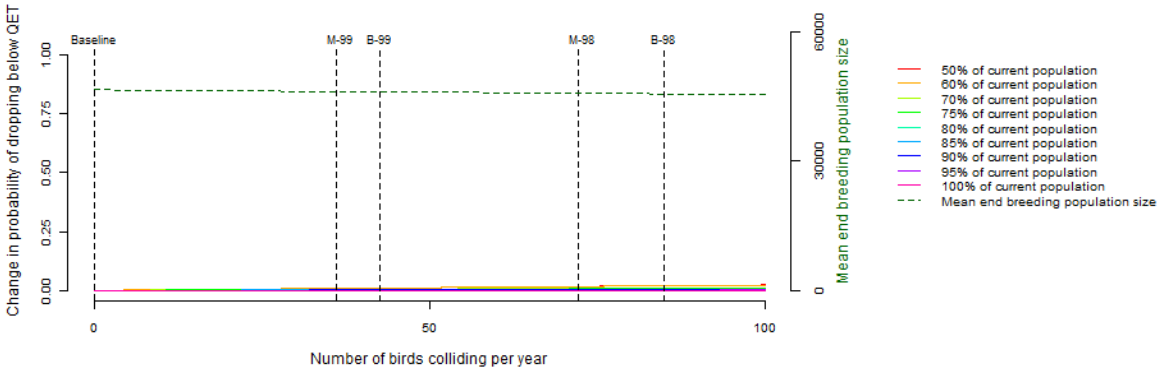


Figure 30. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M99 highlight the collision rates for the three wind farm sites at 98 and 99% avoidance rates, respectively. B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

6.5 Kittiwake – North Caithness Cliffs SPA

The initial population structure for the kittiwake population at North Caithness Cliffs SPA is provided in Table 46. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 31. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different collision rates are shown in Table 47 and Figure 32. The change in probabilities compared to the baseline situation is provided in Figure 33. This information is then repeated in Table 48 and Figures 34-35, but for the 25-year period of the project plus a 10-year recovery period.

Table 46. Initial population structure of the kittiwake population at North Caithness Cliffs.

Age Class	Number of Individuals
First year	20275
Second year	16271
Third year	13057
Fourth year	10478
Breeding adult (5 years and greater)	80820

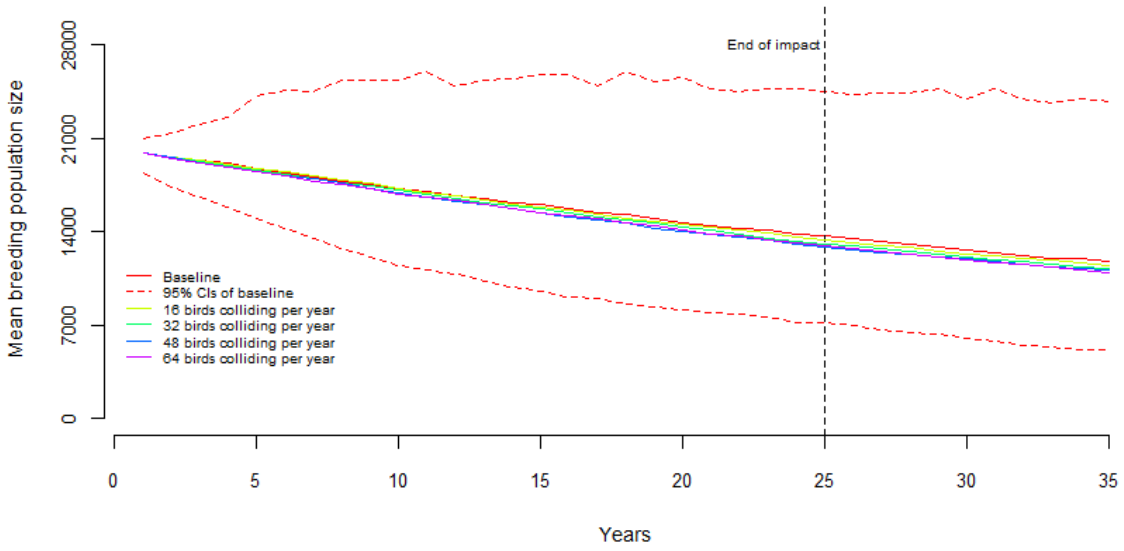


Figure 31. Population projections for the kittiwake population at North Caithness Cliffs at different levels of collision at the realistic level of displacement.

Table 47. Modelled probabilities of dropping below current population size for the kittiwake population at North Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size.

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.358	0.584	0.773	0.846	0.902	0.942	0.967	0.985	0.993	13684
Whole site	10%	86	95.0%	72	0.428	0.656	0.828	0.886	0.929	0.959	0.977	0.990	0.996	12803
Whole site	10%	86	98.0%	29	0.386	0.614	0.796	0.863	0.914	0.949	0.972	0.987	0.994	13325
Whole site	10%	86	98.5%	22	0.379	0.606	0.790	0.859	0.911	0.948	0.971	0.987	0.994	13414
Whole site	10%	86	99.0%	14	0.372	0.599	0.785	0.855	0.908	0.946	0.970	0.986	0.994	13503
Whole site	10%	86	99.5%	7	0.365	0.592	0.779	0.850	0.905	0.944	0.968	0.986	0.994	13593
Sum of MacColl, Telford & Stevenson	10%	86	95.0%	87	0.443	0.670	0.837	0.893	0.934	0.962	0.979	0.991	0.996	12630
Sum of MacColl, Telford & Stevenson	10%	86	98.0%	35	0.391	0.620	0.801	0.866	0.916	0.951	0.973	0.988	0.994	13252
Sum of MacColl, Telford & Stevenson	10%	86	98.5%	26	0.383	0.611	0.794	0.861	0.913	0.949	0.971	0.987	0.994	13359
Sum of MacColl, Telford & Stevenson	10%	86	99.0%	17	0.375	0.602	0.787	0.856	0.909	0.947	0.970	0.987	0.994	13466
Sum of MacColl, Telford & Stevenson	10%	86	99.5%	9	0.366	0.593	0.780	0.851	0.905	0.944	0.969	0.986	0.994	13575
MacColl	10%	86	95.0%	44	0.400	0.629	0.807	0.871	0.919	0.953	0.974	0.988	0.995	13144
MacColl	10%	86	98.0%	18	0.375	0.602	0.787	0.856	0.909	0.947	0.970	0.987	0.994	13465
MacColl	10%	86	98.5%	13	0.371	0.598	0.784	0.854	0.907	0.945	0.969	0.986	0.994	13520
MacColl	10%	86	99.0%	9	0.366	0.593	0.780	0.851	0.905	0.944	0.969	0.986	0.994	13574
MacColl	10%	86	99.5%	4	0.362	0.589	0.776	0.848	0.904	0.943	0.968	0.985	0.993	13629
Stevenson	10%	86	95.0%	25	0.382	0.610	0.793	0.861	0.912	0.949	0.971	0.987	0.994	13369
Stevenson	10%	86	98.0%	10	0.368	0.595	0.781	0.852	0.906	0.945	0.969	0.986	0.994	13557
Stevenson	10%	86	98.5%	8	0.365	0.592	0.779	0.850	0.905	0.944	0.968	0.986	0.994	13589
Stevenson	10%	86	99.0%	5	0.363	0.589	0.777	0.849	0.904	0.943	0.968	0.986	0.994	13621
Stevenson	10%	86	99.5%	3	0.361	0.587	0.775	0.847	0.903	0.943	0.968	0.985	0.993	13652
Telford	10%	86	95.0%	18	0.375	0.603	0.787	0.857	0.909	0.947	0.970	0.987	0.994	13459
Telford	10%	86	98.0%	7	0.365	0.592	0.779	0.850	0.905	0.944	0.968	0.986	0.994	13594
Telford	10%	86	98.5%	5	0.363	0.590	0.777	0.849	0.904	0.943	0.968	0.986	0.994	13616
Telford	10%	86	99.0%	4	0.362	0.588	0.776	0.848	0.903	0.943	0.968	0.985	0.993	13639
Telford	10%	86	99.5%	2	0.360	0.586	0.774	0.847	0.902	0.942	0.967	0.985	0.993	13661
MacColl and Stevenson	10%	86	95.0%	69	0.425	0.653	0.825	0.885	0.928	0.958	0.977	0.990	0.995	12841
MacColl and Stevenson	10%	86	98.0%	28	0.384	0.612	0.795	0.862	0.913	0.949	0.972	0.987	0.994	13340
MacColl and Stevenson	10%	86	98.5%	21	0.378	0.605	0.790	0.858	0.910	0.947	0.970	0.987	0.994	13426
MacColl and Stevenson	10%	86	99.0%	14	0.371	0.598	0.784	0.854	0.908	0.946	0.969	0.986	0.994	13511
MacColl and Stevenson	10%	86	99.5%	7	0.365	0.591	0.778	0.850	0.905	0.944	0.968	0.986	0.994	13597
Telford and MacColl	10%	86	95.0%	62	0.418	0.646	0.820	0.881	0.926	0.957	0.976	0.990	0.995	12928
Telford and MacColl	10%	86	98.0%	25	0.382	0.609	0.793	0.861	0.912	0.948	0.971	0.987	0.994	13376
Telford and MacColl	10%	86	98.5%	19	0.376	0.603	0.788	0.857	0.909	0.947	0.970	0.987	0.994	13453
Telford and MacColl	10%	86	99.0%	12	0.370	0.597	0.783	0.853	0.907	0.945	0.969	0.986	0.994	13529
Telford and MacColl	10%	86	99.5%	6	0.364	0.590	0.778	0.849	0.904	0.944	0.968	0.986	0.994	13607
Stevenson and Telford	10%	86	95.0%	43	0.400	0.628	0.807	0.871	0.919	0.953	0.974	0.988	0.995	13149
Stevenson and Telford	10%	86	98.0%	17	0.375	0.602	0.787	0.856	0.909	0.947	0.970	0.986	0.994	13468
Stevenson and Telford	10%	86	98.5%	13	0.370	0.597	0.783	0.854	0.907	0.945	0.969	0.986	0.994	13521
Stevenson and Telford	10%	86	99.0%	9	0.366	0.593	0.780	0.851	0.905	0.944	0.969	0.986	0.994	13575
Stevenson and Telford	10%	86	99.5%	4	0.362	0.589	0.776	0.848	0.904	0.943	0.968	0.985	0.993	13630
BOWL	10%	86	95.0%	79	0.435	0.663	0.832	0.889	0.931	0.960	0.978	0.991	0.996	12724
BOWL	10%	86	98.0%	32	0.389	0.617	0.798	0.865	0.915	0.950	0.972	0.988	0.994	13287
BOWL	10%	86	98.5%	24	0.381	0.609	0.792	0.860	0.912	0.948	0.971	0.987	0.994	13385
BOWL	10%	86	99.0%	16	0.373	0.601	0.786	0.855	0.908	0.946	0.970	0.986	0.994	13484
BOWL	10%	86	99.5%	8	0.366	0.592	0.779	0.851	0.905	0.944	0.968	0.986	0.994	13584
BOWL and MORL	10%	86	95.0%	151	0.508	0.728	0.875	0.920	0.951	0.972	0.985	0.994	0.997	11905
BOWL and MORL	10%	86	98.0%	60	0.416	0.645	0.819	0.880	0.925	0.957	0.976	0.989	0.995	12943
BOWL and MORL	10%	86	98.5%	45	0.402	0.630	0.808	0.872	0.920	0.953	0.974	0.988	0.995	13124
BOWL and MORL	10%	86	99.0%	30	0.387	0.615	0.797	0.864	0.914	0.950	0.972	0.987	0.994	13308
BOWL and MORL	10%	86	99.5%	15	0.373	0.600	0.785	0.855	0.908	0.946	0.970	0.986	0.994	13495

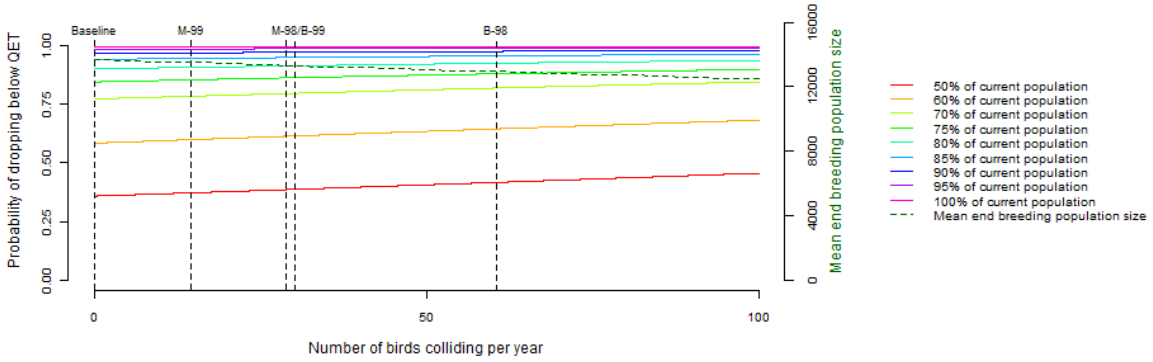


Figure 32. Probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M98 and M99 highlight the collision rates for the three wind farm sites at 98 and 99% avoidance rates, respectively. B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

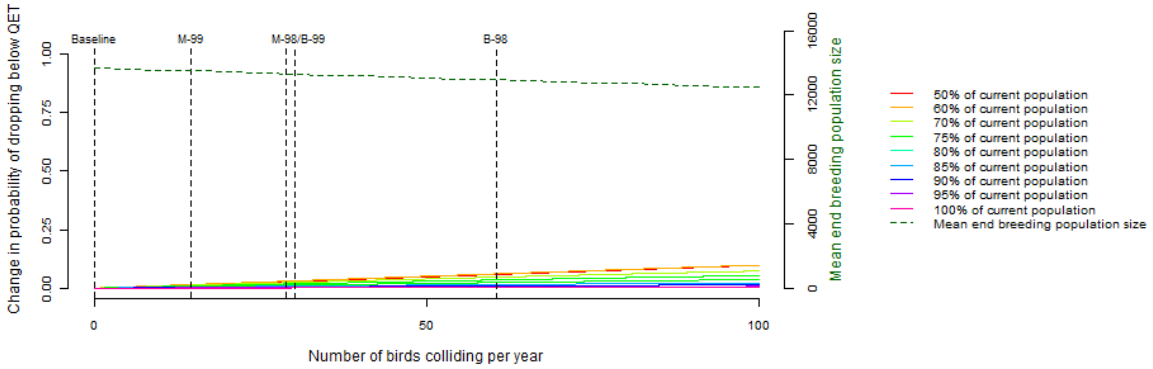


Figure 33. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M98 and M99 highlight the collision rates for the three wind farm sites at 98 and 99% avoidance rates, respectively. B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

Table 48. Modelled probabilities of dropping below current population size for the kittiwake population at North Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.572	0.757	0.877	0.916	0.950	0.974	0.986	0.993	0.997	11727
Whole site	10%	86	95.0%	72	0.642	0.813	0.914	0.943	0.966	0.981	0.991	0.996	0.998	10968
Whole site	10%	86	98.0%	29	0.600	0.781	0.893	0.928	0.957	0.977	0.988	0.995	0.997	11417
Whole site	10%	86	98.5%	22	0.593	0.775	0.889	0.925	0.955	0.976	0.987	0.994	0.997	11494
Whole site	10%	86	99.0%	14	0.586	0.769	0.885	0.922	0.953	0.976	0.987	0.994	0.997	11571
Whole site	10%	86	99.5%	7	0.579	0.763	0.881	0.919	0.952	0.975	0.986	0.994	0.997	11648
Sum of MacColl, Telford & Stevenson	10%	86	95.0%	87	0.656	0.823	0.920	0.947	0.968	0.983	0.992	0.997	0.998	10818
Sum of MacColl, Telford & Stevenson	10%	86	98.0%	35	0.606	0.785	0.896	0.930	0.958	0.978	0.988	0.995	0.998	11354
Sum of MacColl, Telford & Stevenson	10%	86	98.5%	26	0.598	0.779	0.891	0.927	0.956	0.977	0.988	0.995	0.997	11446
Sum of MacColl, Telford & Stevenson	10%	86	99.0%	17	0.589	0.772	0.887	0.923	0.954	0.976	0.987	0.994	0.997	11539
Sum of MacColl, Telford & Stevenson	10%	86	99.5%	9	0.580	0.764	0.882	0.920	0.952	0.975	0.986	0.994	0.997	11632
MacColl	10%	86	95.0%	44	0.615	0.792	0.900	0.933	0.960	0.979	0.989	0.995	0.998	11261
MacColl	10%	86	98.0%	18	0.589	0.772	0.887	0.923	0.954	0.976	0.987	0.994	0.997	11538
MacColl	10%	86	98.5%	13	0.585	0.768	0.884	0.922	0.953	0.976	0.987	0.994	0.997	11585
MacColl	10%	86	99.0%	9	0.581	0.764	0.882	0.920	0.952	0.975	0.986	0.994	0.997	11632
MacColl	10%	86	99.5%	4	0.576	0.761	0.879	0.918	0.951	0.974	0.986	0.994	0.997	11679
Stevenson	10%	86	95.0%	25	0.597	0.778	0.891	0.926	0.956	0.977	0.988	0.995	0.997	11455
Stevenson	10%	86	98.0%	10	0.582	0.766	0.883	0.920	0.952	0.975	0.986	0.994	0.997	11617
Stevenson	10%	86	98.5%	8	0.579	0.763	0.881	0.919	0.952	0.975	0.986	0.994	0.997	11644
Stevenson	10%	86	99.0%	5	0.577	0.761	0.880	0.918	0.951	0.975	0.986	0.994	0.997	11672
Stevenson	10%	86	99.5%	3	0.574	0.759	0.878	0.917	0.950	0.974	0.986	0.994	0.997	11699
Telford	10%	86	95.0%	18	0.590	0.772	0.887	0.924	0.954	0.976	0.987	0.994	0.997	11533
Telford	10%	86	98.0%	7	0.579	0.763	0.881	0.919	0.952	0.975	0.986	0.994	0.997	11649
Telford	10%	86	98.5%	5	0.577	0.762	0.880	0.918	0.951	0.975	0.986	0.994	0.997	11668
Telford	10%	86	99.0%	4	0.575	0.760	0.879	0.918	0.951	0.974	0.986	0.994	0.997	11688
Telford	10%	86	99.5%	2	0.574	0.759	0.878	0.917	0.950	0.974	0.986	0.994	0.997	11707
MacColl and Stevenson	10%	86	95.0%	69	0.639	0.811	0.912	0.942	0.965	0.981	0.991	0.996	0.998	11000
MacColl and Stevenson	10%	86	98.0%	28	0.599	0.780	0.892	0.927	0.957	0.977	0.988	0.995	0.997	11430
MacColl and Stevenson	10%	86	98.5%	21	0.592	0.774	0.888	0.925	0.955	0.976	0.987	0.994	0.997	11504
MacColl and Stevenson	10%	86	99.0%	14	0.586	0.769	0.885	0.922	0.953	0.976	0.987	0.994	0.997	11578
MacColl and Stevenson	10%	86	99.5%	7	0.579	0.763	0.881	0.919	0.952	0.975	0.986	0.994	0.997	11652
Telford and MacColl	10%	86	95.0%	62	0.632	0.806	0.909	0.939	0.964	0.981	0.990	0.996	0.998	11075
Telford and MacColl	10%	86	98.0%	25	0.596	0.777	0.891	0.926	0.956	0.977	0.988	0.995	0.997	11461
Telford and MacColl	10%	86	98.5%	19	0.590	0.772	0.887	0.924	0.954	0.976	0.987	0.994	0.997	11527
Telford and MacColl	10%	86	99.0%	12	0.584	0.767	0.884	0.921	0.953	0.975	0.987	0.994	0.997	11593
Telford and MacColl	10%	86	99.5%	6	0.578	0.762	0.880	0.919	0.951	0.975	0.986	0.994	0.997	11660
Stevenson and Telford	10%	86	95.0%	43	0.614	0.792	0.900	0.933	0.960	0.979	0.989	0.995	0.998	11266
Stevenson and Telford	10%	86	98.0%	17	0.589	0.771	0.887	0.923	0.954	0.976	0.987	0.994	0.997	11540
Stevenson and Telford	10%	86	98.5%	13	0.585	0.768	0.884	0.922	0.953	0.975	0.987	0.994	0.997	11586
Stevenson and Telford	10%	86	99.0%	9	0.580	0.764	0.882	0.920	0.952	0.975	0.986	0.994	0.997	11633
Stevenson and Telford	10%	86	99.5%	4	0.576	0.761	0.879	0.918	0.951	0.974	0.986	0.994	0.997	11680
BOWL	10%	86	95.0%	79	0.648	0.818	0.916	0.945	0.967	0.982	0.991	0.996	0.998	10899
BOWL	10%	86	98.0%	32	0.603	0.783	0.894	0.929	0.958	0.978	0.988	0.995	0.998	11384
BOWL	10%	86	98.5%	24	0.596	0.777	0.890	0.926	0.956	0.977	0.988	0.995	0.997	11469
BOWL	10%	86	99.0%	16	0.588	0.770	0.886	0.923	0.954	0.976	0.987	0.994	0.997	11554
BOWL	10%	86	99.5%	8	0.580	0.764	0.881	0.919	0.952	0.975	0.986	0.994	0.997	11640
BOWL and MORL	10%	86	95.0%	151	0.712	0.862	0.942	0.963	0.978	0.987	0.994	0.998	0.999	10194
BOWL and MORL	10%	86	98.0%	60	0.631	0.805	0.908	0.939	0.964	0.980	0.990	0.996	0.998	11088
BOWL and MORL	10%	86	98.5%	45	0.616	0.793	0.901	0.934	0.961	0.979	0.989	0.995	0.998	11244
BOWL and MORL	10%	86	99.0%	30	0.602	0.782	0.894	0.928	0.957	0.977	0.988	0.995	0.997	11403
BOWL and MORL	10%	86	99.5%	15	0.587	0.770	0.885	0.922	0.954	0.976	0.987	0.994	0.997	11563

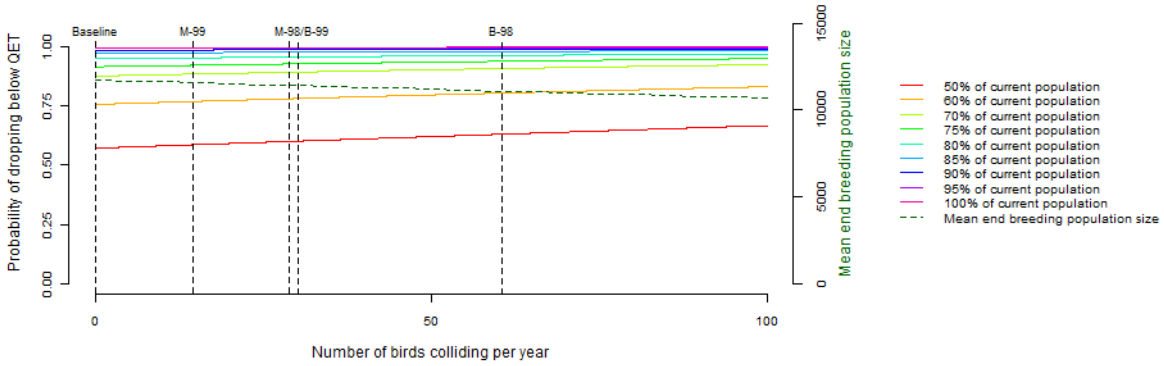


Figure 34. Probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M99 highlight the collision rates for the three wind farm sites at 98 and 99% avoidance rates, respectively. B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

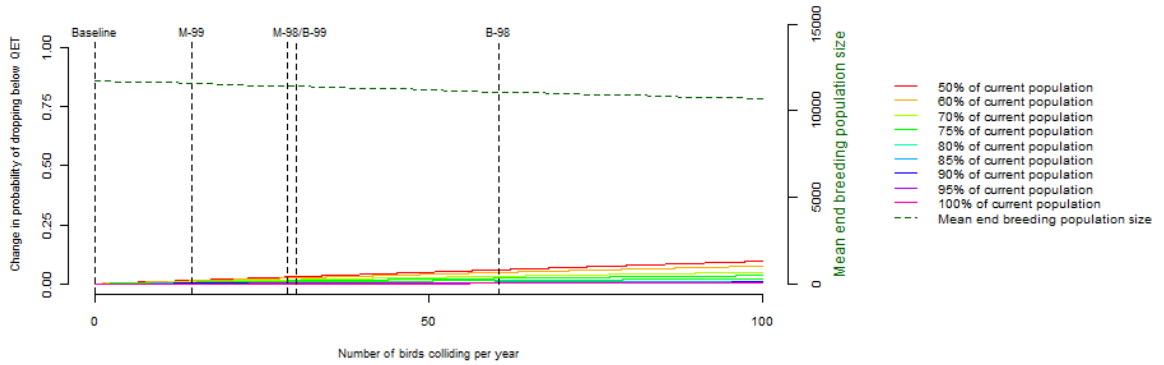


Figure 35. Change in probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M99 highlight the collision rates for the three wind farm sites at 98 and 99% avoidance rates, respectively. B98 and B99 highlight the cumulative collision rates at 98 and 99% avoidance rates, respectively.

6.6 Herring gull – East Caithness Cliffs SPA

The initial population structure for the herring gull population at East Caithness Cliffs SPA is provided in Table 49. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 36. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different collision rates are shown in Table 50 and Figure 37. The change in probabilities compared to the baseline situation is provided in Figure 38. This information is then repeated in Table 51 and Figures 39-40, but for the 25-year period of the project plus a 10-year recovery period.

Table 49. Initial population structure of the herring gull population at East Caithness Cliffs.

Age Class	Number of Individuals
First year	2126
Second year	1675
Third year	1320
Breeding adult (4 years and greater)	6786

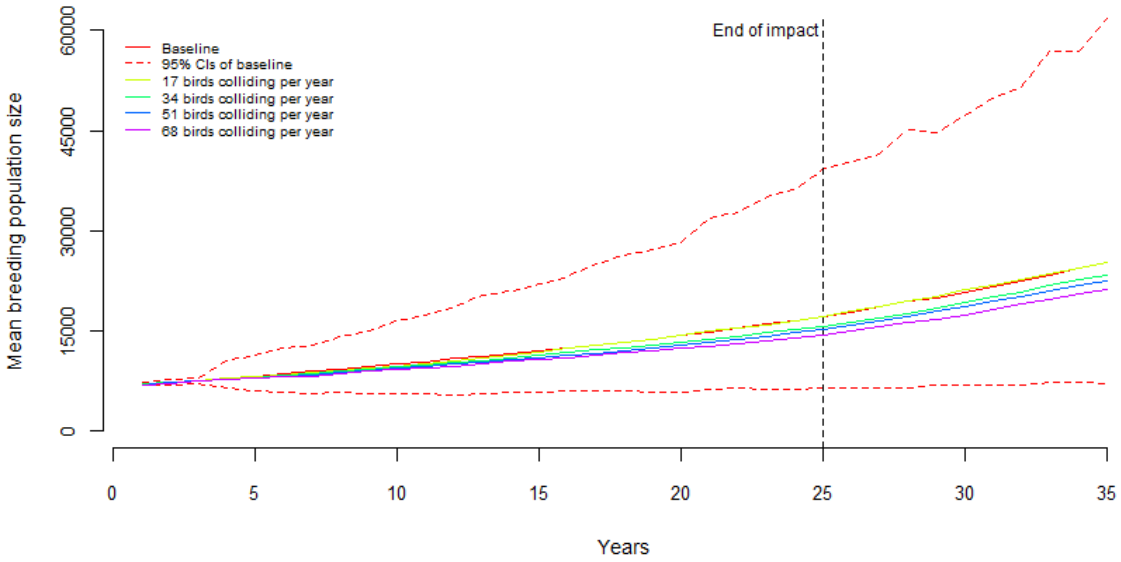


Figure 36. Population projections for the herring gull population at East Caithness Cliffs at different levels of collision.

Table 50. Modelled probabilities of dropping below current population size for the herring gull population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.009	0.033	0.098	0.157	0.246	0.356	0.517	0.644	0.739	17585
Whole site	95.0%	30	0.012	0.042	0.119	0.186	0.282	0.398	0.556	0.677	0.766	16240
Whole site	98.0%	12	0.010	0.036	0.106	0.168	0.260	0.373	0.533	0.657	0.750	17034
Whole site	98.5%	9	0.010	0.035	0.104	0.165	0.257	0.369	0.529	0.654	0.748	17170
Whole site	99.0%	6	0.009	0.034	0.102	0.162	0.253	0.364	0.525	0.651	0.745	17307
Whole site	99.5%	3	0.009	0.033	0.100	0.159	0.250	0.360	0.521	0.647	0.742	17445
Sum of MacColl, Telford & Stevenson	95.0%	36	0.013	0.044	0.124	0.192	0.290	0.406	0.563	0.683	0.771	15989
Sum of MacColl, Telford & Stevenson	98.0%	14	0.010	0.037	0.108	0.170	0.263	0.376	0.536	0.660	0.752	16928
Sum of MacColl, Telford & Stevenson	98.5%	11	0.010	0.036	0.105	0.167	0.259	0.371	0.531	0.656	0.749	17090
Sum of MacColl, Telford & Stevenson	99.0%	7	0.010	0.035	0.103	0.163	0.255	0.366	0.527	0.652	0.746	17253
Sum of MacColl, Telford & Stevenson	99.5%	4	0.009	0.034	0.100	0.160	0.250	0.361	0.522	0.648	0.743	17418
MacColl	95.0%	11	0.010	0.036	0.105	0.167	0.259	0.371	0.532	0.656	0.749	17080
MacColl	98.0%	4	0.009	0.034	0.101	0.161	0.251	0.362	0.523	0.649	0.743	17381
MacColl	98.5%	3	0.009	0.034	0.100	0.160	0.250	0.361	0.522	0.648	0.742	17432
MacColl	99.0%	2	0.009	0.033	0.100	0.159	0.249	0.359	0.520	0.646	0.741	17483
MacColl	99.5%	1	0.009	0.033	0.099	0.158	0.248	0.358	0.519	0.645	0.740	17534
Stevenson	95.0%	13	0.010	0.036	0.107	0.169	0.262	0.374	0.534	0.659	0.751	16984
Stevenson	98.0%	5	0.009	0.034	0.102	0.161	0.252	0.363	0.524	0.650	0.744	17342
Stevenson	98.5%	4	0.009	0.034	0.101	0.160	0.251	0.362	0.522	0.648	0.743	17402
Stevenson	99.0%	3	0.009	0.033	0.100	0.159	0.249	0.360	0.521	0.647	0.742	17463
Stevenson	99.5%	1	0.009	0.033	0.099	0.158	0.248	0.358	0.519	0.646	0.740	17524
Telford	95.0%	12	0.010	0.036	0.106	0.168	0.260	0.372	0.533	0.657	0.750	17044
Telford	98.0%	5	0.009	0.034	0.101	0.161	0.252	0.363	0.523	0.649	0.744	17366
Telford	98.5%	4	0.009	0.034	0.100	0.160	0.250	0.361	0.522	0.648	0.743	17421
Telford	99.0%	2	0.009	0.033	0.100	0.159	0.249	0.359	0.520	0.647	0.741	17475
Telford	99.5%	1	0.009	0.033	0.099	0.158	0.248	0.358	0.519	0.645	0.740	17530
MacColl and Stevenson	95.0%	24	0.011	0.040	0.115	0.180	0.275	0.390	0.548	0.671	0.761	16496
MacColl and Stevenson	98.0%	10	0.010	0.035	0.104	0.166	0.257	0.369	0.530	0.655	0.748	17141
MacColl and Stevenson	98.5%	7	0.010	0.035	0.103	0.163	0.255	0.366	0.527	0.652	0.746	17251
MacColl and Stevenson	99.0%	5	0.009	0.034	0.101	0.161	0.252	0.363	0.524	0.649	0.744	17361
MacColl and Stevenson	99.5%	2	0.009	0.033	0.100	0.159	0.249	0.360	0.521	0.647	0.741	17473
Telford and MacColl	95.0%	23	0.011	0.039	0.114	0.178	0.273	0.388	0.547	0.669	0.760	16555
Telford and MacColl	98.0%	9	0.010	0.035	0.104	0.165	0.257	0.369	0.529	0.654	0.748	17165
Telford and MacColl	98.5%	7	0.010	0.035	0.103	0.163	0.254	0.366	0.526	0.652	0.746	17269
Telford and MacColl	99.0%	5	0.009	0.034	0.101	0.161	0.252	0.362	0.523	0.649	0.743	17374
Telford and MacColl	99.5%	2	0.009	0.033	0.100	0.159	0.249	0.359	0.520	0.647	0.741	17479
Stevenson and Telford	95.0%	25	0.011	0.040	0.115	0.180	0.276	0.391	0.549	0.671	0.762	16461
Stevenson and Telford	98.0%	10	0.010	0.035	0.105	0.166	0.258	0.370	0.530	0.655	0.748	17126
Stevenson and Telford	98.5%	7	0.010	0.035	0.103	0.164	0.255	0.366	0.527	0.652	0.746	17240
Stevenson and Telford	99.0%	5	0.009	0.034	0.101	0.161	0.252	0.363	0.524	0.650	0.744	17354
Stevenson and Telford	99.5%	2	0.009	0.033	0.100	0.159	0.249	0.360	0.521	0.647	0.742	17469
BOWL	95.0%	124	0.031	0.091	0.211	0.303	0.413	0.537	0.671	0.769	0.838	12638
BOWL	98.0%	50	0.015	0.050	0.135	0.207	0.308	0.427	0.581	0.698	0.783	15392
BOWL	98.5%	37	0.013	0.045	0.125	0.193	0.291	0.408	0.565	0.685	0.772	15934
BOWL	99.0%	25	0.011	0.040	0.115	0.181	0.276	0.391	0.550	0.672	0.762	16452
BOWL	99.5%	12	0.010	0.036	0.106	0.168	0.260	0.373	0.533	0.657	0.750	17032
BOWL and MORL	95.0%	154	0.042	0.115	0.250	0.348	0.459	0.581	0.704	0.794	0.857	11672
BOWL and MORL	98.0%	62	0.017	0.055	0.145	0.221	0.324	0.444	0.596	0.710	0.793	14926
BOWL and MORL	98.5%	46	0.014	0.048	0.132	0.203	0.303	0.422	0.577	0.694	0.780	15550
BOWL and MORL	99.0%	31	0.012	0.042	0.120	0.187	0.283	0.399	0.557	0.678	0.767	16201
BOWL and MORL	99.5%	15	0.010	0.037	0.108	0.171	0.264	0.378	0.537	0.661	0.753	16879

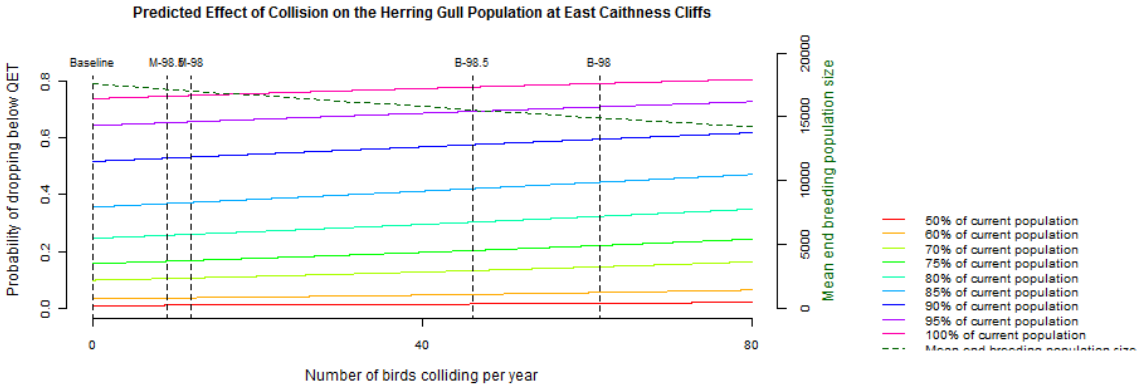


Figure 37. Probability of the herring gull population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M98 and M98.5 highlight the collision rates for the three wind farm sites at 98 and 98.5% avoidance rates, respectively. B98 and B98.5 highlight the cumulative collision rates at 98 and 98.5% avoidance rates, respectively.

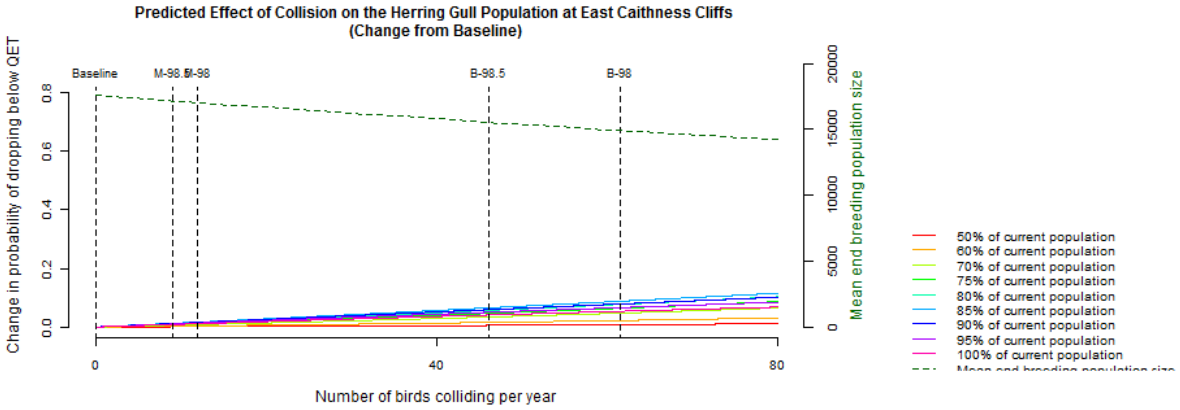


Figure 38. Change in probability of the herring gull population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table 51. Modelled probabilities of dropping below current population size for the herring gull population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.010	0.035	0.100	0.160	0.249	0.360	0.519	0.643	0.740	25987
Whole site	95.0%	30	0.014	0.045	0.122	0.190	0.286	0.403	0.559	0.678	0.768	23990
Whole site	98.0%	12	0.012	0.038	0.109	0.171	0.263	0.377	0.535	0.657	0.751	25169
Whole site	98.5%	9	0.011	0.037	0.106	0.168	0.260	0.373	0.531	0.654	0.749	25371
Whole site	99.0%	6	0.011	0.036	0.104	0.166	0.256	0.369	0.527	0.650	0.746	25575
Whole site	99.5%	3	0.011	0.036	0.102	0.163	0.252	0.364	0.523	0.647	0.743	25780
Sum of MacColl, Telford & Stevenson	95.0%	36	0.015	0.047	0.127	0.197	0.294	0.412	0.567	0.684	0.773	23618
Sum of MacColl, Telford & Stevenson	98.0%	14	0.012	0.039	0.110	0.174	0.266	0.380	0.538	0.660	0.754	25012
Sum of MacColl, Telford & Stevenson	98.5%	11	0.012	0.038	0.108	0.170	0.262	0.375	0.534	0.656	0.750	25253
Sum of MacColl, Telford & Stevenson	99.0%	7	0.011	0.037	0.105	0.167	0.258	0.370	0.529	0.652	0.747	25495
Sum of MacColl, Telford & Stevenson	99.5%	4	0.011	0.036	0.103	0.163	0.253	0.365	0.524	0.647	0.743	25740
MacColl	95.0%	11	0.012	0.038	0.108	0.170	0.262	0.376	0.534	0.656	0.750	25238
MacColl	98.0%	4	0.011	0.036	0.103	0.164	0.254	0.366	0.525	0.648	0.744	25685
MacColl	98.5%	3	0.011	0.036	0.102	0.163	0.253	0.365	0.524	0.647	0.743	25760
MacColl	99.0%	2	0.011	0.035	0.102	0.162	0.252	0.363	0.522	0.646	0.742	25836
MacColl	99.5%	1	0.010	0.035	0.101	0.161	0.250	0.362	0.521	0.645	0.741	25912
Stevenson	95.0%	13	0.012	0.039	0.109	0.173	0.265	0.379	0.537	0.659	0.752	25095
Stevenson	98.0%	5	0.011	0.036	0.104	0.165	0.255	0.368	0.526	0.649	0.745	25627
Stevenson	98.5%	4	0.011	0.036	0.103	0.164	0.254	0.366	0.525	0.648	0.744	25716
Stevenson	99.0%	3	0.011	0.035	0.102	0.162	0.252	0.364	0.523	0.646	0.742	25806
Stevenson	99.5%	1	0.010	0.035	0.101	0.161	0.250	0.362	0.521	0.645	0.741	25897
Telford	95.0%	12	0.012	0.038	0.108	0.171	0.263	0.377	0.535	0.657	0.751	25184
Telford	98.0%	5	0.011	0.036	0.103	0.164	0.255	0.367	0.526	0.649	0.744	25663
Telford	98.5%	4	0.011	0.036	0.103	0.163	0.253	0.365	0.524	0.647	0.743	25744
Telford	99.0%	2	0.011	0.035	0.102	0.162	0.252	0.363	0.523	0.646	0.742	25825
Telford	99.5%	1	0.010	0.035	0.101	0.161	0.250	0.362	0.521	0.645	0.741	25906
MacColl and Stevenson	95.0%	24	0.013	0.043	0.118	0.184	0.279	0.394	0.551	0.671	0.762	24371
MacColl and Stevenson	98.0%	10	0.011	0.038	0.107	0.169	0.261	0.374	0.532	0.655	0.749	25328
MacColl and Stevenson	98.5%	7	0.011	0.037	0.105	0.167	0.258	0.370	0.529	0.652	0.747	25492
MacColl and Stevenson	99.0%	5	0.011	0.036	0.103	0.164	0.255	0.367	0.526	0.649	0.745	25656
MacColl and Stevenson	99.5%	2	0.011	0.035	0.102	0.162	0.252	0.364	0.523	0.646	0.742	25821
Telford and MacColl	95.0%	23	0.013	0.042	0.117	0.182	0.277	0.392	0.550	0.670	0.761	24458
Telford and MacColl	98.0%	9	0.011	0.037	0.106	0.169	0.260	0.373	0.531	0.654	0.749	25365
Telford and MacColl	98.5%	7	0.011	0.037	0.105	0.166	0.257	0.370	0.528	0.651	0.746	25519
Telford and MacColl	99.0%	5	0.011	0.036	0.103	0.164	0.254	0.367	0.525	0.649	0.744	25674
Telford and MacColl	99.5%	2	0.011	0.035	0.102	0.162	0.252	0.363	0.522	0.646	0.742	25830
Stevenson and Telford	95.0%	25	0.013	0.043	0.118	0.185	0.280	0.396	0.552	0.672	0.763	24319
Stevenson and Telford	98.0%	10	0.011	0.038	0.107	0.169	0.261	0.374	0.533	0.655	0.749	25307
Stevenson and Telford	98.5%	7	0.011	0.037	0.105	0.167	0.258	0.371	0.529	0.652	0.747	25475
Stevenson and Telford	99.0%	5	0.011	0.036	0.104	0.165	0.255	0.367	0.526	0.649	0.745	25645
Stevenson and Telford	99.5%	2	0.011	0.035	0.102	0.162	0.252	0.364	0.523	0.646	0.742	25816
BOWL	95.0%	124	0.036	0.098	0.221	0.313	0.422	0.545	0.677	0.773	0.841	18647
BOWL	98.0%	50	0.017	0.053	0.140	0.213	0.313	0.433	0.585	0.700	0.785	22732
BOWL	98.5%	37	0.015	0.048	0.128	0.198	0.296	0.413	0.568	0.686	0.774	23537
BOWL	99.0%	25	0.013	0.043	0.118	0.185	0.280	0.396	0.553	0.672	0.763	24305
BOWL	99.5%	12	0.012	0.038	0.109	0.171	0.263	0.377	0.535	0.657	0.751	25166
BOWL and MORL	95.0%	154	0.049	0.124	0.262	0.360	0.469	0.589	0.711	0.799	0.860	17214
BOWL and MORL	98.0%	62	0.019	0.058	0.150	0.227	0.329	0.450	0.600	0.712	0.795	22040
BOWL and MORL	98.5%	46	0.017	0.051	0.136	0.208	0.308	0.427	0.580	0.696	0.782	22967
BOWL and MORL	99.0%	31	0.014	0.045	0.123	0.191	0.287	0.404	0.560	0.679	0.769	23932
BOWL and MORL	99.5%	15	0.012	0.039	0.111	0.175	0.268	0.382	0.540	0.661	0.755	24939

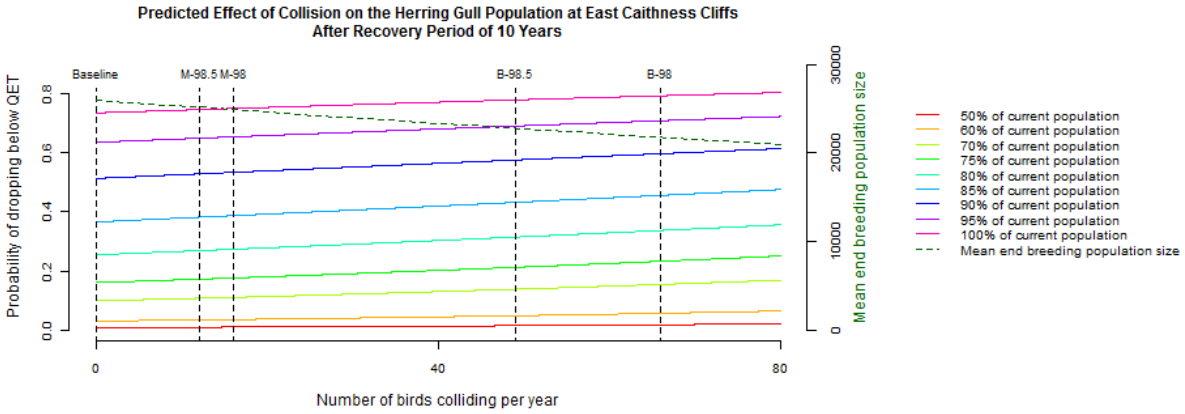


Figure 39. Probability of the herring gull population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M98.5 highlight the collision rates for the three wind farm sites at 98 and 98.5% avoidance rates, respectively. B98 and B98.5 highlight the cumulative collision rates at 98 and 98.5% avoidance rates, respectively.

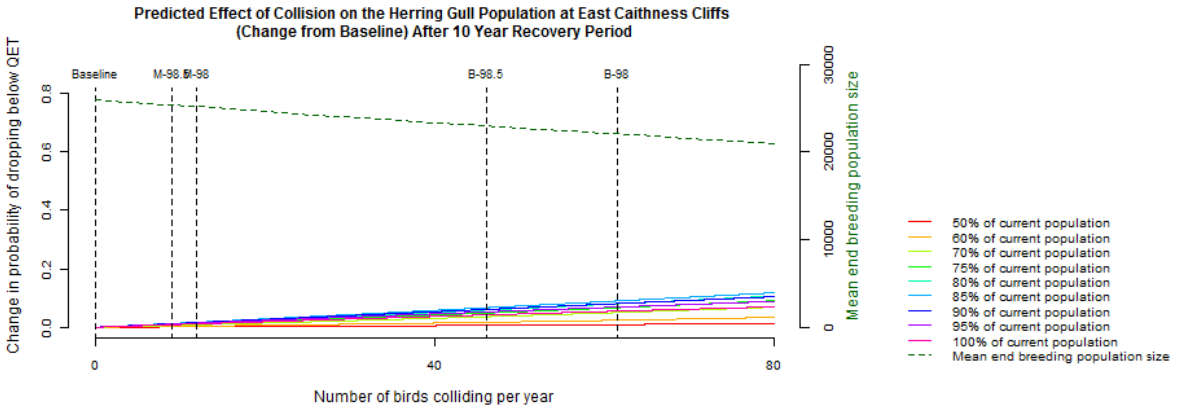


Figure 40. Change in probability of the herring gull population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M98.5 highlight the collision rates for the three wind farm sites at 98 and 98.5% avoidance rates, respectively. B98 and B98.5 highlight the cumulative collision rates at 98 and 98.5% avoidance rates, respectively.

6.7 Great black-backed gull – East Caithness Cliffs SPA

The initial population structure for the great black-backed gull population at East Caithness Cliffs SPA is provided in Table 52. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 41. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different collision rates are shown in Table 53 and Figure 42. The change in probabilities compared to the baseline situation is provided in Figure 43. This information is then repeated in Table 54 and Figures 44-45, but for the 25-year period of the project plus a 10-year recovery period.

Table 52. Initial population structure of the great black-backed gull population at East Caithness Cliffs.

Age Class	Number of Individuals
First year	98
Second year	82
Third year	69
Breeding adult (4 years and greater)	360

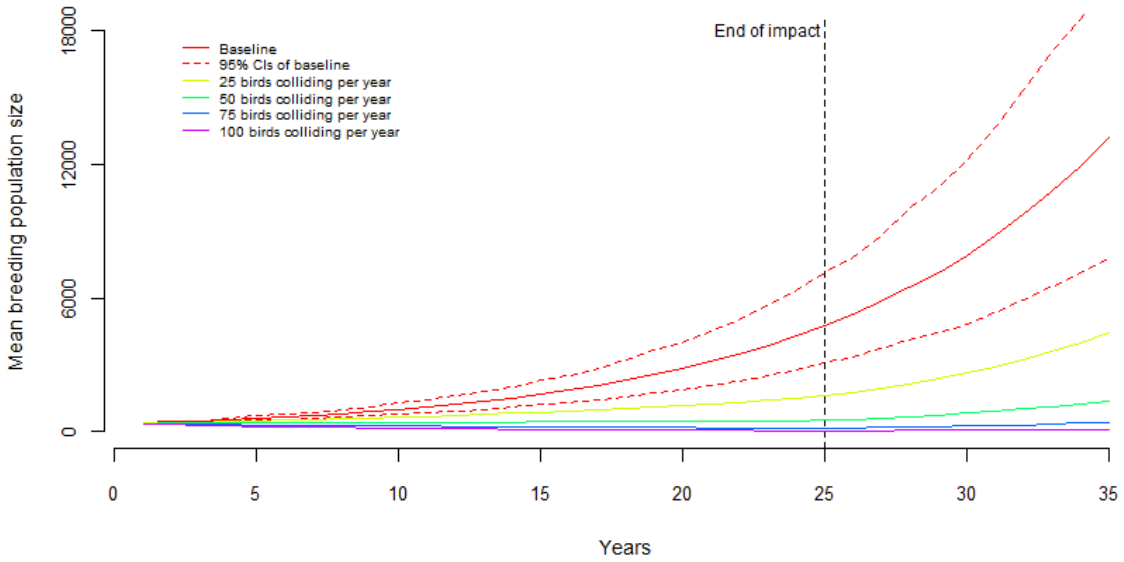


Figure 41. Population projections for the great black-backed gull population at East Caithness Cliffs at different levels of collision.

Table 53. Modelled probabilities of dropping below current population size for the great black backed population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.052	4783
Whole site	95.0%	62	0.058	0.225	0.496	0.660	0.784	0.869	0.913	0.959	0.975	279
Whole site	98.0%	25	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.059	0.254	1534
Whole site	98.5%	19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.174	2039
Whole site	99.0%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.118	2709
Whole site	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.079	3600
Sum of MacColl, Telford & Stevenson	95.0%	72	0.705	0.934	0.977	0.983	0.988	0.992	0.991	1.000	0.999	176
Sum of MacColl, Telford & Stevenson	98.0%	29	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.089	0.319	1276
Sum of MacColl, Telford & Stevenson	98.5%	22	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.042	0.210	1775
Sum of MacColl, Telford & Stevenson	99.0%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.134	2470
Sum of MacColl, Telford & Stevenson	99.5%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.084	3438
MacColl	95.0%	35	0.000	0.000	0.000	0.000	0.001	0.002	0.015	0.156	0.431	987
MacColl	98.0%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.129	2544
MacColl	98.5%	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.103	2979
MacColl	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.083	3488
MacColl	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.066	4085
Stevenson	95.0%	26	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.064	0.266	1478
Stevenson	98.0%	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.103	2990
Stevenson	98.5%	8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.087	3363
Stevenson	99.0%	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.074	3782
Stevenson	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.062	4253
Telford	95.0%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.115	2758
Telford	98.0%	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.072	3838
Telford	98.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.067	4055
Telford	99.0%	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.062	4285
Telford	99.5%	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.057	4527
MacColl and Stevenson	95.0%	60	0.030	0.120	0.322	0.500	0.662	0.790	0.868	0.925	0.961	305
MacColl and Stevenson	98.0%	24	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.054	0.242	1590
MacColl and Stevenson	98.5%	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.168	2094
MacColl and Stevenson	99.0%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.115	2758
MacColl and Stevenson	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.078	3632
Telford and MacColl	95.0%	47	0.000	0.001	0.003	0.010	0.027	0.068	0.207	0.456	0.722	569
Telford and MacColl	98.0%	19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.174	2041
Telford and MacColl	98.5%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.130	2525
Telford and MacColl	99.0%	9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.097	3125
Telford and MacColl	99.5%	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.071	3866
Stevenson and Telford	95.0%	38	0.000	0.000	0.000	0.001	0.002	0.006	0.031	0.212	0.504	852
Stevenson and Telford	98.0%	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.140	2399
Stevenson and Telford	98.5%	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.110	2851
Stevenson and Telford	99.0%	8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.086	3387
Stevenson and Telford	99.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.067	4025
BOWL	95.0%	179	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
BOWL	98.0%	72	0.670	0.922	0.973	0.980	0.987	0.991	0.990	1.000	0.999	179
BOWL	98.5%	54	0.003	0.012	0.042	0.105	0.211	0.375	0.595	0.733	0.877	408
BOWL	99.0%	36	0.000	0.000	0.000	0.000	0.001	0.003	0.021	0.178	0.462	926
BOWL	99.5%	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.167	2105
BOWL and MORL	95.0%	241	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0
BOWL and MORL	98.0%	97	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	59
BOWL and MORL	98.5%	72	0.701	0.933	0.977	0.983	0.988	0.992	0.991	1.000	0.999	176
BOWL and MORL	99.0%	48	0.000	0.001	0.005	0.017	0.043	0.103	0.275	0.513	0.759	529
BOWL and MORL	99.5%	24	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.054	0.242	1591

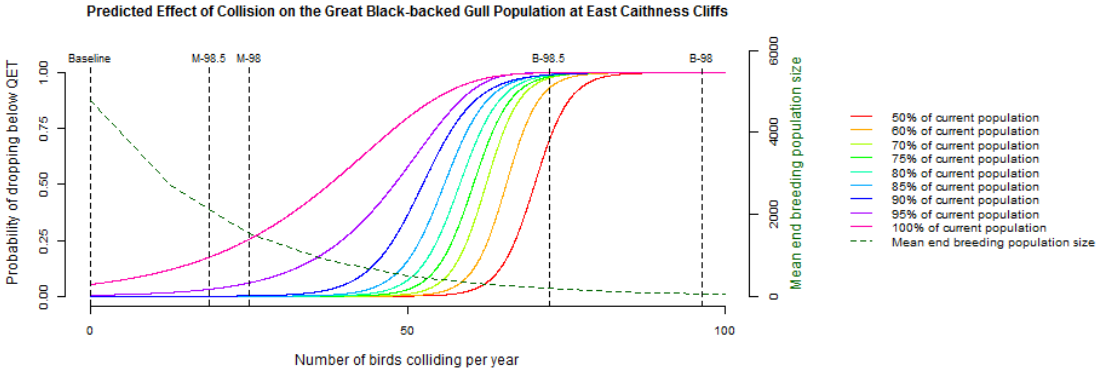


Figure 42. Probability of the great black-backed gull at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M98 and M98.5 highlight the collision rates for the three wind farm sites at 98 and 98.5% avoidance rates, respectively. B98 and B98.5 highlight the cumulative collision rates at 98 and 98.5% avoidance rates, respectively.

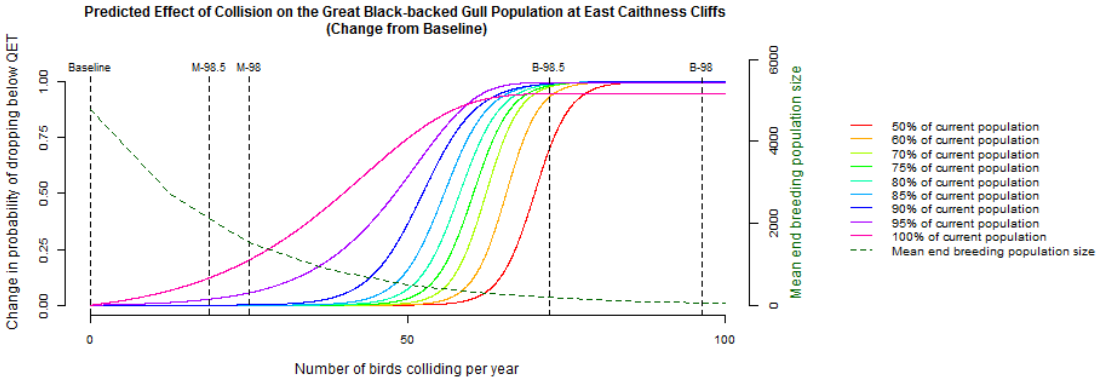


Figure 43. Change in probability of the great black-backed gull population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M98 and M98.5 highlight the collision rates for the three wind farm sites at 98 and 98.5% avoidance rates, respectively. B98 and B98.5 highlight the cumulative collision rates at 98 and 98.5% avoidance rates, respectively.

Table 54. Modelled probabilities of dropping below current population size for the great black backed population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.052	13271
Whole site	95.0%	62	0.058	0.226	0.497	0.660	0.784	0.869	0.913	0.959	0.975	769
Whole site	98.0%	25	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.059	0.254	4248
Whole site	98.5%	19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.174	5647
Whole site	99.0%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.118	7508
Whole site	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.079	9982
Sum of MacColl, Telford & Stevenson	95.0%	72	0.705	0.934	0.977	0.983	0.988	0.992	0.991	1.000	0.999	485
Sum of MacColl, Telford & Stevenson	98.0%	29	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.089	0.319	3531
Sum of MacColl, Telford & Stevenson	98.5%	22	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.042	0.210	4916
Sum of MacColl, Telford & Stevenson	99.0%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.134	6845
Sum of MacColl, Telford & Stevenson	99.5%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.084	9531
MacColl	95.0%	35	0.000	0.000	0.000	0.000	0.001	0.002	0.015	0.156	0.431	2729
MacColl	98.0%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.129	7049
MacColl	98.5%	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.103	8257
MacColl	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.083	9672
MacColl	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.066	11329
Stevenson	95.0%	26	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.064	0.266	4090
Stevenson	98.0%	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.103	8288
Stevenson	98.5%	8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.087	9323
Stevenson	99.0%	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.074	10487
Stevenson	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.062	11797
Telford	95.0%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.115	7644
Telford	98.0%	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.072	10643
Telford	98.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.067	11246
Telford	99.0%	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.062	11884
Telford	99.5%	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.057	12558
MacColl and Stevenson	95.0%	60	0.030	0.121	0.322	0.500	0.662	0.790	0.868	0.925	0.961	841
MacColl and Stevenson	98.0%	24	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.054	0.242	4403
MacColl and Stevenson	98.5%	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.168	5801
MacColl and Stevenson	99.0%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.115	7644
MacColl and Stevenson	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.078	10072
Telford and MacColl	95.0%	47	0.000	0.001	0.003	0.010	0.027	0.068	0.207	0.456	0.722	1572
Telford and MacColl	98.0%	19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.174	5654
Telford and MacColl	98.5%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.130	6998
Telford and MacColl	99.0%	9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.097	8662
Telford and MacColl	99.5%	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.071	10721
Stevenson and Telford	95.0%	38	0.000	0.000	0.000	0.001	0.002	0.006	0.031	0.212	0.504	2356
Stevenson and Telford	98.0%	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.140	6647
Stevenson and Telford	98.5%	11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.110	7901
Stevenson and Telford	99.0%	8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.086	9392
Stevenson and Telford	99.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.067	11164
BOWL	95.0%	179	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4
BOWL	98.0%	72	0.670	0.922	0.973	0.980	0.987	0.991	0.990	1.000	0.999	494
BOWL	98.5%	54	0.003	0.012	0.042	0.105	0.211	0.375	0.595	0.733	0.877	1125
BOWL	99.0%	36	0.000	0.000	0.000	0.000	0.001	0.003	0.021	0.178	0.462	2562
BOWL	99.5%	18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.167	5830
BOWL and MORL	95.0%	241	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0
BOWL and MORL	98.0%	97	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	161
BOWL and MORL	98.5%	72	0.701	0.933	0.977	0.983	0.988	0.992	0.991	1.000	0.999	486
BOWL and MORL	99.0%	48	0.000	0.001	0.005	0.017	0.043	0.103	0.275	0.513	0.759	1463
BOWL and MORL	99.5%	24	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.054	0.242	4406

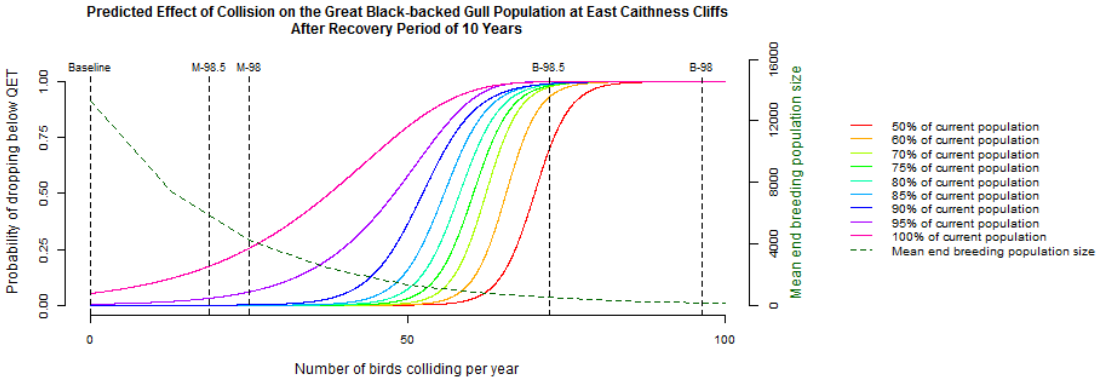


Figure 44. Probability of the great black-backed gull at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M98.5 highlight the collision rates for the three wind farm sites at 98 and 98.5% avoidance rates, respectively. B98 and B98.5 highlight the cumulative collision rates at 98 and 98.5% avoidance rates, respectively.

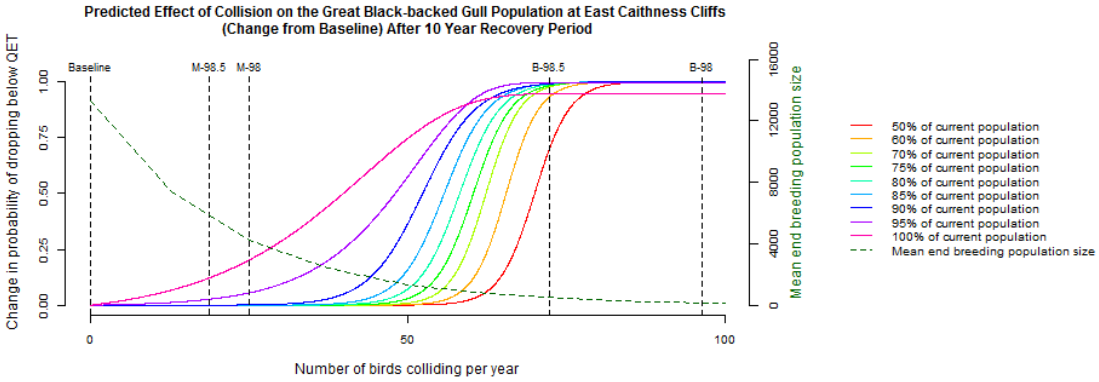


Figure 45. Change in probability of the great black-backed gull population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M98 and M98.5 highlight the collision rates for the three wind farm sites at 98 and 98.5% avoidance rates, respectively. B98 and B98.5 highlight the cumulative collision rates at 98 and 98.5% avoidance rates, respectively.

6.8 Guillemot – East Caithness Cliffs SPA

The initial population structure for the guillemot population at East Caithness Cliffs SPA is provided in Table 55. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 46. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different displacement rates are shown in Table 56 and Figure 47. The change in probabilities compared to the baseline situation is provided in Figure 48. This information is then repeated in Table 57 and Figures 49-50, but for the 25-year period of the project plus a 10-year recovery period.

Table 55. Initial population structure used in the PVAs for guillemot at Troup, Pennan and Lion's Heads SPA.

Age class	Number of individuals
First year	5058
Second year	2678
Third year	2005
Fourth year	1739
Breeding adult (5 years and greater)	17598

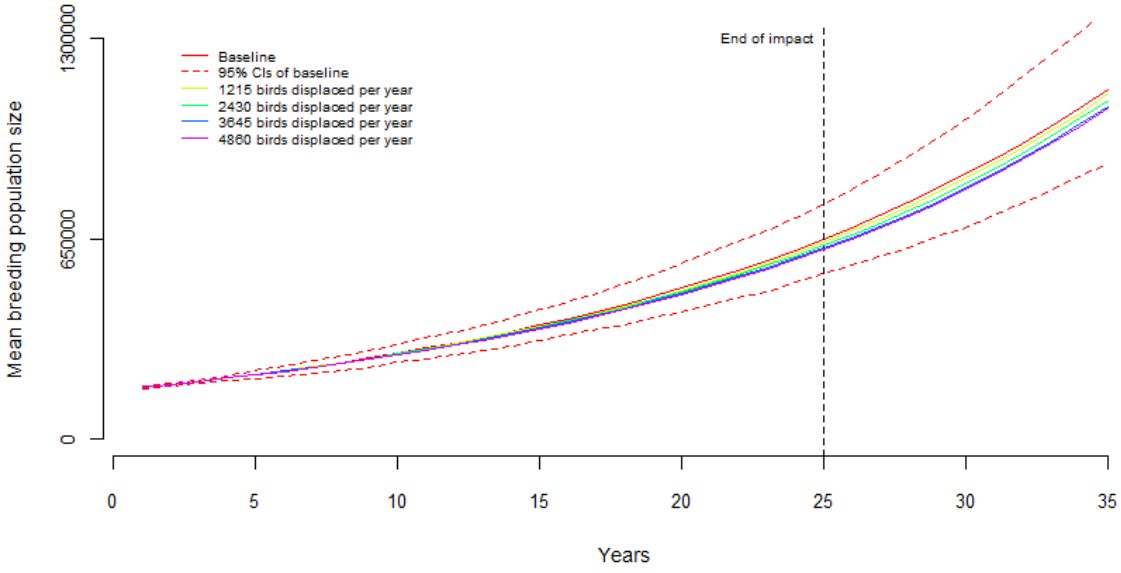


Figure 46. Population projections for the guillemot population at East Caithness Cliffs at different levels of displacement.

Table 56. Modelled probabilities of dropping below current population size for guillemot population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.161	647506
Whole site	100%	3443	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.029	0.176	625411
Whole site	50%	1721	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.168	636363
Sum of MacColl, Telford & Stevenson	100%	3443	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.029	0.176	625411
Sum of MacColl, Telford & Stevenson	50%	1721	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.168	636363
MacColl	100%	1495	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.167	637818
MacColl	50%	747	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.164	642644
Telford	100%	1104	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.165	640334
Telford	50%	552	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.163	643910
Stevenson	100%	843	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.164	642022
Stevenson	50%	422	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.163	644758
MacColl and Stevenson	100%	2338	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.171	632416
MacColl and Stevenson	50%	1169	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.166	639917
Stevenson and Telford	100%	1948	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.169	634911
Stevenson and Telford	50%	974	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.165	641178
Telford and MacColl	100%	2599	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.172	630754
Telford and MacColl	50%	1300	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.166	639075
BOWL	100%	1415	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.167	638334
BOWL	50%	707	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.164	642904
BOWL and MORL	100%	4857	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	0.182	616552
BOWL and MORL	50%	2429	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.171	631840

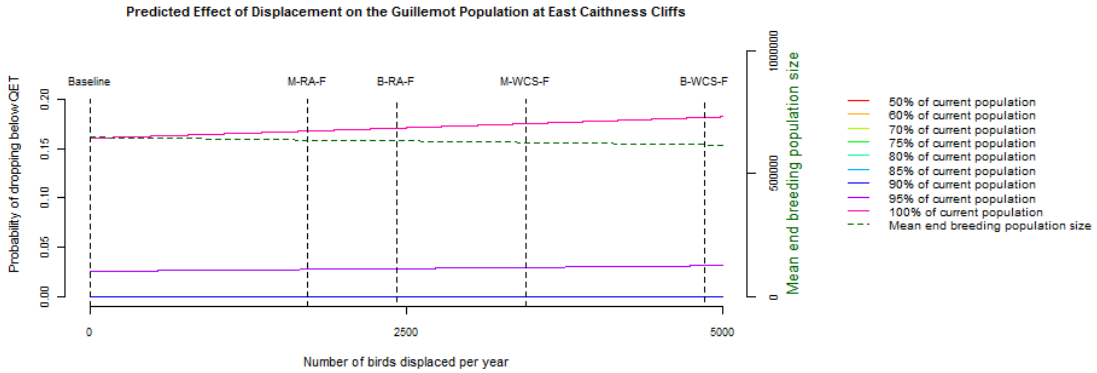


Figure 47. Probability of the guillemot at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

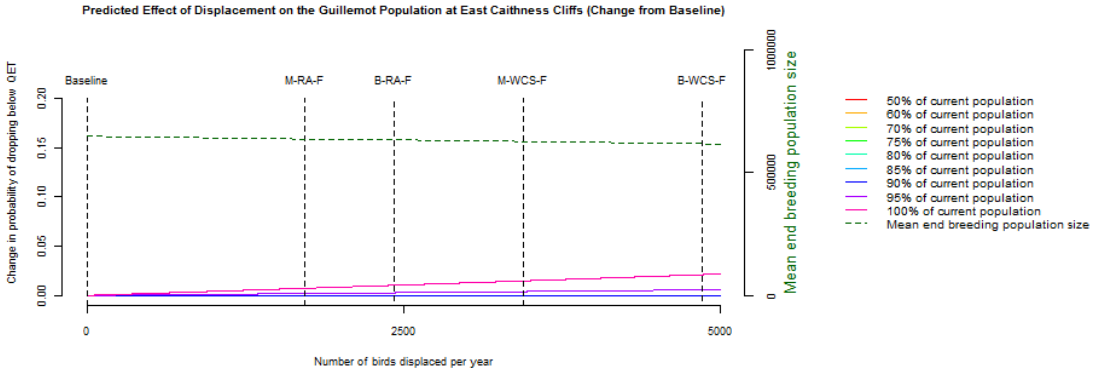


Figure 48. Change in probability of the guillemot population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

Table 57. Modelled probabilities of dropping below current population size for the guillemot population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size)

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.161	1135192
Whole site	100%	3443	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.029	0.176	1092154
Whole site	50%	1721	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.168	1113465
Sum of MacColl, Telford & Stevenson	100%	3443	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.029	0.176	1092154
Sum of MacColl, Telford & Stevenson	50%	1721	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.168	1113465
MacColl	100%	1495	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.167	1116300
MacColl	50%	747	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.164	1125706
Telford	100%	1104	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.165	1121204
Telford	50%	552	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.163	1128176
Stevenson	100%	843	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.164	1124494
Stevenson	50%	422	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.163	1129830
MacColl and Stevenson	100%	2338	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.171	1105780
MacColl and Stevenson	50%	1169	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.166	1120390
Stevenson and Telford	100%	1948	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.169	1110637
Stevenson and Telford	50%	974	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.165	1122848
Telford and MacColl	100%	2599	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.172	1102544
Telford and MacColl	50%	1300	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.166	1118749
BOWL	100%	1415	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	0.167	1117305
BOWL	50%	707	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.164	1126213
BOWL and MORL	100%	4857	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	0.182	1074945
BOWL and MORL	50%	2429	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.171	1104658

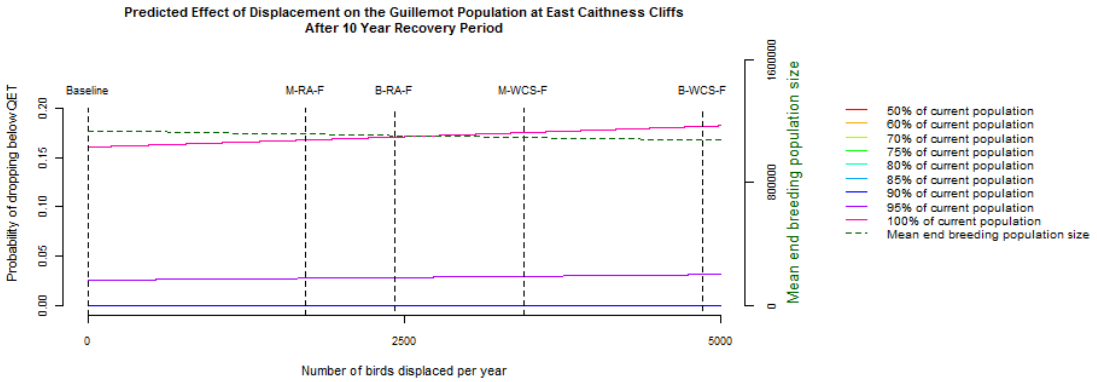


Figure 49. Probability of the guillemot at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

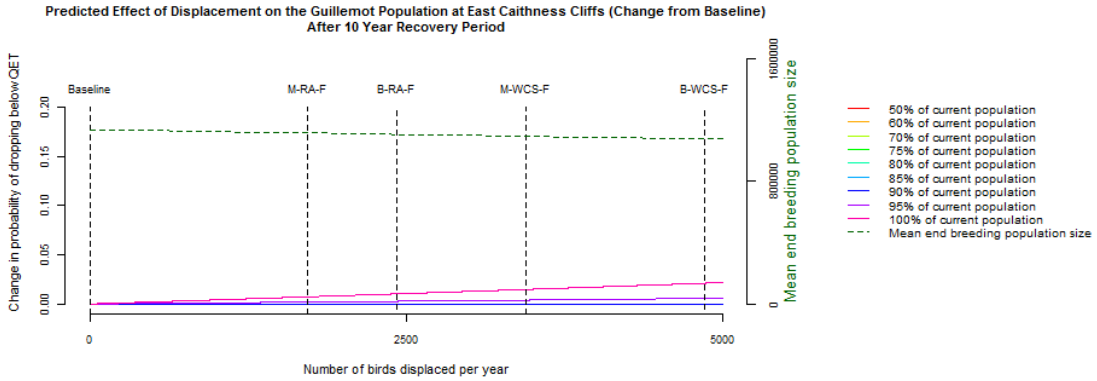


Figure 50. Change in probability of the guillemot population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

6.9 Guillemot – North Caithness Cliffs SPA

The initial population structure for the guillemot population at North Caithness Cliffs SPA is provided in Table 58. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 51. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different displacement rates are shown in Table 59 and Figure 52. The change in probabilities compared to the baseline situation is provided in Figure 53. This information is then repeated in Table 60 and Figures 54-55, but for the 25-year period of the project plus a 10-year recovery period.

Table 58. Initial population structure of the guillemot population at North Caithness Cliffs.

Age Class	Number of Individuals
First year	40572
Second year	21481
Third year	16086
Fourth year	13946
Breeding adult (5 years and greater)	141168

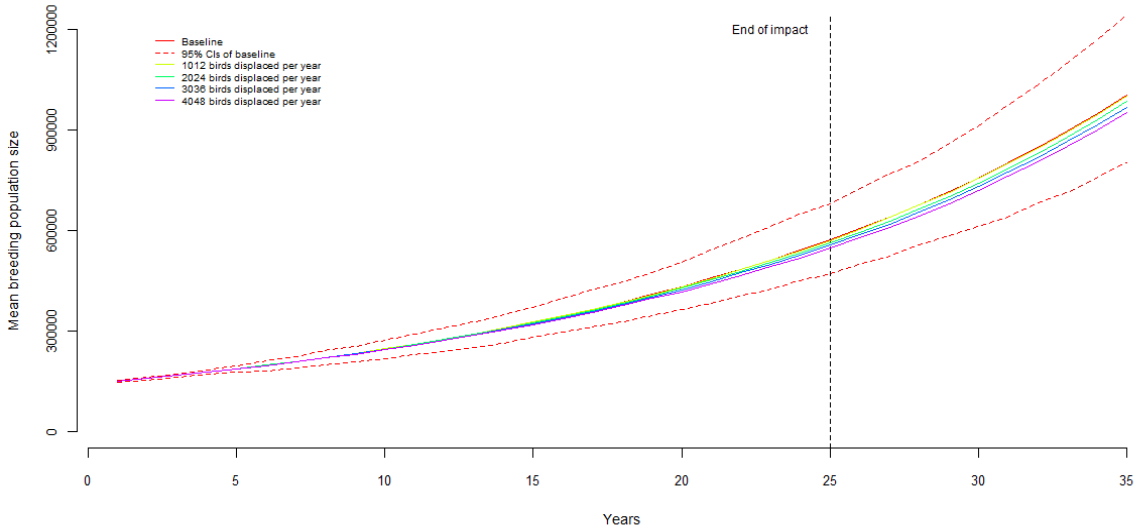


Figure 51. Population projections for the guillemot population at North Caithness Cliffs at different levels of displacement.

Table 59. Modelled probabilities of dropping below current population size for the guillemot population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.021	0.160	574757
Whole site	100%	2869	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.178	558132
Whole site	50%	1434	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.169	566383
Sum of MacColl, Telford & Stevenson	100%	2869	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.178	558132
Sum of MacColl, Telford & Stevenson	50%	1434	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.169	566383
MacColl	100%	1246	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.168	567478
MacColl	50%	623	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.164	571106
Telford	100%	920	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	0.166	569370
Telford	50%	460	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.163	572057
Stevenson	100%	703	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	0.165	570639
Stevenson	50%	351	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.162	572694
MacColl and Stevenson	100%	1948	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.172	563412
MacColl and Stevenson	50%	974	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	0.166	569056
Stevenson and Telford	100%	1623	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.025	0.170	565291
Stevenson and Telford	50%	812	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	0.165	570004
Telford and MacColl	100%	2166	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.174	562160
Telford and MacColl	50%	1083	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.167	568424
BOWL	100%	1179	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.167	567866
BOWL	50%	589	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.164	571301
BOWL and MORL	100%	4048	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.032	0.186	551440
BOWL and MORL	50%	2024	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.173	562978

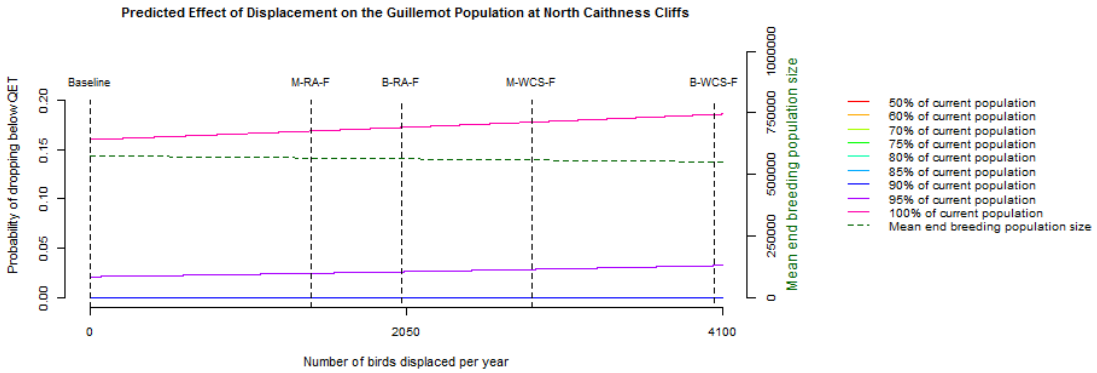


Figure 52. Probability of the guillemot at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

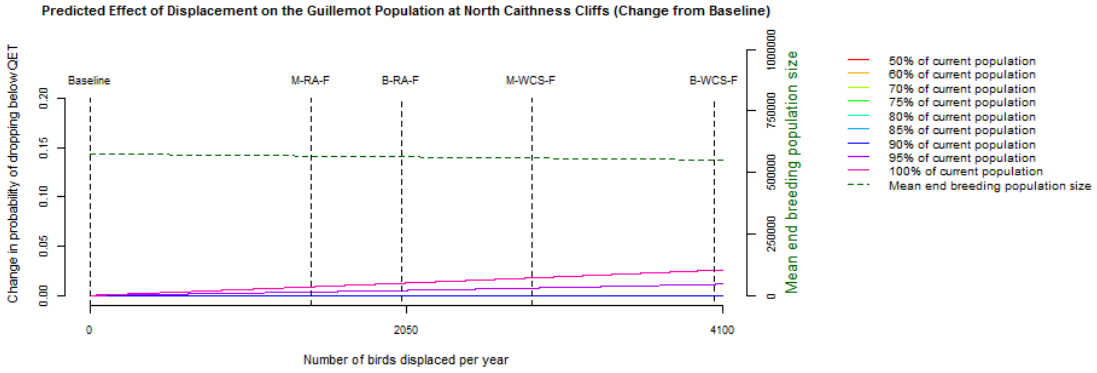


Figure 53. Change in probability of the guillemot population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

Table 60. Modelled probabilities of dropping below current population size for the guillemot population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.021	0.160	574757
Whole site	100%	2869	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.178	558132
Whole site	50%	1434	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.169	566383
Sum of MacColl, Telford & Stevenson	100%	2869	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.178	558132
Sum of MacColl, Telford & Stevenson	50%	1434	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.169	566383
MacColl	100%	1246	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.168	567478
MacColl	50%	623	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.164	571106
Telford	100%	920	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	0.166	569370
Telford	50%	460	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.163	572057
Stevenson	100%	703	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	0.165	570639
Stevenson	50%	351	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.162	572694
MacColl and Stevenson	100%	1948	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.172	563412
MacColl and Stevenson	50%	974	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	0.166	569056
Stevenson and Telford	100%	1623	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.025	0.170	565291
Stevenson and Telford	50%	812	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	0.165	570004
Telford and MacColl	100%	2166	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.174	562160
Telford and MacColl	50%	1083	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.167	568424
BOWL	100%	1179	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.024	0.167	567866
BOWL	50%	589	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.022	0.164	571301
BOWL and MORL	100%	4048	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.032	0.186	551440
BOWL and MORL	50%	2024	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	0.173	562978

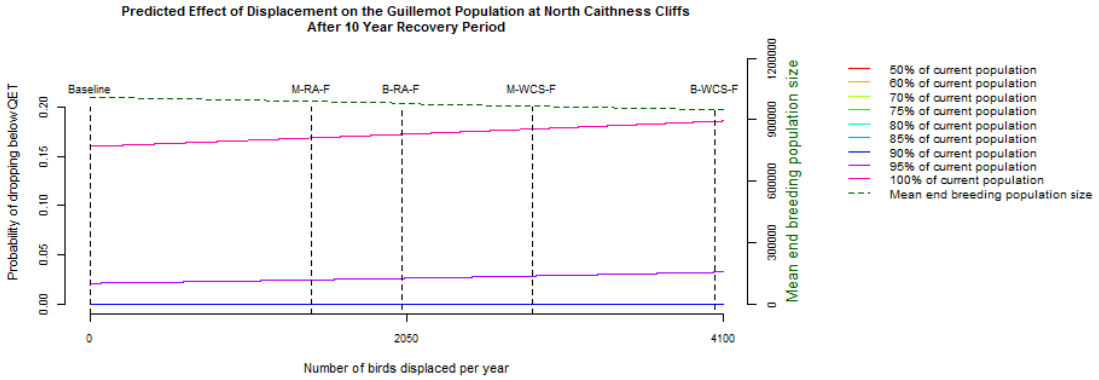


Figure 54. Probability of the guillemot at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

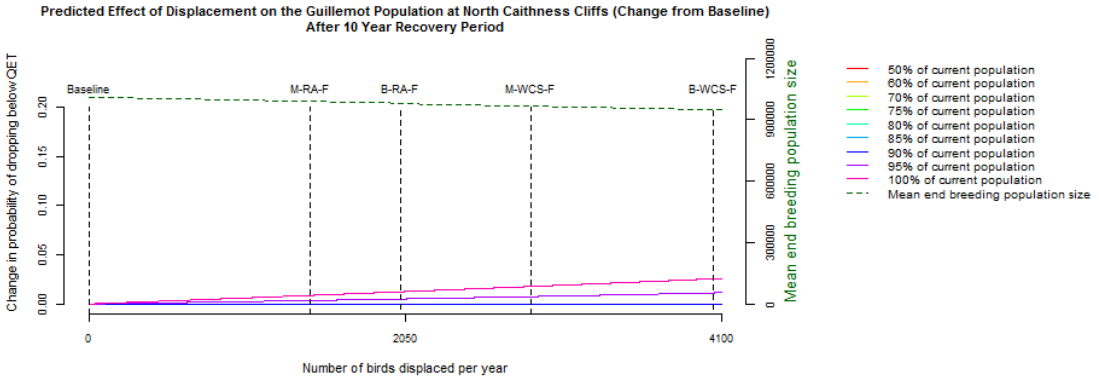


Figure 55. Change in probability of the guillemot population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

6.10 Razorbill – East Caithness Cliffs SPA

The initial population structure for the razorbill population at East Caithness Cliffs SPA is provided in Table 61. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 56. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different displacement rates are shown in Table 62 and Figure 57. The change in probabilities compared to the baseline situation is provided in Figure 58. This information is then repeated in Table 63 and Figures 59-60, but for the 25-year period of the project plus a 10-year recovery period.

Table 61. Initial population structure of the razorbill population at East Caithness Cliffs.

Age Class	Number of Individuals
First year	4928
Second year	4128
Third year	3457
Breeding adult (4 years and greater)	17830

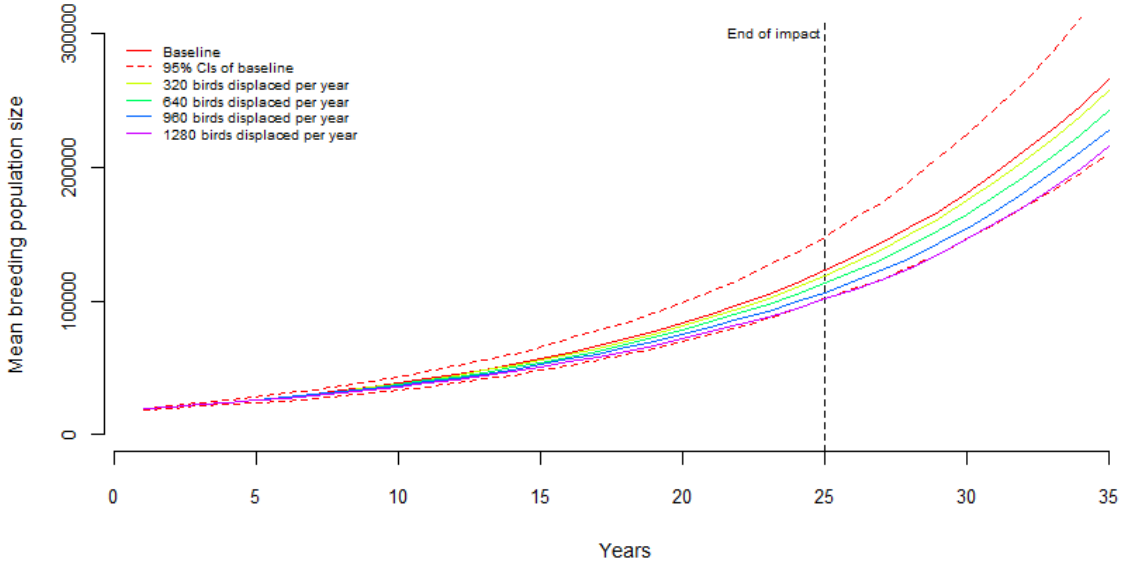


Figure 56. Population projections for the razorbill population at East Caithness Cliffs at different levels of displacement.

Table 62. Modelled probabilities of dropping below current population size for the razorbill population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	123548
Whole site	100%	989.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	106036
Whole site	50%	494.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	114458
Sum of MacColl, Telford & Stevenson	100%	989.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	106036
Sum of MacColl, Telford & Stevenson	50%	494.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	114458
MacColl	100%	460.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	115058
MacColl	50%	230.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	119228
Telford	100%	265.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	118580
Telford	50%	132.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	121039
Stevenson	100%	263.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	118630
Stevenson	50%	131.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	121064
MacColl and Stevenson	100%	723.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	110478
MacColl and Stevenson	50%	361.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	116831
Stevenson and Telford	100%	528.6	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	113860
Stevenson and Telford	50%	264.3	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	118605
Telford and MacColl	100%	726.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	110432
Telford and MacColl	50%	363.3	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	116806
BOWL	100%	287.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	118191
BOWL	50%	143.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	120840
BOWL and MORL	100%	1276.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	101438
BOWL and MORL	50%	638.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	111949

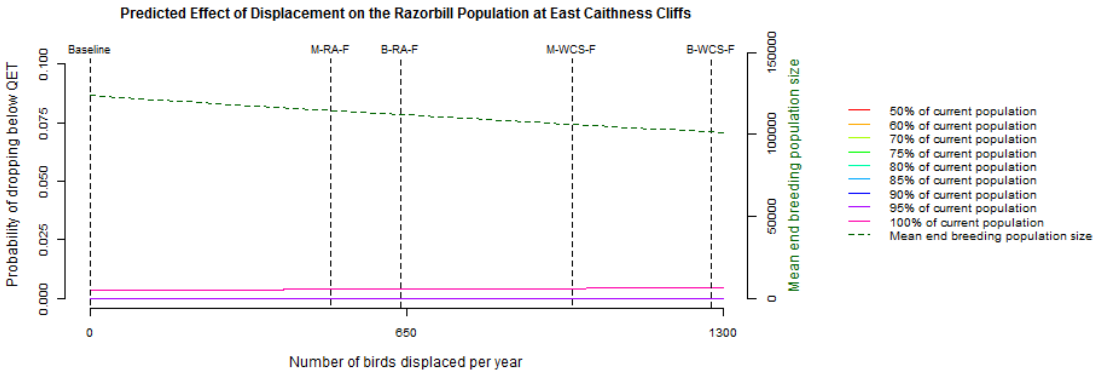


Figure 57. Probability of the razorbill at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

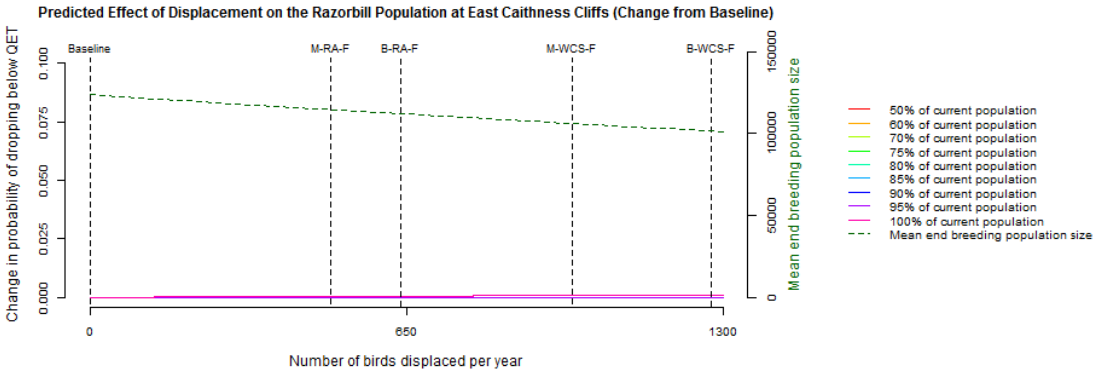


Figure 58. Change in probability of the razorbill population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

Table 63. Modelled probabilities of dropping below current population size for the razorbill population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	268278
Whole site	100%	989.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	226534
Whole site	50%	494.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	246524
Sum of MacColl, Telford & Stevenson	100%	989.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	226534
Sum of MacColl, Telford & Stevenson	50%	494.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	246524
MacColl	100%	460.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	247956
MacColl	50%	230.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	257917
Telford	100%	265.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	256368
Telford	50%	132.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	262256
Stevenson	100%	263.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	256487
Stevenson	50%	131.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	262316
MacColl and Stevenson	100%	723.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	237058
MacColl and Stevenson	50%	361.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	252185
Stevenson and Telford	100%	528.6	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	245100
Stevenson and Telford	50%	264.3	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	256428
Telford and MacColl	100%	726.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	236948
Telford and MacColl	50%	363.3	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	252127
BOWL	100%	287.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	255437
BOWL	50%	143.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	261779
BOWL and MORL	100%	1276.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	215691
BOWL and MORL	50%	638.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	240552

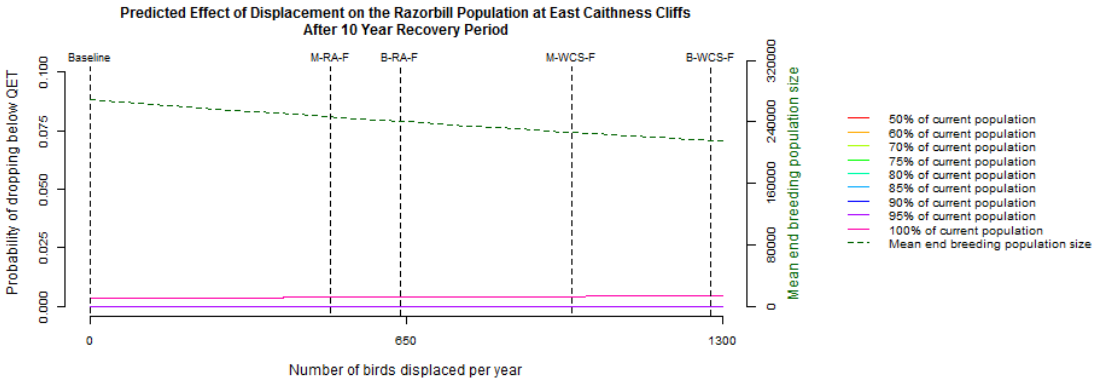


Figure 59. Probability of the razorbill at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

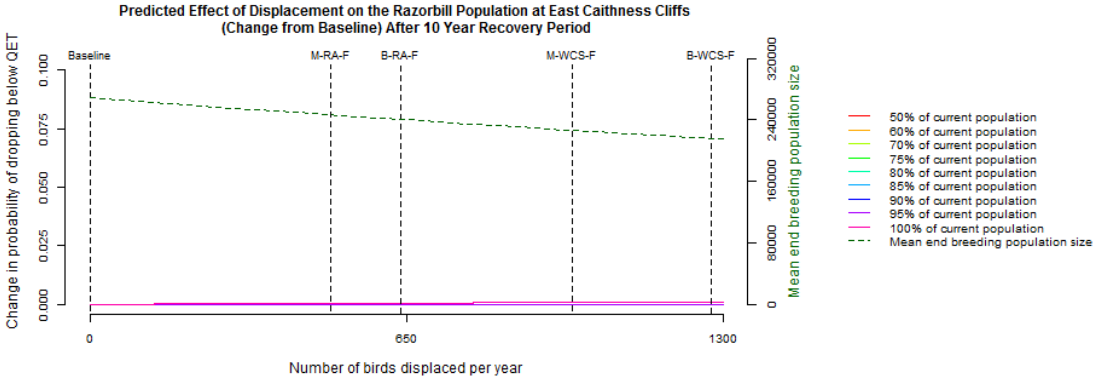


Figure 60. Change in probability of the razorbill population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

6.11 Razorbill – North Caithness Cliffs SPA

The initial population structure for the razorbill population at North Caithness Cliffs SPA is provided in Table 64. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 61. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different displacement rates are shown in Table 65 and Figure 62. The change in probabilities compared to the baseline situation is provided in Figure 63. This information is then repeated in Table 66 and Figures 64-65, but for the 25-year period of the project plus a 10-year recovery period.

Table 64. Initial population structure of the razorbill population at North Caithness Cliffs.

Age Class	Number of Individuals
First year	681
Second year	570
Third year	478
Breeding adult (>4years)	2463

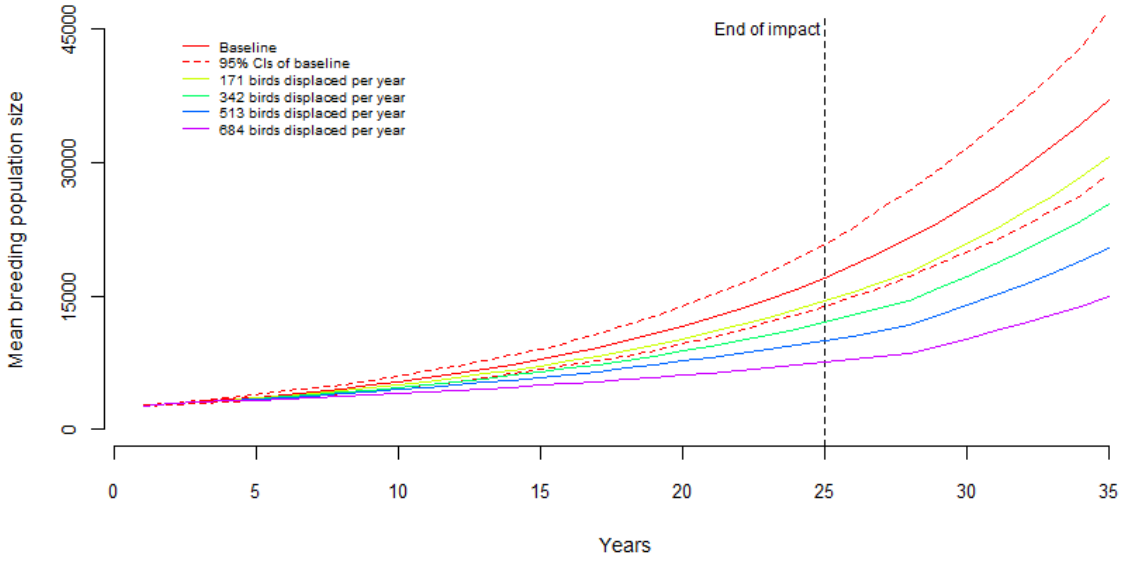


Figure 61. Population projections for the razorbill population at North Caithness Cliffs at different levels of displacement.

Table 65. Modelled probabilities of dropping below current population size for the razorbill population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	17349
Whole site	100%	527.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.061	9032
Whole site	50%	263.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013	12518
Sum of MacColl, Telford & Stevenson	100%	527.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.061	9032
Sum of MacColl, Telford & Stevenson	50%	263.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013	12518
MacColl	100%	245.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	12801
MacColl	50%	122.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	14902
Telford	100%	141.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	14560
Telford	50%	70.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	15893
Stevenson	100%	140.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	14586
Stevenson	50%	70.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	15908
MacColl and Stevenson	100%	386.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	10763
MacColl and Stevenson	50%	193.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	13664
Stevenson and Telford	100%	281.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	12241
Stevenson and Telford	50%	141.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	14573
Telford and MacColl	100%	387.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	10743
Telford and MacColl	50%	193.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	13652
BOWL	100%	153.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	14357
BOWL	50%	76.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	15782
BOWL and MORL	100%	680.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.143	7475
BOWL and MORL	50%	340.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.020	11388

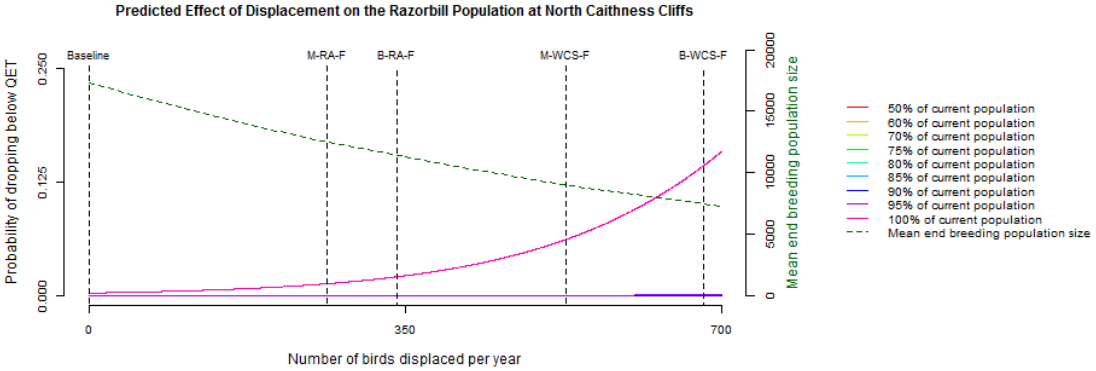


Figure 62. Probability of the razorbill at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

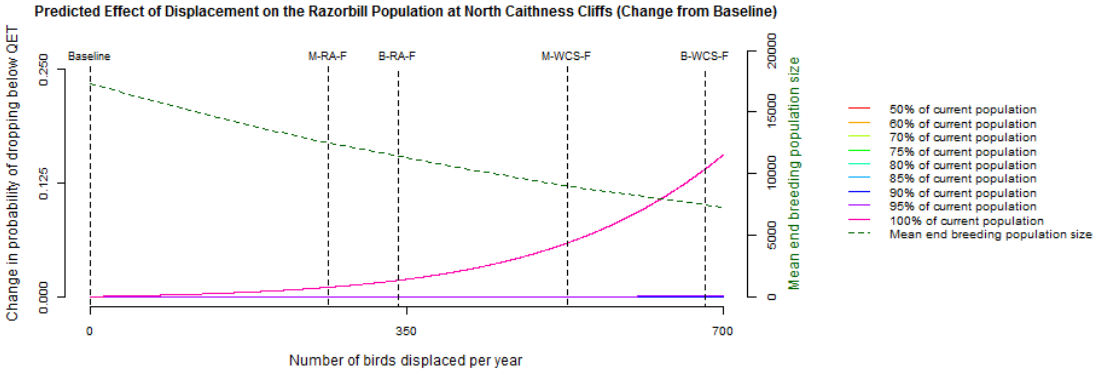


Figure 63. Change in probability of the razorbill population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

Table 66. Modelled probabilities of dropping below current population size for the razorbill population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	37757
Whole site	100%	527.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.061	18352
Whole site	50%	263.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013	26323
Sum of MacColl, Telford & Stevenson	100%	527.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.061	18352
Sum of MacColl, Telford & Stevenson	50%	263.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013	26323
MacColl	100%	245.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	26981
MacColl	50%	122.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	31918
Telford	100%	141.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	31108
Telford	50%	70.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	34271
Stevenson	100%	140.2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	31169
Stevenson	50%	70.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	34305
MacColl and Stevenson	100%	386.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	22274
MacColl and Stevenson	50%	193.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	29000
Stevenson and Telford	100%	281.9	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	25681
Stevenson and Telford	50%	141.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	31139
Telford and MacColl	100%	387.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	22230
Telford and MacColl	50%	193.7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	28971
BOWL	100%	153.0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.007	30629
BOWL	50%	76.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	34007
BOWL and MORL	100%	680.8	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.143	14887
BOWL and MORL	50%	340.4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.020	23708

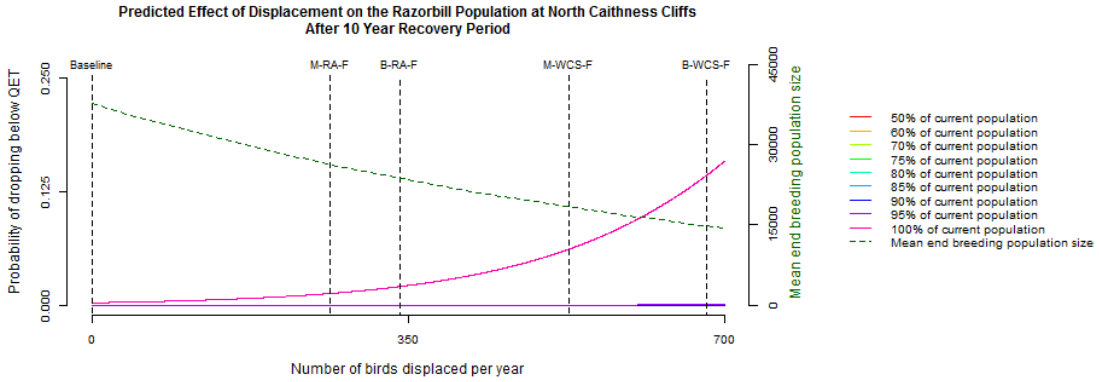


Figure 64. Probability of the razorbill at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

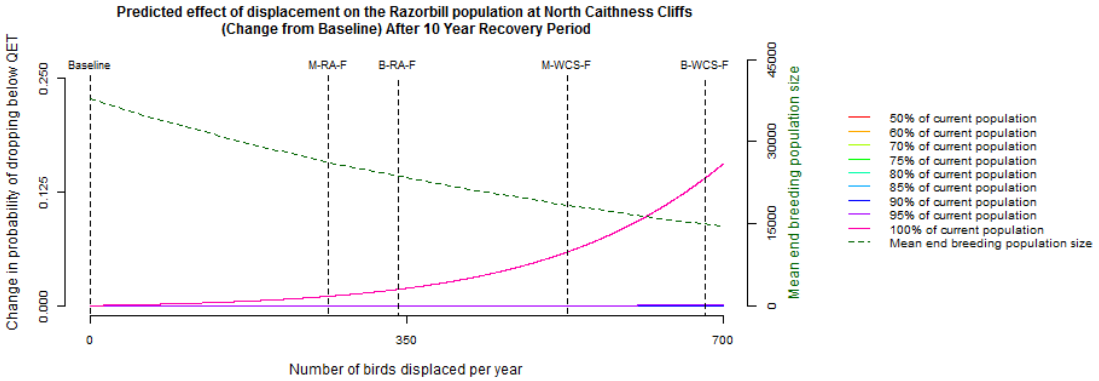


Figure 65. Change in probability of the razorbill population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

6.12 Puffin – East Caithness Cliffs SPA

The initial population structure for the puffin population at East Caithness Cliffs SPA is provided in Table 67. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 66. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different displacement rates are shown in Table 68 and Figure 67. The change in probabilities compared to the baseline situation is provided in Figure 68. This information is then repeated in Table 69 and Figures 69-70, but for the 25-year period of the project plus a 10-year recovery period.

Table 67. Initial population structure of the puffin population at East Caithness Cliffs.

Age Class	Number of Individuals
First year	160
Second year	136
Third year	115
Fourth year	98
Breeding adult (5 years and greater)	548

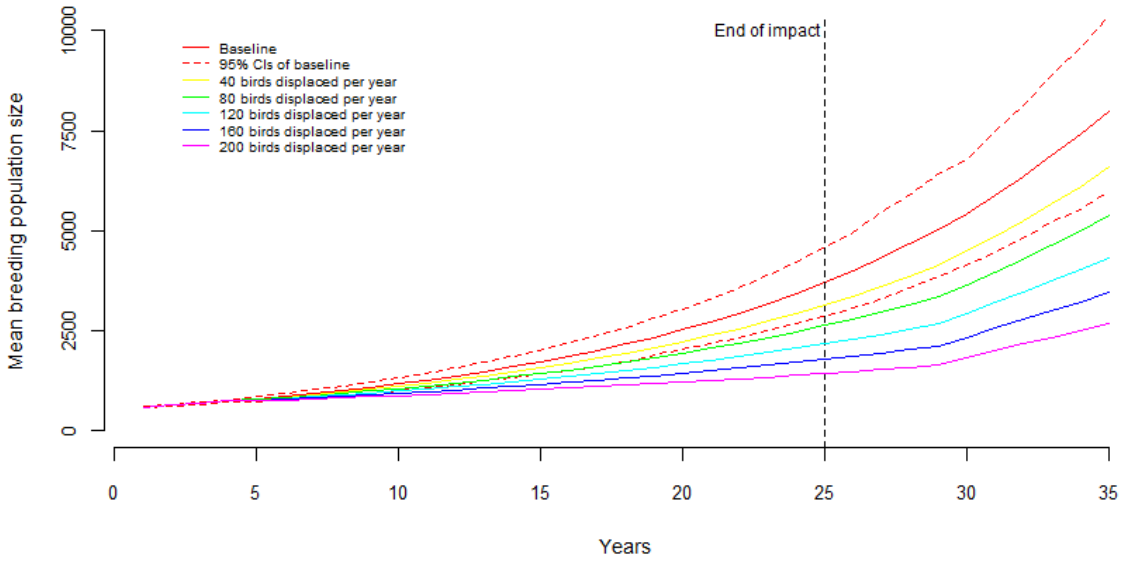


Figure 66. Population projections for the puffin population at East Caithness Cliffs at different levels of displacement.

Table 68. Modelled probabilities of dropping below current population size for the puffin population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	4207
Whole site	100%	159	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.226	1683
Whole site	50%	79	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.039	2668
Sum of MacColl, Telford & Stevenson	100%	159	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.226	1683
Sum of MacColl, Telford & Stevenson	50%	79	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.039	2668
MacColl	100%	138	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.148	1899
MacColl	50%	69	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	2827
Telford	100%	165	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.253	1626
Telford	50%	82	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.042	2623
Stevenson	100%	95	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.057	2433
Stevenson	50%	47	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.018	3209
MacColl and Stevenson	100%	232	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.032	0.637	1105
MacColl and Stevenson	50%	116	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.092	2156
Stevenson and Telford	100%	259	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.151	0.773	946
Stevenson and Telford	50%	130	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.125	1989
Telford and MacColl	100%	302	<0.001	<0.001	<0.001	0.002	0.013	0.049	0.269	0.726	0.908	738
Telford and MacColl	50%	151	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.193	1762
BOWL	100%	38	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.015	3380
BOWL	50%	19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	3771
BOWL and MORL	100%	197	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.426	1352
BOWL and MORL	50%	98	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.061	2392

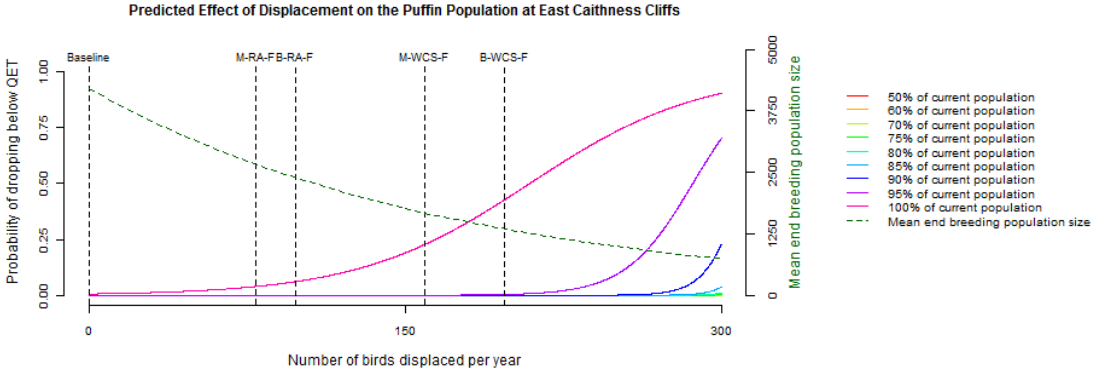


Figure 67. Probability of the puffin at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

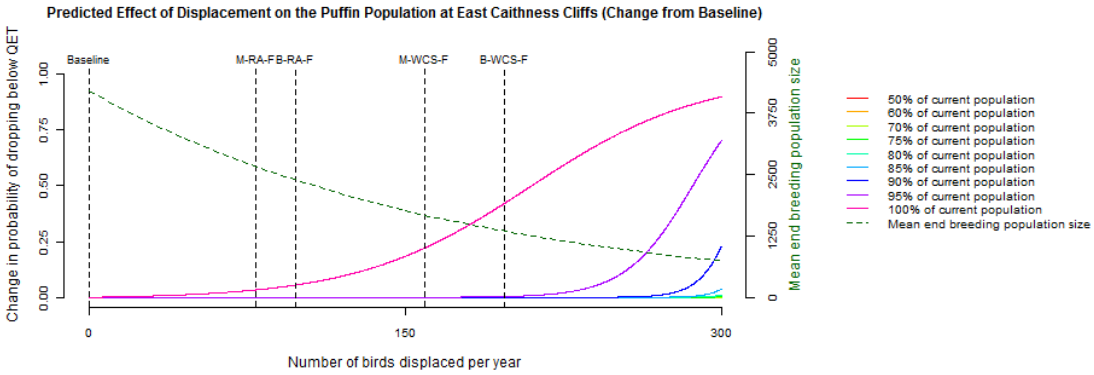


Figure 68. Change in probability of the puffin population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

Table 69. Modelled probabilities of dropping below current population size for the puffin population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	9209
Whole site	100%	159	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.226	3241
Whole site	50%	79	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.039	5481
Sum of MacColl, Telford & Stevenson	100%	159	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.226	3241
Sum of MacColl, Telford & Stevenson	50%	79	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.039	5481
MacColl	100%	138	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.148	3720
MacColl	50%	69	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	5853
Telford	100%	165	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.253	3116
Telford	50%	82	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.042	5374
Stevenson	100%	95	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.057	4934
Stevenson	50%	47	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.018	6763
MacColl and Stevenson	100%	232	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.032	0.637	2007
MacColl and Stevenson	50%	116	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.092	4299
Stevenson and Telford	100%	259	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.151	0.773	1681
Stevenson and Telford	50%	130	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.125	3921
Telford and MacColl	100%	302	<0.001	<0.001	<0.001	0.002	0.013	0.049	0.269	0.726	0.908	1267
Telford and MacColl	50%	151	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.193	3416
BOWL	100%	38	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.015	7175
BOWL	50%	19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	8128
BOWL and MORL	100%	197	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.426	2525
BOWL and MORL	50%	98	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.061	4838

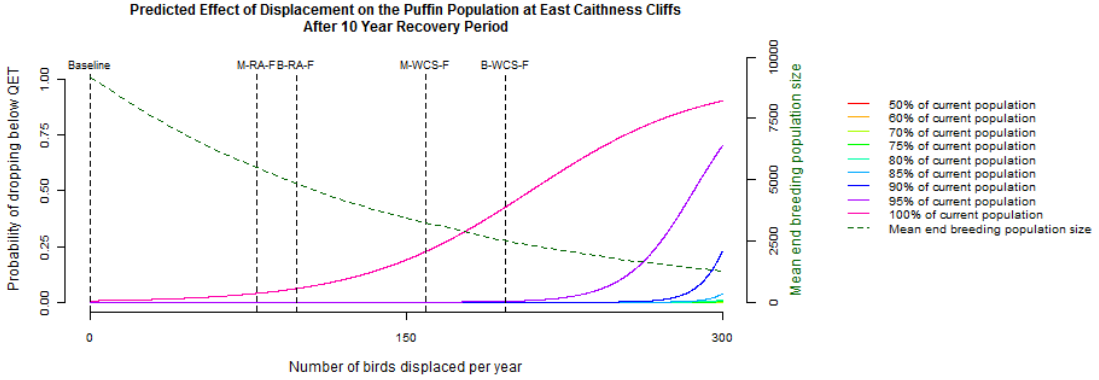


Figure 69. Probability of the puffin at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

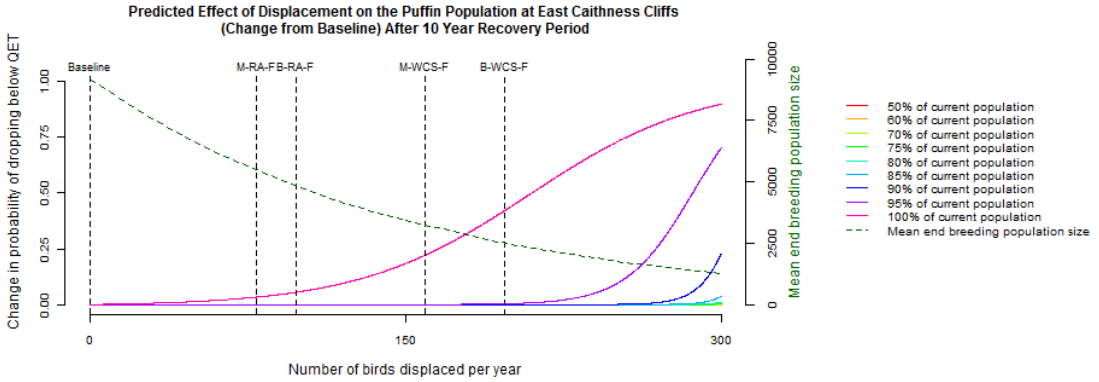


Figure 70. Change in probability of the puffin population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

6.13 Puffin – North Caithness Cliffs SPA

The initial population structure for the puffin population at North Caithness Cliffs SPA is provided in Table 70. A graph showing the projected population estimates based on the PVA model, over a 35 year period for this population is provided in Figure 71. The probabilities of the population dropping below the current population size, during the 25-year period of the project, at different displacement rates are shown in Table 71 and Figure 72. The change in probabilities compared to the baseline situation is provided in Figure 73. This information is then repeated in Table 72 and Figures 74-75, but for the 25-year period of the project plus a 10-year recovery period.

Table 70. Initial population structure of the puffin population at North Caithness Cliffs.

Age Class	Number of Individuals
First year	4124
Second year	3499
Third year	2968
Breeding adult (4 years and greater)	2518

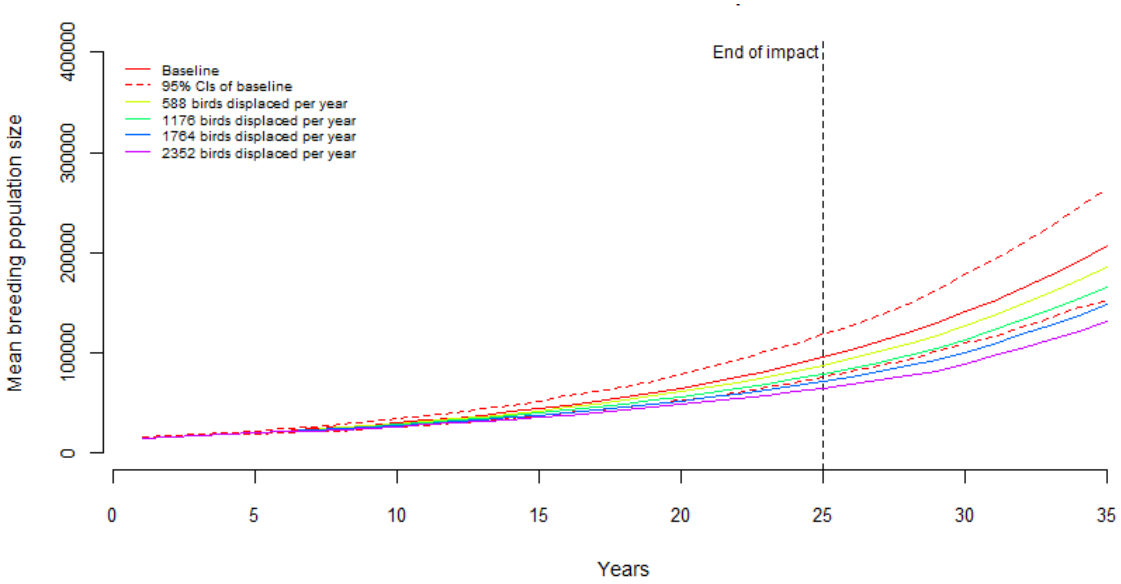


Figure 71. Population projections for the puffin population at North Caithness Cliffs at different levels of displacement.

Table 71. Modelled probabilities of dropping below current population size for the puffin population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	96443
Whole site	100%	1587	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.058	73475
Whole site	50%	794	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037	84172
Sum of MacColl, Telford & Stevenson	100%	1587	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.058	73475
Sum of MacColl, Telford & Stevenson	50%	794	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037	84172
MacColl	100%	468	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	89009
MacColl	50%	234	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	92652
Telford	100%	559	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.032	87632
Telford	50%	280	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	91924
Stevenson	100%	322	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	91265
Stevenson	50%	161	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	93818
MacColl and Stevenson	100%	790	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037	84230
MacColl and Stevenson	50%	395	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.029	90130
Stevenson and Telford	100%	881	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.039	82926
Stevenson and Telford	50%	440	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.030	89437
Telford and MacColl	100%	1028	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.042	80863
Telford and MacColl	50%	514	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	88310
BOWL	100%	763	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.036	84621
BOWL	50%	382	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.029	90331
BOWL and MORL	100%	2350	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.087	64468
BOWL and MORL	50%	1176	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.046	78838

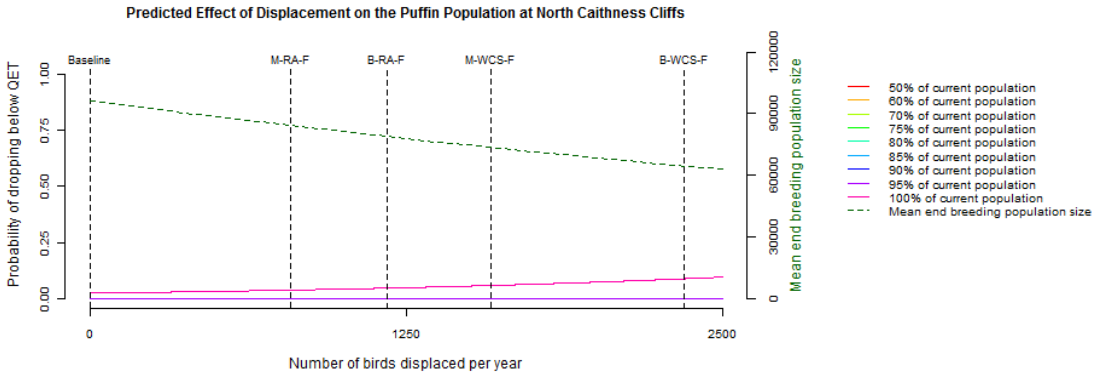


Figure 72. Probability of the puffin at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

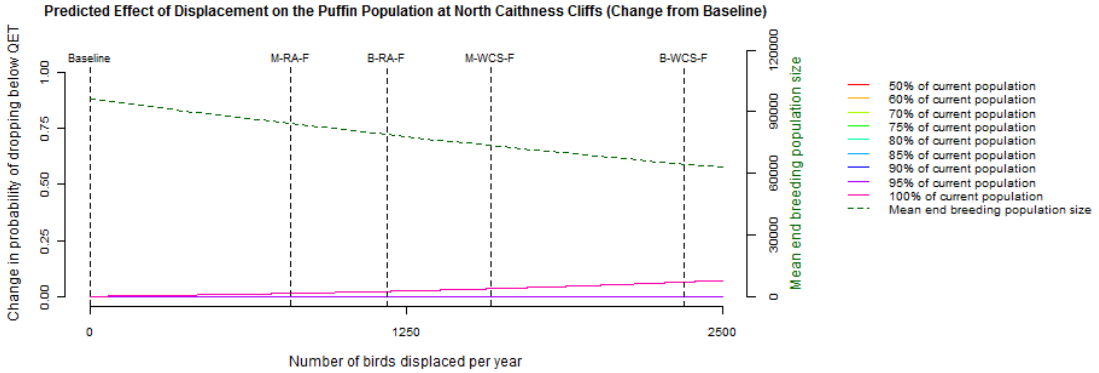


Figure 73. Change in probability of the puffin population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

Table 72. Modelled probabilities of dropping below current population size for the puffin population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.023	207811
Whole site	100%	1587	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.058	152441
Whole site	50%	794	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037	177968
Sum of MacColl, Telford & Stevenson	100%	1587	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.058	152441
Sum of MacColl, Telford & Stevenson	50%	794	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037	177968
MacColl	100%	468	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	189664
MacColl	50%	234	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	198531
Telford	100%	559	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.032	186324
Telford	50%	280	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.027	196756
Stevenson	100%	322	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.028	195149
Stevenson	50%	161	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	201381
MacColl and Stevenson	100%	790	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037	178108
MacColl and Stevenson	50%	395	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.029	192387
Stevenson and Telford	100%	881	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.039	174971
Stevenson and Telford	50%	440	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.030	190704
Telford and MacColl	100%	1028	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.042	170021
Telford and MacColl	50%	514	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.031	187969
BOWL	100%	763	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.036	179049
BOWL	50%	382	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.029	192876
BOWL and MORL	100%	2350	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.087	131342
BOWL and MORL	50%	1176	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.046	165178

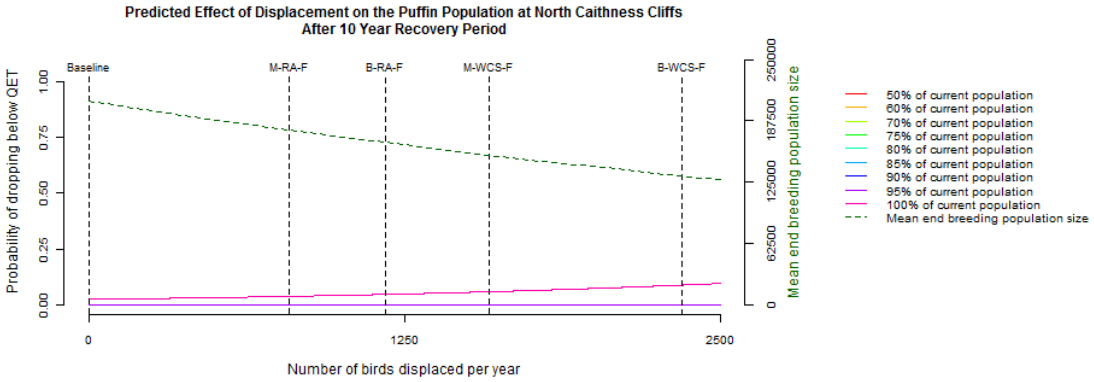


Figure 74. Probability of the puffin at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

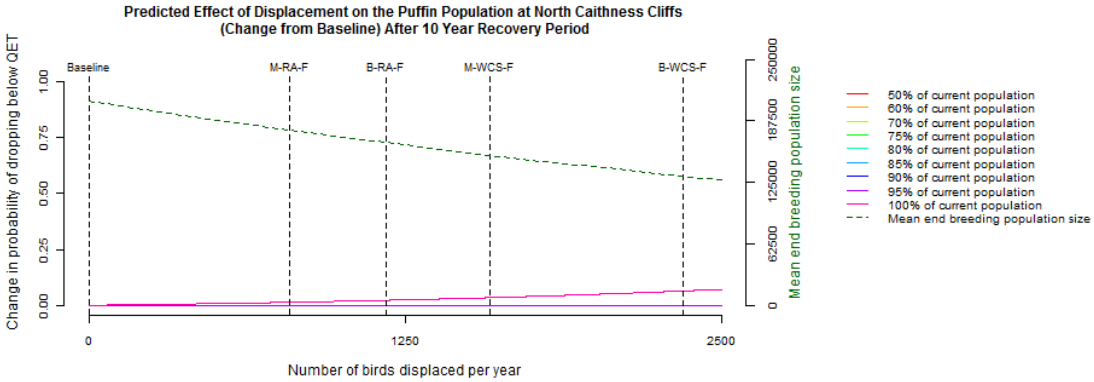


Figure 75. Change in probability of the puffin population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period). M-RA-F and M-WCS-F highlight the displacement rates for the three wind farm sites at 50 and 100% displacement, respectively. B-RA-F and B-WCS-F highlight the cumulative displacement rates at 50 and 100% displacement, respectively.

7 Analysis of PVA Outputs

The EIA methodology is described in the ES in Section 7.4.4, with the approach for the cumulative impact assessment provided in Section 14.4.4. The PVA outputs (Section 6) have been considered to identify whether the assessments presented in the ES would change, particularly in light of the adoption of Option 3 of Band model (2012) in combination with the other refinements to the methodologies as described in section 4. This section provides the following:

- A comparison of the population projections for different levels of displacement or collision, relative to the baseline predictions (i.e. without the three wind farms present);
- An assessment on the species arising from the three proposed wind farm sites, and whether this differs from the assessments in Table 7.4-13 of the ES; and
- An assessment on the species arising from the three proposed wind farm sites cumulatively with the BOWL wind farm, and whether this differs from the assessments in Table 14.4-7 of the ES.

The assessment criteria used in the ES has adopted in the analysis presented in this Report. An option of 'minor to moderate' has been added to the assessment options used in the ES to describe situations that are between the 'minor' or 'moderate' criteria. The criteria are summarised below:

- An effect has been assessed as 'minor' if there is a < 10 % increase in the likelihood of a 10 % population reduction, or in the event that no assessment is possible on the likelihood of a 10 % population reduction then a < 5 % increase in the likelihood of a 20 % population reduction.
- An effect has been assessed as 'minor to moderate' if there is a < 10 % increase in the likelihood of a 10 % population reduction, a > 5 % increase in the likelihood of a 20% population reduction and a < 2 % increase in the likelihood of a 50% population.
- An effect has been assessed as 'moderate' if there is a > 10 % increase in the likelihood of a 10 % population reduction, but a < 5 % increase in the likelihood of a 20% population reduction.
- An effect has been assessed as 'moderate-high' if there is a > 5 % increase in the likelihood of a 20 % population reduction.

7.1 Fulmar

The projected fulmar population estimates for East Caithness Cliffs SPA and North Caithness Cliffs SPA, based on different levels of collision, are shown in Figures 11 and 16 respectively. These show that the projected population sizes for the populations based on a range of collisions per year (2-8 for East Caithness Cliffs SPA and 3-10 for North Caithness Cliffs SPA) are very similar. They are also within the 95% confidence limits of the baseline estimate, so therefore there is no statistically significant difference from the projected population estimates with no collisions.

The outputs of the population viability analysis for North Caithness Cliffs SPA and East Caithness Cliffs SPA are summarised in Table 73 (the summary is the same for both SPAs). There would not be a change to the assessment for this species for displacement and collision ('minor') compared to that provided in the ES, either for the three proposed wind farm sites alone or as part of the cumulative impact assessment.

Table 73. Results of population viability analysis for fulmar for North Caithness Cliffs SPA and East Caithness Cliffs SPA.

Site	Results at 98.0% avoidance rate	
Whole site	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
Sum of secondary assessments	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
BOWL	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
MORL whole site + BOWL	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor

7.2 Gannet

The projected gannet population size for Troup Head based on different levels of collision is shown in Figure 21. This shows that the projected population sizes for the population based on a range of 21-84 collisions per year. At 42 collisions per year the population is stable, above which a decline in population size is shown over the 25-year period. At 35 years, however, the population predictions are for the rise again at a steady rate, showing that the population is able to recover even at 84 collisions per year.

The outputs of the population viability analysis for Troup Head are summarised in Table 74. The refinement to the collision risk model (i.e. use of the option 3; see Section 4.2) would change the assessment for this species for the three proposed wind farm sites to '**minor**' compared to 'moderate' in the ES. The cumulative impact assessment would also change to '**minor'** from 'moderate to high' in the ES.

Table 74. Results of population viability analysis for gannet for Troup Head.

Site	Results at 99.5% avoidance rate	
Whole site	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
Sum of secondary assessments	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
BOWL	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
MORL whole site + BOWL	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor

7.3 Kittiwake

The projected kittiwake population estimates for East Caithness Cliffs SPA and North Caithness Cliffs SPA, based on different levels of collision, are shown in Figures 26 and 31 respectively. This show that

the projected population sizes for the populations based on a range of collisions per year (23-92 for East Caithness Cliffs SPA and 16-64 for North Caithness Cliffs SPA) are very similar. They are also within the 95% confidence limits of the baseline estimate, so therefore there is no statistically significant difference from the projected population estimates with no collisions.

The outputs of the population viability analysis for North Caithness Cliffs SPA and East Caithness Cliffs SPA are summarised in Table 75 (the summary is the same for both SPAs). There would be no change to the assessment for this species ('**minor**') compared to that provided in the ES, either for the three proposed wind farm sites alone or as part of the cumulative impact assessment.

Table 75. Results of population viability analysis for kittiwake for North Caithness Cliffs SPA and East Caithness Cliffs SPA.

Site	Results at 99.0% avoidance rate	
Whole site	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
Sum of secondary assessments	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
BOWL	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
MORL whole site + BOWL	No assessment possible on the likelihood of a 10% population decrease <5% increase in the likelihood of a 20% population decrease at 25 years >2% increase in the likelihood of a 50% population decrease at 25 years	Minor

7.4 Herring gull

The projected herring gull population size for East Caithness Cliffs SPA based on different levels of collision is shown in Figure 37. This shows that the projected population sizes for the population based on a range of 17-68 collisions per year are very similar and within the 95% confidence limits of the baseline estimate, so therefore there is no statistically significant difference from the projected population estimate with no collisions.

The outputs of the population viability analysis for East Caithness Cliffs SPA are summarised in Table 76. The refinement to the collision risk model (i.e. use of the option 3; see Section 4.2) would change the assessment for this species for the three proposed wind farms alone to '**minor**' compared to 'moderate' in the ES. The cumulative impact assessment would also change to '**minor to moderate'** from 'moderate to high' in the ES.

Table 76. Results of population viability analysis for herring gull for East Caithness Cliffs SPA.

Site	Results at 98.5% avoidance rate	
Whole site	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
Sum of secondary assessments	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor

Site	Results at 98.5% avoidance rate	
BOWL	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
MORL whole site + BOWL	<10% increase in the likelihood of a 10% population decrease at 25 years >5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor to moderate

7.5 Great black-backed gull

The projected great black-backed gull population size for East Caithness Cliffs SPA based on different levels of collision is shown in Figure 41. This shows that the projected population sizes for the population based on a range of 25-100 collisions per year. At 75 collisions and greater per year there is a small decline in population size is shown over the 25-year period; for rates of collisions below this the population increases during this period. At 35 years, however, the population predictions are for the rise again at a steady rate, showing that the population is able to recover even at 100 collisions per year. As described in Section 5, carrying capacity has not been included in these models, which means that the population projections, particularly for the 25-35 year period, will be much higher than would be expected; emphasising that these models are best used as a comparative tool.

The outputs of the population viability analysis for East Caithness Cliffs SPA are summarised in Table 77. There would be no change to the assessment for this species compared to that provided in the ES, either for the three proposed wind farm sites alone ('**minor**') or as part of the cumulative impact assessment ('**moderate to high'**). The 'moderate to high' assessment for this species would be due mainly to the level of collisions predicted for the BOWL site, with 75% predicted to occur at the BOWL site.

Table 77. Results of population viability analysis for great black-backed gull for East Caithness Cliffs SPA.

Site	Results at 98.5% avoidance rate	
Whole site	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
Sum of secondary assessments	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
BOWL	>10% increase in the likelihood of a 10% population decrease at 25 years >5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Moderate to high
MORL whole site + BOWL	>10% increase in the likelihood of a 10% population decrease at 25 years >5% increase in the likelihood of a 20% population decrease at 25 years >2% increase in the likelihood of a 50% population decrease at 25 years	Moderate to high

7.6 Guillemot

The projected guillemot population estimates for East Caithness Cliffs SPA and North Caithness Cliffs SPA, based on different levels of displacement, are shown in Figures 46 and 51 respectively. These shows that the projected population sizes based on a range of displacement (pairs failing to breed)

per year (1215-4800 for East Caithness Cliffs SPA and 1012-4048 for North Caithness Cliffs SPA) are very similar. They are also within the 95% confidence limits of the baseline estimate, so therefore there is no statistically significant difference from the projected population estimates with no displacement.

The outputs of the population viability analysis for North Caithness Cliffs SPA and East Caithness Cliffs SPA are summarised in Table 78 (the summary is the same for both SPAs). There would be no change to the assessment for this species ('**minor**') compared to that provided in the ES, either for the three proposed wind farm sites alone or as part of the cumulative impact assessment.

Table 78. Results of population viability analysis for guillemot for North Caithness Cliffs SPA and East Caithness Cliffs SPA.

Site	Results	
Whole site	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
Sum of secondary assessments	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
BOWL	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
MORL whole site + BOWL	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor

7.7 Razorbill

The projected razorbill population estimates for East Caithness Cliffs SPA, based on different levels of displacement, is shown in Figure 56. This shows that the projected population sizes based on a range of displacement (pairs failing to breed) per year (270-1282) are very similar. They are also within the 95% confidence limits of the baseline estimate, so therefore do not significantly differ from the projected population estimates with no displacement.

The projected razorbill population estimates for North Caithness Cliffs SPA, based on different levels of displacement, is shown in Figure 57. This shows that the projected population sizes for the population based on a range of 171-684 individuals being displaced per year (and failing to breed in the current year). At a displacement level of 171 individuals, the population projection is within the 95% confidence limits of the baseline estimate, so therefore there is no statistically significant difference from the projected population estimates with no displacement. At higher levels of displacement, the population is still shown to be increasing. After 25 years, the population growth rates are then predicted to increase again.

The outputs of the population viability analysis for North Caithness Cliffs SPA and East Caithness Cliffs SPA are summarised in Table 79 (the summary is the same for both SPAs). There would be no change to the assessment for this species ('**minor**') compared to that provided in the ES, either for the three proposed wind farm sites alone or as part of the cumulative impact assessment.

Table 79. Results of population viability analysis for razorbill for North Caithness Cliffs SPA and East Caithness Cliffs SPA.

Site	Results	
Whole site	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
Sum of secondary assessments	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
BOWL	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
MORL whole site + BOWL	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor

7.8 Puffin

The projected puffin population estimates for East Caithness Cliffs SPA, based on different levels of displacement, are shown in Figure 66. This shows that the projected population sizes based on a range of 40-200 individuals being displaced per year (and failing to breed in the current year). At a displacement level of 40 individuals, the population projection is within the 95% confidence limits of the baseline estimate, so therefore there is no statistically significant difference from the projected population estimates with no displacement. At higher levels of displacement the population is still shown to be increasing. After 25 years, the population growth rates are then predicted to increase again.

The projected puffin population estimates for North Caithness Cliffs SPA, based on different levels of displacement, are shown in Figure 71. This shows that the projected population sizes for the population based on a range of 480-2300 individuals being displaced per year (and failing to breed in the current year). At displacement levels of 588 and 2352 individuals, the population projection is within the 95% confidence limits of the baseline estimate, so therefore do not significantly differ from the projected population estimates with no displacement. At levels of displacement of 1725 and greater, the population is still shown to be increasing. After 25 years, the population growth rates are then predicted to increase again.

The outputs of the population viability analysis for North Caithness Cliffs SPA and East Caithness Cliffs SPA are summarised in Table 80 (the summary is the same for both SPAs). There would be no change to the assessment for this species ('**minor**') compared to that provided in the ES, either for the three proposed wind farm sites alone or as part of the cumulative impact assessment.

Table 80. Results of population viability analysis for puffin for North Caithness Cliffs SPA and East Caithness Cliffs SPA.

Site	Results	
Whole site	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
Sum of secondary assessments	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor

Site	Results	
BOWL	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor
MORL whole site + BOWL	<10% increase in the likelihood of a 10% population decrease at 25 years <5% increase in the likelihood of a 20% population decrease at 25 years <2% increase in the likelihood of a 50% population decrease at 25 years	Minor

Given the above analysis of outputs for the North Caithness Cliffs SPA and East Caithness Cliffs SPA that would result in an assessment of 'minor', it was determined that a quantitative assessment using PVA was not required for puffins at the Hoy SPA, as per JNCC and SNH advice. A qualitative assessment has therefore been carried out, with reference to the PVAs for the North Caithness Cl iffs SPA and the East Caithness Cliffs SPA colonies. Given that the Hoy SPA is at a further distance from the three proposed wind farms to the former two SPAs would be predicted to be '**minor**' at worst.

7.9 Whole Project Assessment

As described in Chapter 12.1.10 of the ES, the overall assessment for the Whole Project (the three proposed wind farms plus TI) will be the same as the three proposed wind farms on their own, i.e. the TI does not increase the significance of any impacts on birds.

7.10 Habitats Regulations Appraisal

Information to support the AA is contained in the ES. The methodology as described in Section 7.4.5 remains the same other than that advice has been provided by SNH/JNCC/MSS that a conclusion of no LSE has now been made for all SPAs other than East Caithness Cliffs SPA, North Caithness Cliffs SPA, and Hoy SPA (confirmation provided via email on the 14/02/13).

There would be no change to the assessments made in Section 7.4.14 for the three proposed wind farms alone, with the conclusion remaining the same that there will be no effects on the Conservation Objectives of these SPAs, and therefore no change to the population viability of the designated species.

In combination with other plans and projects, the ES (Section 14.4.7) predicted an effect on the Conservation Objectives of the East Caithness Cliffs SPA due to an increase in mortality of herring gull and great black-backed gull arising cumulatively with BOWL wind farm. Due to the change of the collision risk model used, no impact would be predicted on herring gull that would affect the species viability within the SPA. There would still be such an effect predicted for great black-backed gull, being that an effect would still be predicted on site integrity for the East Caithness Cliffs SPA to arise cumulatively with the BOWL wind farm.

There would be no further changes to the in-combination assessments to SPAs compared to that made in the ES (Section 14.4.7), i.e. there is the conclusion of no effects on the Conservation Objectives of North Caithness Cliffs SPA or Hoy SPA.

8 Summary and Conclusions

8.1 Primary Impact Assessment

There would be no change to any of the overall assessments for the three proposed wind farm sites alone (all of '**no significant effects predicted'**) compared to those made in the ES (Table 81).

For gannet and herring gull the risk to collision during operation would be refined to '**minor**' from 'moderate'; there would be no change made to any of the risk assessments made in the ES for the other species (fulmar, kittiwake, great black-backed gull, guillemot, razorbill and puffin).

Table 81. Summary of likely significant effects from the three proposed wind farm sites.

Species	Summary
Fulmar	Assessment as per ES ('minor'): no significant effect predicted.
Gannet	Refinement of collision risk assessment would change the assessment to 'minor' from 'moderate' in the ES; no change in overall prediction of significant effect.
Kittiwake	Assessment as per ES ('minor'): no significant effect predicted.
Herring gull	Refinement of collision risk assessment would change the assessment to 'minor' from 'moderate' in the ES; no change in overall prediction of significant effect.
Great black-backed gull	Assessment as per ES ('minor'): no significant effect predicted.
Guillemot	Assessment as per ES ('minor'): no significant effect predicted.
Razorbill	Assessment as per ES ('minor'): no significant effect predicted.
Puffin	Assessment as per ES ('minor'): no significant effect predicted.

8.2 Cumulative Impact Assessment

There would be no change to any of the overall cumulative impact assessment of '**no significant effects predicted**', compared to those made in the ES, for the following species:

- Fulmar
- Kittiwake
- Guillemot
- Razorbill
- Puffin

There would also be no change to the overall cumulative impact assessment of '**significant effects predicted**', compared to that made in the ES, for:

- Great black-backed gull (with the majority of the impact – 75% - coming from the BOWL sites).

There would be the following changes to the overall cumulative impact assessments, compared to those made in the ES, for the following species:

- The overall impact assessment for gannet would be refined to '**minor**' from '**moderate to high**' due to the change of the collision risk model used.
- The overall impact assessment for herring gull would be refined to '**minor to moderate**' from '**moderate to high**' due to the change of the collision risk model used.

The above is summarised in Table 82.

Table 82. Cumulative impact summary.

Species	Summary
Fulmar	Assessment as per ES ('minor'): no significant effect predicted.
Gannet	Refinement of collision risk assessment would change the assessment to 'minor' from 'moderate to high' in the ES; change to overall prediction of no significant effect.
Kittiwake	Assessment as per ES ('minor'): no significant effect predicted.
Herring gull	Refinement of collision risk assessment would change the assessment to 'minor to moderate' from 'moderate to high' in the ES; change to overall prediction of no significant effect.
Great black-backed gull	Assessment as per ES ('moderate to high'): significant effect predicted.
Guillemot	Assessment as per ES ('minor'): no significant effect predicted.
Razorbill	Assessment as per ES ('minor'): no significant effect predicted.
Puffin	Assessment as per ES ('minor'): no significant effect predicted.

8.3 Whole Project

As described in Chapter 12.1.10 of the ES, the overall assessment for the Whole Project (the three proposed wind farms plus TI) would be the same as the three proposed wind farms on their own, i.e. the TI would not increase the significance of any impacts on birds.

8.4 Habitats Regulations Appraisal

JNCC, SNH and MSS have determined that the assessment of no LSE has now been made for all SPAs other than East Caithness Cliffs SPA, North Caithness Cliffs SPA and Hoy SPA. For the three proposed wind farm sites alone there would be the conclusion of no effects on the Conservation Objectives, and therefore site integrity, for these three SPAs. For the three proposed wind farm sites in combination with other plans and projects, particularly the BOWL wind farm, there would be the conclusion of:

- no effects on the Conservation Objectives, and therefore site integrity, for North Caithness Cliffs SPA and Hoy SPA; and
- an effect on the Conservation Objectives, and therefore site integrity, for East Caithness Cliffs SPA due to an increase in collision mortality on great black-backed gull, with 25 % of these collisions predicted from the three proposed wind farm sites and 75 % from the BOWL wind farm site.

9 References

Band, B. 2012. Using a collision risk model to assess bird collision risks for offshore windfarms. The Crown Estate Strategic Ornithological Support Services. Project SOSS-02.

Birkhead, T.R. & Hudson, P.J. 1977. Population Parameters for the Common Guillemot *Uria aalge*. Ornis Scandinavica 8 (2) 145-154.

Camphuysen, K. J., Fox, A. D., Leopold, M. F. and Petersen, I. K. 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K.: a comparison of ship and aerial sampling methods for marine birds, and their applicability to offshore wind farm assessments. NIOZ report to COWRIE (BAM - 02-2002).

Cook, A.S.C.P., Johnston, A., Wright, L.J. and Burton, N.H.K. 2012. A review of flight heights and avoidance rates of birds in relation to offshore windfarms. The Crown Estate Strategic Ornithological Support Services. Project SOSS-02.

Cook, A.S.C.P. and Robinson, R.A. 2010. How representative is the current monitoring of breeding success in the UK? BTO Research Report No. 573, BTO, Thetford.

Coulson, J. C. & White, E. 1959. The post-fledging mortality of the kittiwake. Bird Study 6 (3): 97-102.

Craik, C. (1997) Long-term effects of North American Mink *Mustela vison* on seabirds in western Scotland. Bird Study 44, 303-309.

Frederiksen, M., Wanless, S., Harris, M. P., Rothery, P., & Wilson, L. J. 2004. The role of industrial fisheries and oceanographic change in the decline of North Sea black‐legged kittiwakes. Journal of Applied Ecology, 41: 1129-1139.

Garthe, S. & Huppop, O. 1994. Distribution of ship-following seabirds and their utilisation of discards in the North Sea in summer. Marine Ecology Progress Series 106: 1-9.

Harris, M.P., Frederiksen, M. & Wanless, S. 2007. Within- and between-year variation in the juvenile survival of common guillemots *Uria aalge* Ibis 149: 472–481.

Harris, M.P.; Wanless, S.; Rothery, P. (2000). Adult survival rates of shag *Phalacrocorax aristotelis*, common guillemot *Uria aalge*, razorbill *Alca torda*, puffin *Fratercula arctica* and kittiwake *Rissa tridactyla* on the Isle of May 1986-96. Atlantic Seabirds 2: 133-150.

JNCC. 2012. Seabird Population Trends and Causes of Change: 2012 Report (http://www.jncc.defra.gov.uk/page-3201). Joint Nature Conservation Committee. Updated July 2012. Accessed 27/05/2013.

Leopold, M. F., Digkman & Teal, L. 2011. Local birds in and around the Offshore Wind Farm Egmond aan Zee. NoordzeeWind report.

Lewis, S., Sherratt, T. N., Hamer, K. C., & Wanless, S. 2001. Evidence of intra-specific competition for food in a pelagic seabird. Nature, 412: 816-819.

Madden, B. and Newton, S.F. 2004. Herring Gull *Larus argentatus*. In: Mitchell, P.I., Newton, S.F., Ratcliffe, N. and Dunn, T.E. (eds.) 2004. Seabird Populations of Britain and Ireland: 242-262. Poyser, London.

Mavor, R.A., Heubeck, M., Schmitt, S. and Parsons, M. 2008. Seabird numbers and breeding success in Britain and Ireland, 2006. Peterborough, Joint Nature Conservation Committee. (UK Nature Conservation, No. 31.).

Meade, J., Hatchwell, B.J., Blanchard, J., Birkhead, T.R. 2012. The population increase of common guillemots on Skomer Island is explained by intrinsic demographic properties. Journal of Avian Biology 43:001-007.

Nelson, B. 2002. The Atlantic gannet. Fenix Books Ltd., Great Yarmouth.

Robinson, R.A. 2005. BirdFacts: profiles of birds occurring in Britain & Ireland (BTO Research Report 407). BTO, Thetford (http://www.bto.org/birdfacts, accessed on 15/11/2011).

Shenton, S and Walls, R. 2011. Presentation at a SNH Marine Sharing Good Practice event, 3 November 2011.

Snow, D.W. & Perrins, C.M. 1998. The birds of the western Palearctic, Concise editon. Oxford University Press.

Swann, B. 2012. East Caithness Cliffs SPA Site Condition Monitoring 2005. Scottish Natural Heritage Commissioned Report No.148.

Vanerman, N. & Stienen, E.W.M. 2009. Seabirds and offshore wind farms: monitoring results, 2008. In: Degraer, S. & Brabant, R. Offshore wind farms in the Belgian part of the North Sea. Royal Belgian Institute for Natural Science.

Wanless, S., Frederiksen, M., Harris, M.P. & Freeman, S.N. 2006. Survival of gannets *Morus bassanus* in Britain and Ireland, 1959–2002. Bird Study 53: 79–85.

Wanless, S., Harris, M.P., Calladine, J., Rothery, P. (1996) Modelling Responses of Herring Gull and Lesser Black Backed Gull Populations to Reduction of Reproductive Output: Implications for Control Measures. Journal of Applied Ecology 33, 1420 – 1432.

Appendix A – Post Application Ornithology Consultation Log

Please see Post-Application Ornithology Consultation Log in enclosed CD.

For printed copies please contact:

moray offshore renewables limited
4th Floor
40 Princes Street
Edinburgh
EH2 2BY

Email: info@morayoffshorerenewables.co.uk

Appendix B - Growth rates

Table B.1. Data from JNCC Seabird Monitoring Program and Lewis et al (2012) used to calculate annual population growth rates and model predictions for fulmar.

Spatial Scale	Temporal Scale	Value
UK Population estimate (Individuals)	Operation Seafarer (1969-70)	291,294
	Seabird Colony Register (1985-88)	516,939
	Seabird 2000 (1998-2002)	501,609
	2011	541738
Year between each census (approx.)	1969/70 to 1985/88	17
	1985/88 to 1998/02	14
	2000 - 2011	11
Growth rate (Lambda) - UK	1969/70 to 1985/88	1.0343
	1985/88 to 1998/02	0.9979
	2000 - 2011	1.0070
	1969/70 to 2011	1.0149
Scotland Population estimate (Individuals)	Operation Seafarer (1969-70)	285,067
	Seabird Colony Register (1985-88)	504,640
	Seabird 2000 (1998-2002)	485,852
	2000 - 2011	0
Growth rate (Lambda) - Scotland	1969/70 to 1985/88	1.0342
	1985/88 to 1998/02	0.9973
	2000 - 2011	n/a
	1969/70 to 1998/02	1.0173
Stroma Island population	1986	1032
	1990	1098
	1993	2439
	2000	300
	2001	208
	2002	285
Years between each census	1986 - 1990	4
	1990 - 1993	3
	1993 - 2000	7
	2000 - 2001	1
	2001 - 2002	1
	1986 - 2002	16
Growth rate (Lambda) - Stroma	1986 - 1990	1.0156
	1990 - 1993	1.3048
	1993 - 2000	0.7413
	2000 - 2001	0.6933
	2001 - 2002	1.3702
	1986 - 2002	0.7660
	Total lambda UK (1969/70 to 2011)	1.01453
	Total lambda Scotland (1969/70 to 2000)	1.01248
	Total lambda Stroma (1986 - 2002)	0.76595
	Deterministic Growth Rate	0.9807
	Stochastic Growth Rate	0.9804
	Lower 95% C.I.	0.9654
	Upper 95% C.I.	0.9957

Table B.2. Data from JNCC Seabird Monitoring Program and Lewis et al (2012) used to calculate annual population growth rates and model predictions for gannet.

Spatial Scale	Temporal Scale	Value
UK Population estimate (Individuals)	Operation Seafarer (1969-70)	137,661
	Seabird Colony Register (1985-88)	186,508
	1994 to 1995 National gannet census	231,565
	2004 to 2005 National gannet census	218,546
Year between each census (approx.)	1969/70 to 1985/88	17
	1985/88 to 1994/95	10
	1994/95 to 2004/05	10
Growth rate (Lambda) - UK	1969/70 to 1985/88	1.0180
	1985/88 to 1994/95	1.0219
	1994/95 to 2004/05	0.9942
	1969/70 to 2004/05	1.0133
Scotland Population estimate (Individuals)	Operation Seafarer (1969-70)	96,860
	Seabird Colony Register (1985-88)	127,867
	1994 to 1995 National gannet census	167,407
	2004 to 2005 National gannet census	182,511
Growth rate (Lambda) - Scotland	1969/70 to 1985/88	1.0165
	1985/88 to 1994/95	1.0362
	1994/95 to 2004/05	1.0087
	1969/70 to 2004/05	1.0183
	Total lambda UK (1969/70 to 2004/05)	1.01902
	Total lambda Scotland (1969/70 to 2004/05)	1.01827
	Deterministic Growth Rate	1.0118
	Stochastic Growth Rate	1.0116
	Lower 95% C.I.	1.0058
	Upper 95% C.I.	1.0175

Table B.3. Data from JNCC Seabird Monitoring Program and Lewis et al (2012) used to calculate annual population growth rates and model predictions for kittiwake.

Spatial Scale	Temporal Scale	Value
UK Population estimate (Individuals)	Operation Seafarer (1969-70)	407,417
	Seabird Colony Register (1985-88)	504,055
	Seabird 2000 (1998-2002)	378,847
	2011	223,520
Year between each census (approx.)	1969/70 to 1985/88	17
	1985/88 to 1998/02	14
	2000 - 2011	11
Growth rate (Lambda) - UK	1969/70 to 1985/88	1.0126
	1985/88 to 1998/02	0.9798
	2000 - 2011	0.9532
	1969/70 to 2011	0.9861
Scotland Population estimate (Individuals)	Operation Seafarer (1969-70)	346,097
	Seabird Colony Register (1985-88)	359,425
	Seabird 2000 (1998-2002)	282,213
	2000 - 2011	0
Growth rate (Lambda) - Scotland	1969/70 to 1985/88	1.0022
	1985/88 to 1998/02	0.9829
	2000 - 2011	na
	1969/70 to 1998/02	0.9940
	Total lambda UK (1969/70 to 2011)	0.98614
	Total lambda Scotland (1969/70 to 2000)	0.99527
	Deterministic Growth Rate	0.9844
	Stochastic Growth Rate	0.9827
	Lower 95% C.I.	0.9571
	Upper 95% C.I.	1.0089
Troup, Pennan and Lions Heads SPA Population estimate (pairs)	1986	16,596
	1995	31,664
	2001	18,482
	2004	15,570
	2007	17,171
Troup, Pennan and Lions Heads SPA (Lambda)	1986 - 1995	1.0841
	1995 - 2001	0.9142
	2001 - 2004	0.9445
	2004 - 2007	1.0332
	1986 - 2004	1.0019

Table B.4. Data from JNCC Seabird Monitoring Program and Lewis et al (2012) used to calculate annual population growth rates and model predictions for herring gull.

Spatial Scale	Temporal Scale	Value
UK Population estimate (Individuals)	Operation Seafarer (1969-70)	285,929
	Seabird Colony Register (1985-88)	149,197
	Seabird 2000 (1998-2002)	130,230
	2000 - 2011	87,254
Year between each census (approx.)	1969/70 to 1985/88	17
	1985/88 to 1998/02	14
	2000 - 2011	11
Growth rate (Lambda) - UK	1969/70 to 1985/88	0.9625
	1985/88 to 1998/02	0.9903
	2000 - 2011	0.9642
	1969/70 to 2011	0.9721
Scotland Population estimate (Individuals)	Operation Seafarer (1969-70)	159,237
	Seabird Colony Register (1985-88)	92,950
	Seabird 2000 (1998-2002)	71,659
	2000 - 2011	0
Growth rate (Lambda) - Scotland	1969/70 to 1985/88	0.9688
	1985/88 to 1998/02	0.9816
	2000 - 2011	
	1969/70 to 1998/02	0.9746
	Total lambda UK (1969/70 to 2011)	0.97277
	Total lambda Scotland (1969/70 to 2000)	0.98160
	Deterministic Growth Rate	1.0393
	Stochastic Growth Rate	1.0344
	Lower 95% C.I.	0.9977
	Upper 95% C.I.	1.0727
Troup, Pennan and Lions Heads SPA Population estimate (pairs)	1986	2590
	1995	4196
	2001	1951
	2007	1687
Troup, Pennan and Lions Heads SPA (Lambda)	1986 to 1995	1.0551
	1995 to 2001	0.8802
	2001 to 2007	0.9761
	1986 to 2007	0.9736

Table B.5. Data from JNCC Seabird Monitoring Program and Lewis et al (2012) used to calculate annual population growth rates and model predictions for great black-backed gull.

Spatial Scale	Temporal Scale	Value
UK Population estimate (Individuals)	Operation Seafarer (1969-70)	18,771
	Seabird Colony Register (1985-88)	17,415
	Seabird 2000 (1998-2002)	16,735
	2000 - 2011	10,543
Year between each census (approx.)	1969/70 to 1985/88	17
	1985/88 to 1998/02	14
	2000 - 2011	11
Growth rate (Lambda) - UK	1969/70 to 1985/88	0.9956
	1985/88 to 1998/02	0.9972
	2000 - 2011	0.9589
	1969/70 to 2011	0.9864
Scotland Population estimate (Individuals)	Operation Seafarer (1969-70)	15,950
	Seabird Colony Register (1985-88)	15,315
	Seabird 2000 (1998-2002)	14,773
	2000 - 2011	no data
Growth rate (Lambda) - Scotland	1969/70 to 1985/88	0.9976
	1985/88 to 1998/02	0.9974
	2000 - 2011	no data
	1969/70 to 1998/02	0.9975
	Total lambda UK (1969/70 to 2011)	0.98667
	Total lambda Scotland (1969/70 to 2000)	0.99822
	Deterministic Growth Rate	1.1084
	Stochastic Growth Rate	1.1070
	Lower 95% C.I.	1.0744
	Upper 95% C.I.	1.1405

Table B.6. Data from JNCC Seabird Monitoring Program and Lewis et al (2012) used to calculate annual population growth rates and model predictions for guillemot.

Spatial Scale	Temporal Scale	Value
UK Population estimate (Individuals)	Operation Seafarer (1969-70)	611,281
	Seabird Colony Register (1985-88)	1,081,341
	Seabird 2000 (1998-2002)	1,416,334
	2011	1501314
Year between each census (approx.)	1969/70 to 1985/88	17
	1985/88 to 1998/02	14
	2000 - 2011	11
Growth rate (Lambda) - UK	1969/70 to 1985/88	1.0341
	1985/88 to 1998/02	1.0195
	2000 to 2011	1.0053
	1969/70 to 2011	1.0216
Scotland Population estimate (Individuals)	Operation Seafarer (1969-70)	519,461
	Seabird Colony Register (1985-88)	943,098
	Seabird 2000 (1998-2002)	1,167,841
	2000 - 2011	n/a
Growth rate (Lambda) - Scotland	1969/70 to 1985/88	1.0357
	1985/88 to 1998/02	1.0154
	2000 to 2011	n/a
	1969/70 to 1998/02	1.0265
	Total lambda UK (1969/70 to 2011)	1.02162
	Total lambda Scotland (1969/70 to 2000)	1.02648
North Caithness Cliffs - Stroma	1986	13600
	1993	13563
	2000	14760
	2001	16714
Stroma Lambda values	1986 to 1993	0.9996
	1993 to 2000	1.0122
	2000 to 2001	1.1324
	1986 to 2001	1.0138
	Deterministic Growth Rate	1.0577
	Stochastic Growth Rate	1.0575
	Lower 95% C.I.	1.0487
	Upper 95% C.I.	1.0665

Table B.7. Data from JNCC Seabird Monitoring Program and Lewis et al (2012) used to calculate annual population growth rates and model predictions for razorbill.

Spatial Scale	Temporal Scale	Value
UK Population estimate (Individuals)	Operation Seafarer (1969-70)	132,734
	Seabird Colony Register (1985-88)	154,219
	Seabird 2000 (1998-2002)	187,052
	2011	213,239
Year between each census (approx.)	1969/70 to 1985/88	17
	1985/88 to 1998/02	14
	2000 - 2011	11
Growth rate (Lambda) - UK	1969/70 to 1985/88	1.0089
	1985/88 to 1998/02	1.0139
	2000 - 2011	1.0120
	1969/70 to 2011	1.0114
Scotland Population estimate (Individuals)	Operation Seafarer (1969-70)	111,038
	Seabird Colony Register (1985-88)	125,586
	Seabird 2000 (1998-2002)	139,186
	2011	na
Growth rate (Lambda) - Scotland	1969/70 to 1985/88	1.0073
	1985/88 to 1998/02	1.0074
	2000 - 2011	na
	1969/70 to 1998/02	1.0073
	Total lambda UK (1969/70 to 2011)	1.01109
	Total lambda Scotland (1969/70 to 2000)	1.00709
	Deterministic Growth Rate	1.0805
	Stochastic Growth Rate	1.0801
	Lower 95% C.I.	1.0710
	Upper 95% C.I.	1.0892
Troup, Pennan and Lions Heads SPA Population estimate (pairs)	1986	1638
	1995	4423
	2001	2900
	2007	1795
Troup, Pennan and Lions Heads SPA (Lambda)	1986 - 1995	1.1167
	1995 - 2001	0.9321
	2001 - 2007	0.9232
	1986 - 2007	1.0044

Table B.8. Data from JNCC Seabird Monitoring Program and Lewis et al (2012) used to calculate annual population growth rates and model predictions for puffin.

Spatial Scale	Temporal Scale	Value
UK Population estimate (Individuals)	Operation Seafarer (1969-70)	132,734
	Seabird Colony Register (1985-88)	154,219
	Seabird 2000 (1998-2002)	187,052
	2011	213,239
Year between each census (approx.)	1969/70 to 1985/88	17
	1985/88 to 1998/02	14
	2000 - 2011	11
Growth rate (Lambda) - UK	1969/70 to 1985/88	1.0089
	1985/88 to 1998/02	1.0139
	2000 - 2011	1.0120
	1969/70 to 2011	1.0114
Scotland Population estimate (Individuals)	Operation Seafarer (1969-70)	111,038
	Seabird Colony Register (1985-88)	125,586
	Seabird 2000 (1998-2002)	139,186
	2011	na
Growth rate (Lambda) - Scotland	1969/70 to 1985/88	1.0073
	1985/88 to 1998/02	1.0074
	2000 - 2011	na
	1969/70 to 1998/02	1.0073
	Total lambda UK (1969/70 to 2011)	1.01109
	Total lambda Scotland (1969/70 to 2000)	1.00709
	Deterministic Growth Rate	1.0805
	Stochastic Growth Rate	1.0801
	Lower 95% C.I.	1.0710
	Upper 95% C.I.	1.0892
Troup, Pennan and Lions Heads SPA Population estimate (pairs)	1986	1638
	1995	4423
	2001	2900
	2007	1795
Troup, Pennan and Lions Heads SPA (Lambda)	1986 - 1995	1.1167
	1995 - 2001	0.9321
	2001 - 2007	0.9232
	1986 - 2007	1.0044

Appendix C – PVA Outputs: Fulmar – East Caithness Cliffs

Collision and displacement

Table C.1. Modelled probabilities of dropping below baseline predicted population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	<0.001	0.007	0.046	0.087	0.144	0.224	0.317	0.422	0.521	17479
BOWL and MORL	50%	177	95.0%	7	0.001	0.008	0.048	0.091	0.149	0.232	0.326	0.432	0.533	17392
BOWL and MORL	50%	177	98.0%	3	0.001	0.007	0.047	0.089	0.146	0.227	0.321	0.426	0.526	17442
BOWL and MORL	50%	177	98.5%	2	0.001	0.007	0.047	0.088	0.145	0.226	0.319	0.425	0.524	17454
BOWL and MORL	50%	177	99.0%	1	0.001	0.007	0.047	0.088	0.145	0.225	0.318	0.423	0.523	17467
BOWL and MORL	50%	177	99.5%	1	0.001	0.007	0.047	0.088	0.145	0.225	0.318	0.423	0.523	17467

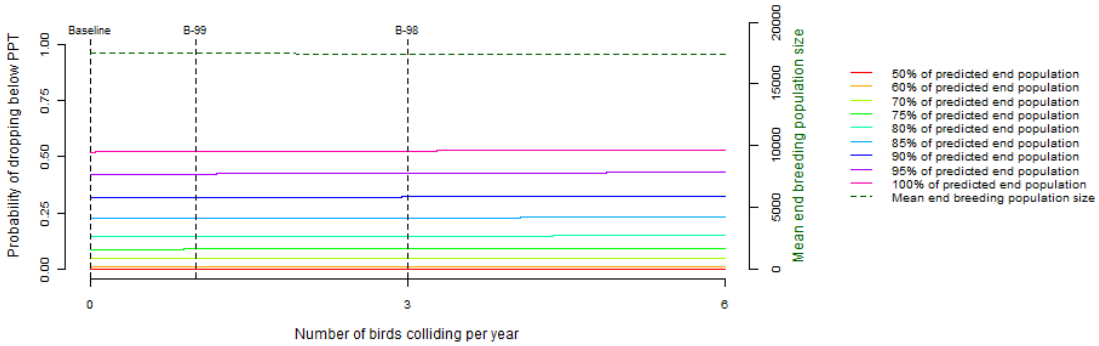


Figure C.1. Probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

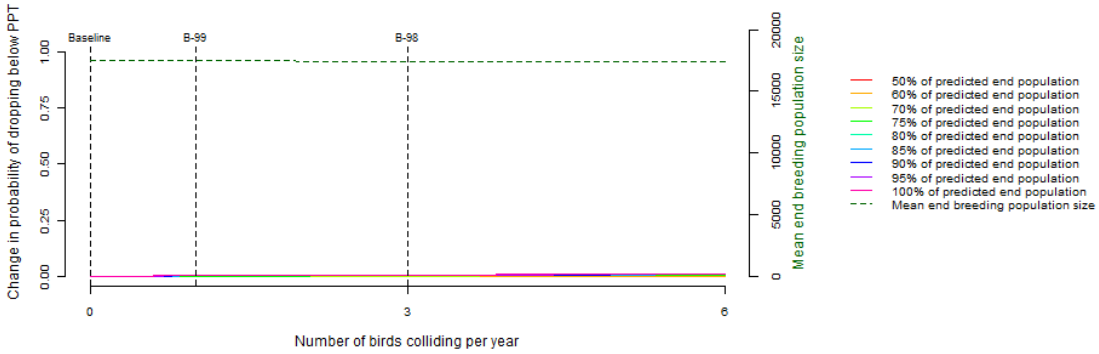


Figure C.2. Change in probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table C.2. Modelled probabilities of dropping below baseline predicted population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.027	0.103	0.258	0.366	0.476	0.582	0.679	0.763	0.829	14400
BOWL and MORL	50%	177	95.0%	7	0.027	0.107	0.268	0.376	0.486	0.591	0.688	0.769	0.834	14325
BOWL and MORL	50%	177	98.0%	3	0.027	0.105	0.263	0.371	0.480	0.586	0.683	0.765	0.831	14368
BOWL and MORL	50%	177	98.5%	2	0.027	0.104	0.261	0.369	0.479	0.584	0.682	0.764	0.831	14379
BOWL and MORL	50%	177	99.0%	1	0.027	0.104	0.260	0.368	0.477	0.583	0.680	0.764	0.830	14390
BOWL and MORL	50%	177	99.5%	1	0.027	0.104	0.260	0.368	0.477	0.583	0.680	0.764	0.830	14390

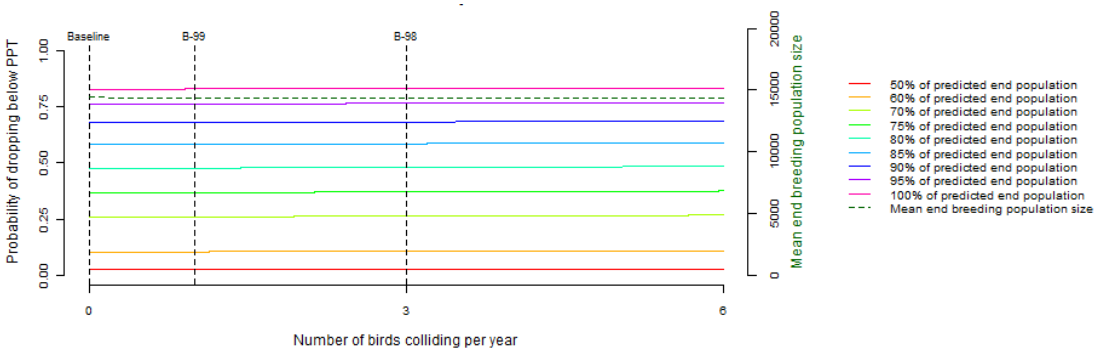


Figure C.3. Probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

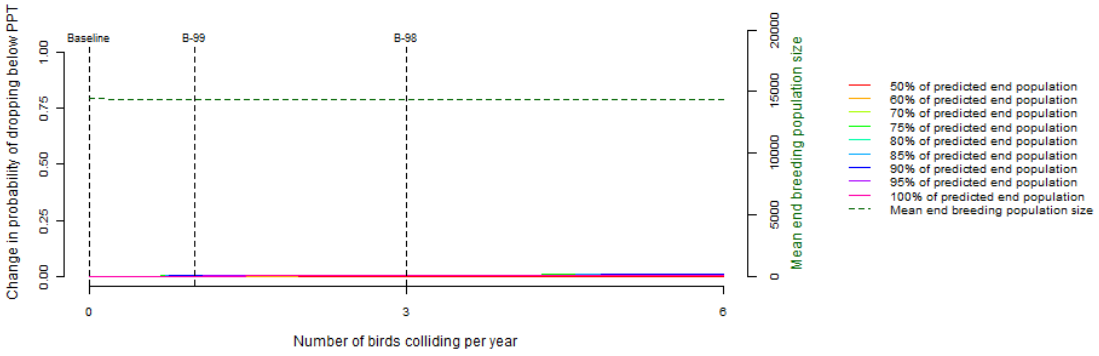


Figure C.4. Change in probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

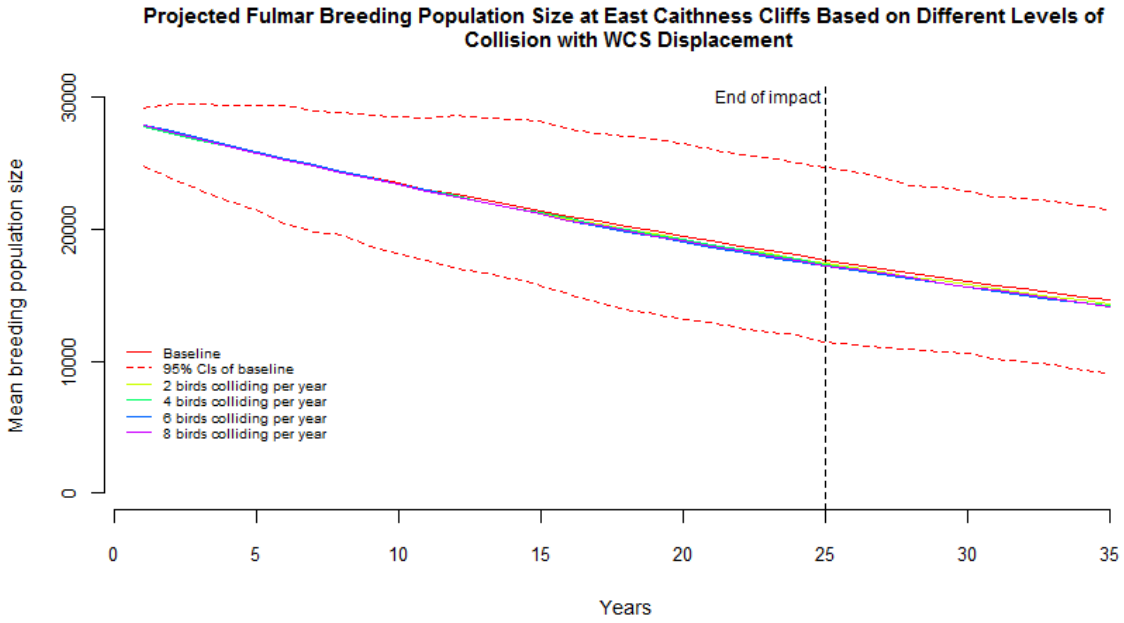


Figure C.5. Population projections for the fulmar population at East Caithness Cliffs at different levels of collision with a high level of displacement.

Table C.3. Modelled probabilities of dropping below current population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.197	0.541	0.830	0.910	0.960	0.985	0.995	1.000	1.000	17319
BOWL and MORL	100%	580	95.0%	7	0.203	0.547	0.834	0.913	0.961	0.985	0.995	1.000	1.000	17262
BOWL and MORL	100%	580	98.0%	3	0.200	0.544	0.832	0.911	0.961	0.985	0.995	1.000	1.000	17294
BOWL and MORL	100%	580	98.5%	2	0.199	0.543	0.831	0.910	0.960	0.985	0.995	1.000	1.000	17302
BOWL and MORL	100%	580	99.0%	1	0.198	0.542	0.831	0.910	0.960	0.985	0.995	1.000	1.000	17311
BOWL and MORL	100%	580	99.5%	1	0.198	0.542	0.831	0.910	0.960	0.985	0.995	1.000	1.000	17311

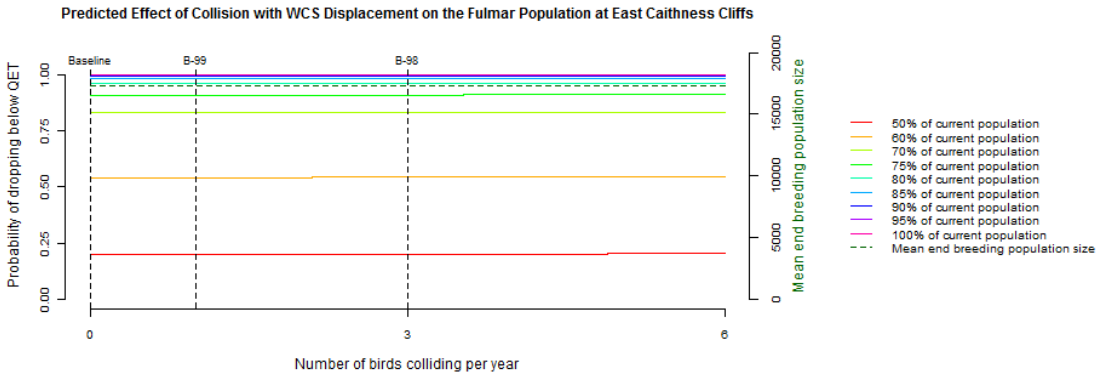


Figure C.6. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

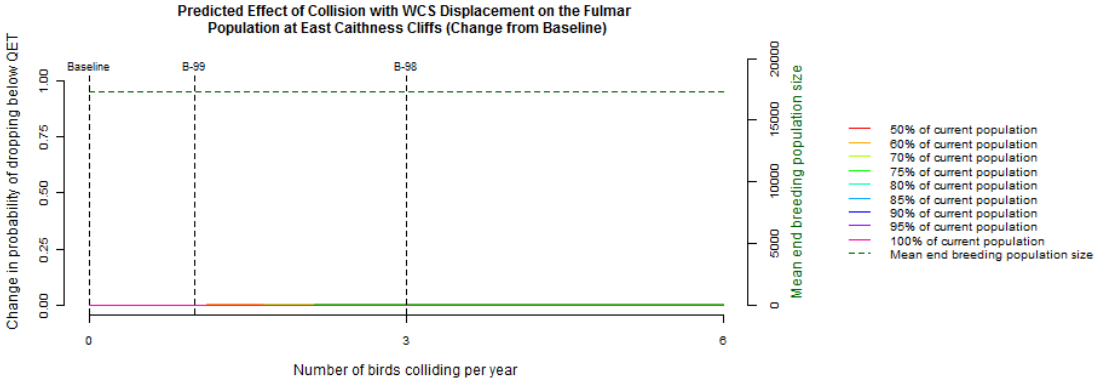


Figure C.7. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table C.4. Modelled probabilities of dropping below current population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size)

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.568	0.848	0.966	0.986	0.994	0.998	0.999	1.000	1.000	14199
BOWL and MORL	100%	580	95.0%	7	0.574	0.849	0.966	0.985	0.994	0.998	0.999	1.000	1.000	14162
BOWL and MORL	100%	580	98.0%	3	0.571	0.848	0.966	0.986	0.994	0.998	0.999	1.000	1.000	14184
BOWL and MORL	100%	580	98.5%	2	0.570	0.848	0.966	0.986	0.994	0.998	0.999	1.000	1.000	14189
BOWL and MORL	100%	580	99.0%	1	0.569	0.848	0.966	0.986	0.994	0.998	0.999	1.000	1.000	14194
BOWL and MORL	100%	580	99.5%	1	0.569	0.848	0.966	0.986	0.994	0.998	0.999	1.000	1.000	14194

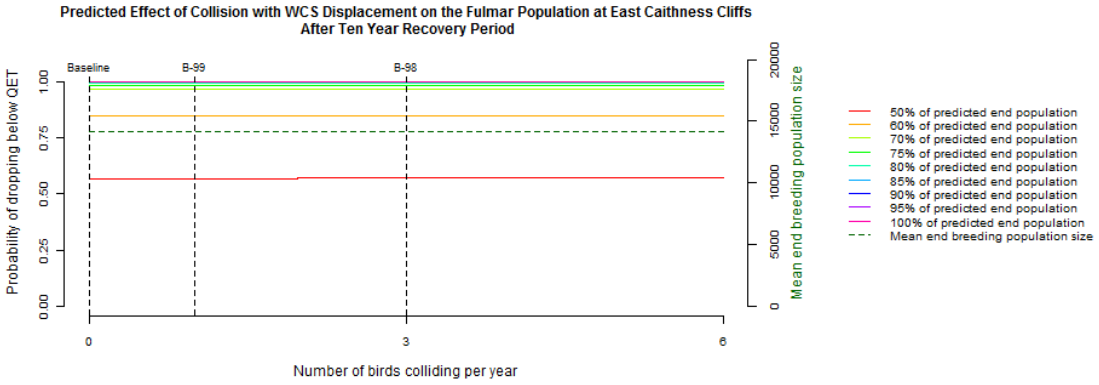


Figure C.8. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

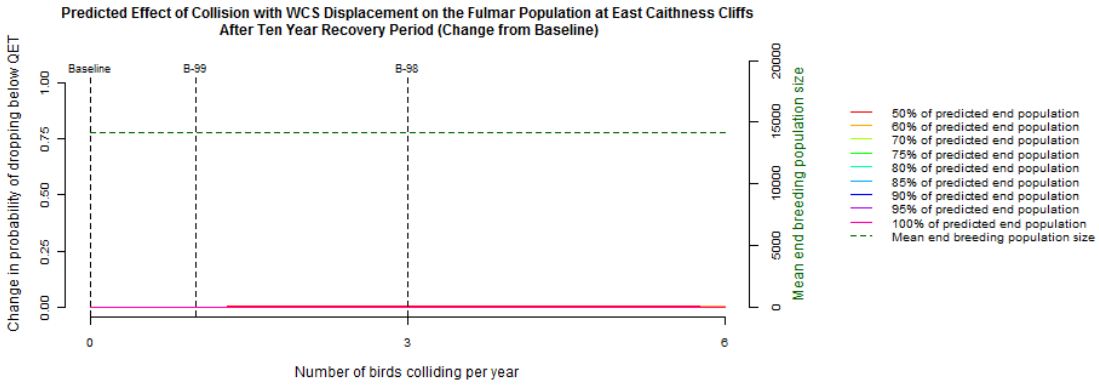


Figure C.9. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table C.5. Modelled probabilities of dropping below baseline predicted population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (PPT= population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	<0.001	0.008	0.049	0.096	0.156	0.244	0.341	0.451	0.549	17319
BOWL and MORL	100%	580	95.0%	7	0.001	0.009	0.052	0.100	0.162	0.250	0.347	0.457	0.556	17262
BOWL and MORL	100%	580	98.0%	3	0.001	0.009	0.050	0.098	0.159	0.246	0.343	0.454	0.552	17294
BOWL and MORL	100%	580	98.5%	2	0.001	0.008	0.050	0.097	0.158	0.246	0.343	0.453	0.551	17302
BOWL and MORL	100%	580	99.0%	1	<0.001	0.008	0.049	0.097	0.157	0.245	0.342	0.452	0.550	17311
BOWL and MORL	100%	580	99.5%	1	<0.001	0.008	0.049	0.097	0.157	0.245	0.342	0.452	0.550	17311

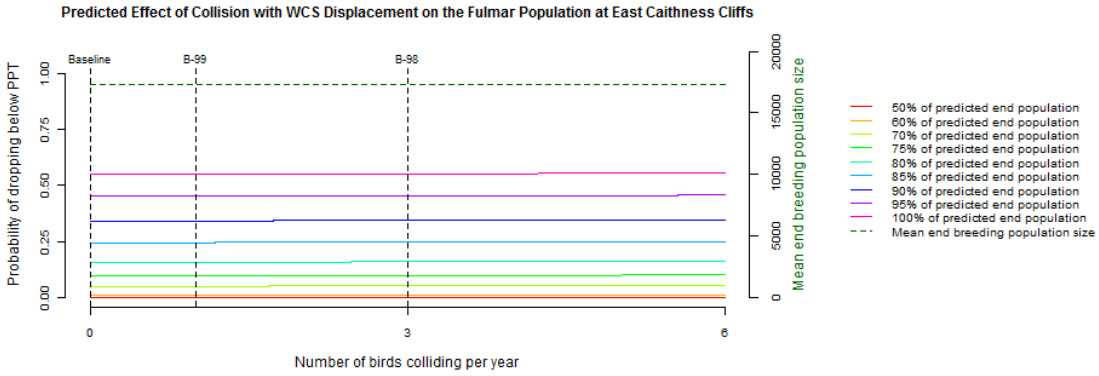


Figure C.10. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

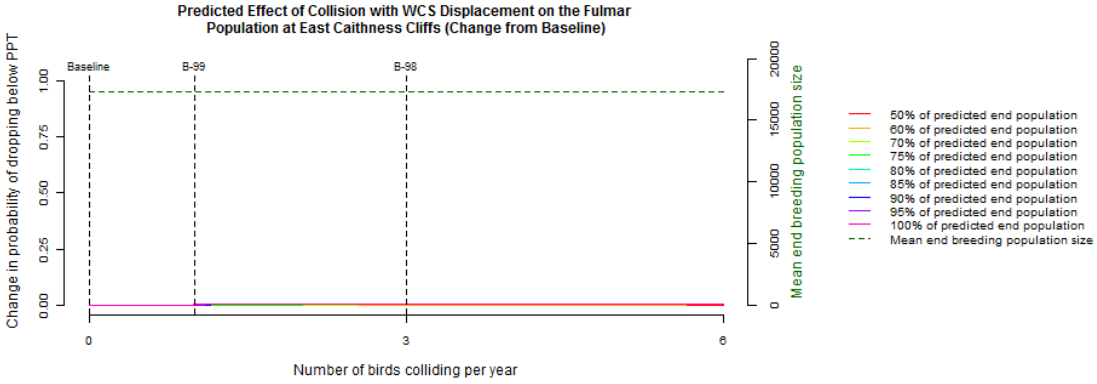


Figure C.11. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table C.6. Modelled probabilities of dropping below baseline predicted population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.022	0.112	0.287	0.394	0.500	0.606	0.701	0.782	0.843	14199
BOWL and MORL	100%	580	95.0%	7	0.025	0.116	0.292	0.400	0.506	0.611	0.705	0.783	0.844	14162
BOWL and MORL	100%	580	98.0%	3	0.023	0.114	0.289	0.397	0.503	0.608	0.703	0.783	0.844	14184
BOWL and MORL	100%	580	98.5%	2	0.023	0.113	0.288	0.396	0.502	0.608	0.702	0.782	0.844	14189
BOWL and MORL	100%	580	99.0%	1	0.023	0.113	0.288	0.395	0.501	0.607	0.702	0.782	0.843	14194
BOWL and MORL	100%	580	99.5%	1	0.023	0.113	0.288	0.395	0.501	0.607	0.702	0.782	0.843	14194

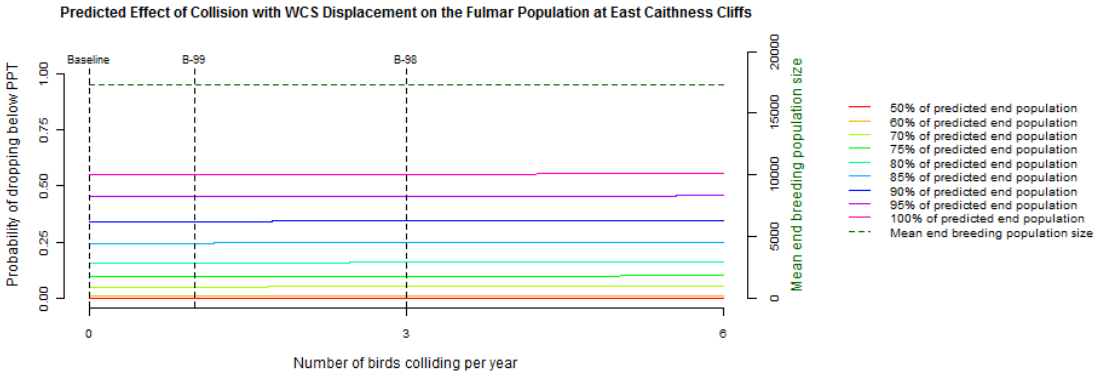


Figure C.12. Probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

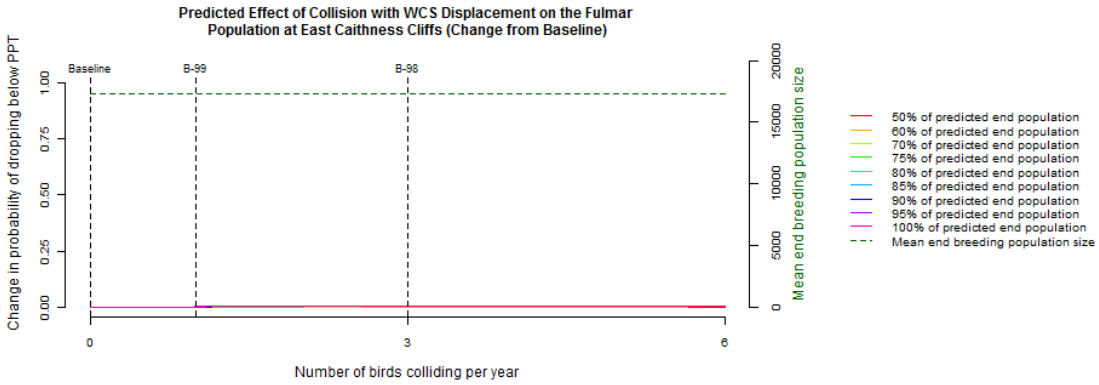


Figure C.13. Change in probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table C.7. Modelled probabilities of dropping below baseline predicted population size for the fulmar population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.022	0.112	0.287	0.394	0.500	0.606	0.701	0.782	0.843	14199
BOWL and MORL	100%	580	95.0%	7	0.025	0.116	0.292	0.400	0.506	0.611	0.705	0.783	0.844	14162
BOWL and MORL	100%	580	98.0%	3	0.023	0.114	0.289	0.397	0.503	0.608	0.703	0.783	0.844	14184
BOWL and MORL	100%	580	98.5%	2	0.023	0.113	0.288	0.396	0.502	0.608	0.702	0.782	0.844	14189
BOWL and MORL	100%	580	99.0%	1	0.023	0.113	0.288	0.395	0.501	0.607	0.702	0.782	0.843	14194
BOWL and MORL	100%	580	99.5%	1	0.023	0.113	0.288	0.395	0.501	0.607	0.702	0.782	0.843	14194

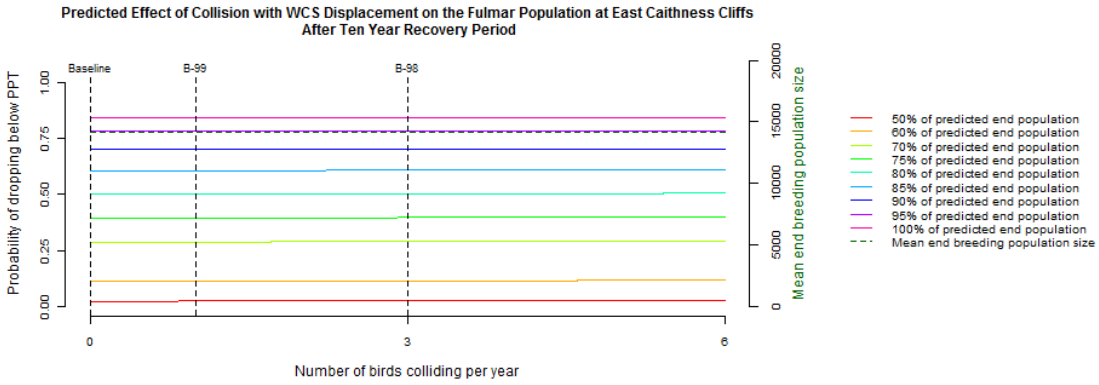


Figure C.14. Probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

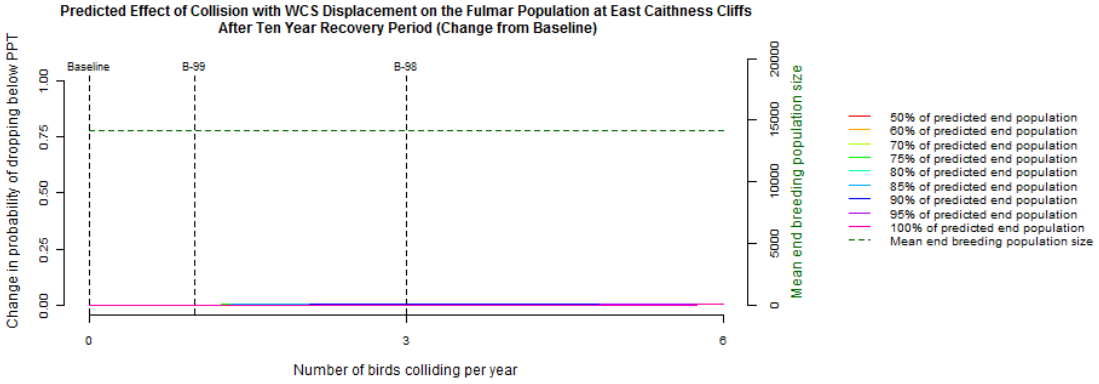


Figure C.15. Change in probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Displacement

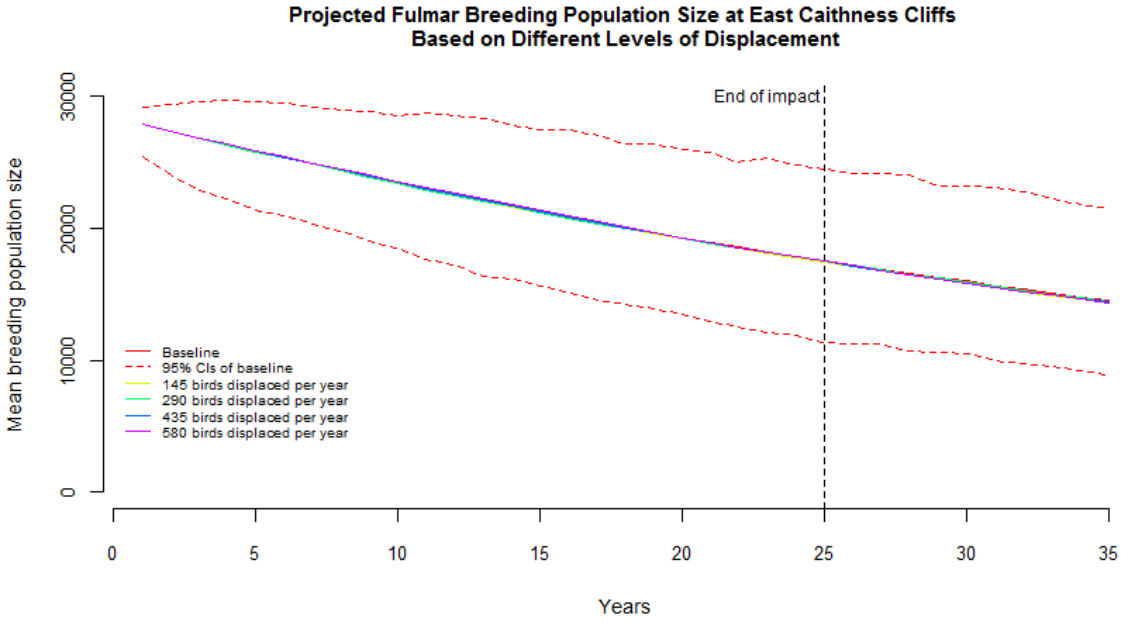


Figure C.16. Population projections for the fulmar population at East Caithness Cliffs at different levels of displacement.

Table C.8. Modelled probabilities of dropping below current population size for the fulmar population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0	0.512	0.809	0.890	0.945	0.978	0.992	0.998	0.999	17555
Whole site	100%	354	0	0.525	0.821	0.901	0.953	0.982	0.994	0.998	1.000	17453
Whole site	50%	177	0	0.519	0.815	0.896	0.949	0.980	0.993	0.998	1.000	17504
Sum of MacColl, Telford & Stevenson	100%	354	0	0.525	0.821	0.901	0.953	0.982	0.994	0.998	1.000	17453
Sum of MacColl, Telford & Stevenson	50%	177	0	0.519	0.815	0.896	0.949	0.980	0.993	0.998	1.000	17504
MacColl	100%	131	0	0.517	0.813	0.894	0.948	0.980	0.993	0.998	1.000	17517
MacColl	50%	66	0	0.515	0.811	0.892	0.947	0.979	0.993	0.998	0.999	17536
Telford	100%	123	0	0.517	0.813	0.894	0.948	0.980	0.993	0.998	1.000	17519
Telford	50%	62	0	0.515	0.811	0.892	0.946	0.979	0.993	0.998	0.999	17537
Stevenson	100%	99	0	0.516	0.812	0.893	0.947	0.979	0.993	0.998	0.999	17526
Stevenson	50%	50	0	0.514	0.811	0.892	0.946	0.979	0.992	0.998	0.999	17540
MacColl and Stevenson	100%	231	0	0.521	0.817	0.897	0.950	0.981	0.993	0.998	1.000	17488
MacColl and Stevenson	50%	115	0	0.516	0.813	0.894	0.948	0.980	0.993	0.998	1.000	17521
Stevenson and Telford	100%	223	0	0.521	0.816	0.897	0.950	0.981	0.993	0.998	1.000	17490
Stevenson and Telford	50%	111	0	0.516	0.813	0.894	0.948	0.979	0.993	0.998	0.999	17523
Telford and MacColl	100%	255	0	0.522	0.818	0.898	0.951	0.981	0.993	0.998	1.000	17481
Telford and MacColl	50%	127	0	0.517	0.813	0.894	0.948	0.980	0.993	0.998	1.000	17518
BOWL	100%	226	0	0.521	0.817	0.897	0.950	0.981	0.993	0.998	1.000	17489
BOWL	50%	113	0	0.516	0.813	0.894	0.948	0.980	0.993	0.998	0.999	17522
BOWL and MORL	100%	580	0	0.534	0.828	0.907	0.957	0.984	0.995	0.998	1.000	17388
BOWL and MORL	50%	290	0	0.523	0.819	0.899	0.952	0.981	0.994	0.998	1.000	17471

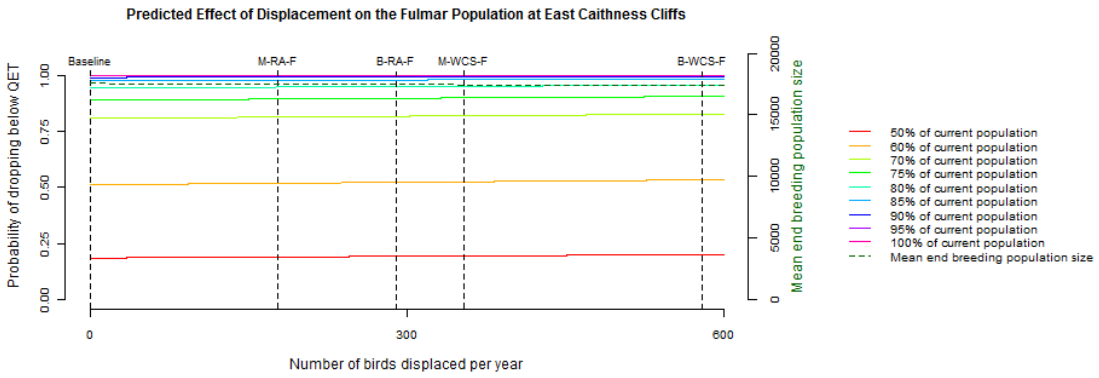


Figure C.17. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

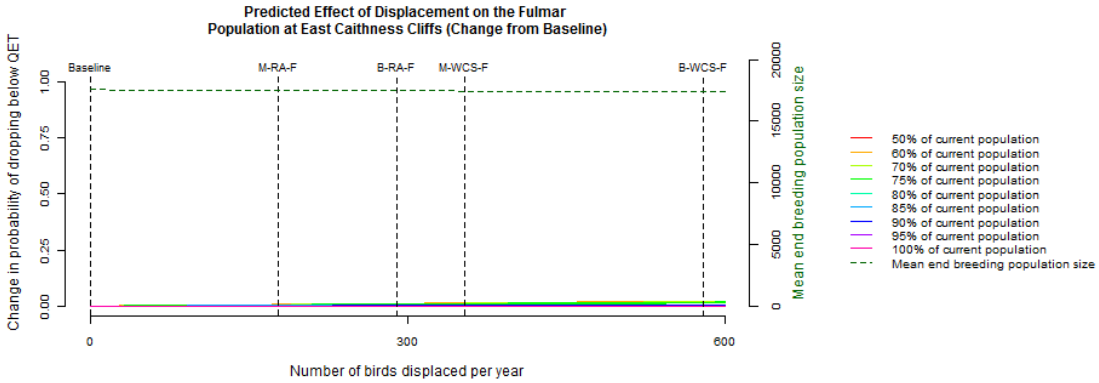


Figure C.18. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table C.9. Modelled probabilities of dropping below current population size for the fulmar population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	1	0.829	0.952	0.974	0.989	0.996	0.999	0.999	1.000	14458
Whole site	100%	354	1	0.837	0.957	0.979	0.991	0.997	0.999	1.000	1.000	14344
Whole site	50%	177	1	0.833	0.955	0.976	0.990	0.997	0.999	1.000	1.000	14401
Sum of MacColl, Telford & Stevenson	100%	354	1	0.837	0.957	0.979	0.991	0.997	0.999	1.000	1.000	14344
Sum of MacColl, Telford & Stevenson	50%	177	1	0.833	0.955	0.976	0.990	0.997	0.999	1.000	1.000	14401
MacColl	100%	131	1	0.832	0.954	0.976	0.990	0.997	0.999	1.000	1.000	14416
MacColl	50%	66	1	0.830	0.953	0.975	0.989	0.996	0.999	0.999	1.000	14437
Telford	100%	123	1	0.832	0.954	0.976	0.990	0.997	0.999	1.000	1.000	14418
Telford	50%	62	1	0.830	0.953	0.975	0.989	0.996	0.999	0.999	1.000	14438
Stevenson	100%	99	1	0.831	0.954	0.975	0.990	0.996	0.999	0.999	1.000	14426
Stevenson	50%	50	1	0.830	0.953	0.975	0.989	0.996	0.999	0.999	1.000	14442
MacColl and Stevenson	100%	231	1	0.834	0.956	0.977	0.991	0.997	0.999	1.000	1.000	14384
MacColl and Stevenson	50%	115	1	0.832	0.954	0.975	0.990	0.996	0.999	1.000	1.000	14421
Stevenson and Telford	100%	223	1	0.834	0.956	0.977	0.990	0.997	0.999	1.000	1.000	14386
Stevenson and Telford	50%	111	1	0.831	0.954	0.975	0.990	0.996	0.999	1.000	1.000	14422
Telford and MacColl	100%	255	1	0.835	0.956	0.977	0.991	0.997	0.999	1.000	1.000	14376
Telford and MacColl	50%	127	1	0.832	0.954	0.976	0.990	0.997	0.999	1.000	1.000	14417
BOWL	100%	226	1	0.834	0.956	0.977	0.990	0.997	0.999	1.000	1.000	14385
BOWL	50%	113	1	0.831	0.954	0.975	0.990	0.996	0.999	1.000	1.000	14422
BOWL and MORL	100%	580	1	0.843	0.960	0.981	0.992	0.998	0.999	1.000	1.000	14271
BOWL and MORL	50%	290	1	0.836	0.956	0.978	0.991	0.997	0.999	1.000	1.000	14364

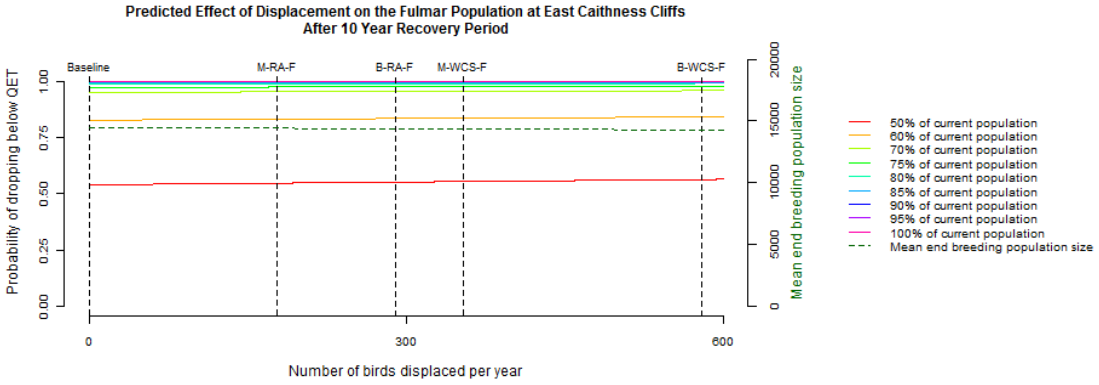


Figure C.19. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

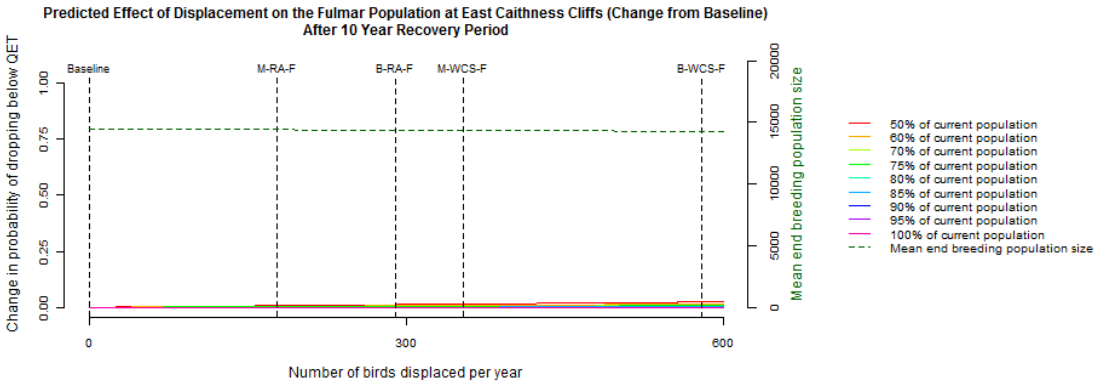


Figure C.20. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table C.10. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the fulmar population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0	0.008	0.045	0.089	0.145	0.225	0.318	0.418	0.518	17555
Whole site	100%	354	0	0.009	0.048	0.094	0.153	0.236	0.329	0.431	0.533	17453
Whole site	50%	177	0	0.008	0.047	0.091	0.149	0.231	0.324	0.425	0.525	17504
Sum of MacColl, Telford & Stevenson	100%	354	0	0.009	0.048	0.094	0.153	0.236	0.329	0.431	0.533	17453
Sum of MacColl, Telford & Stevenson	50%	177	0	0.008	0.047	0.091	0.149	0.231	0.324	0.425	0.525	17504
MacColl	100%	131	0	0.008	0.046	0.090	0.148	0.229	0.322	0.423	0.524	17517
MacColl	50%	66	0	0.008	0.046	0.090	0.146	0.227	0.320	0.421	0.521	17536
Telford	100%	123	0	0.008	0.046	0.090	0.148	0.229	0.322	0.423	0.523	17519
Telford	50%	62	0	0.008	0.045	0.090	0.146	0.227	0.320	0.421	0.521	17537
Stevenson	100%	99	0	0.008	0.046	0.090	0.147	0.228	0.321	0.422	0.522	17526
Stevenson	50%	50	0	0.008	0.045	0.089	0.146	0.227	0.320	0.420	0.520	17540
MacColl and Stevenson	100%	231	0	0.008	0.047	0.092	0.150	0.232	0.326	0.427	0.528	17488
MacColl and Stevenson	50%	115	0	0.008	0.046	0.090	0.147	0.229	0.322	0.423	0.523	17521
Stevenson and Telford	100%	223	0	0.008	0.047	0.092	0.150	0.232	0.325	0.427	0.527	17490
Stevenson and Telford	50%	111	0	0.008	0.046	0.090	0.147	0.229	0.322	0.422	0.523	17523
Telford and MacColl	100%	255	0	0.008	0.047	0.092	0.151	0.233	0.326	0.428	0.529	17481
Telford and MacColl	50%	127	0	0.008	0.046	0.090	0.148	0.229	0.322	0.423	0.523	17518
BOWL	100%	226	0	0.008	0.047	0.092	0.150	0.232	0.325	0.427	0.528	17489
BOWL	50%	113	0	0.008	0.046	0.090	0.147	0.229	0.322	0.422	0.523	17522
BOWL and MORL	100%	580	0	0.009	0.051	0.097	0.159	0.243	0.336	0.440	0.543	17388
BOWL and MORL	50%	290	0	0.009	0.048	0.093	0.152	0.234	0.327	0.429	0.530	17471

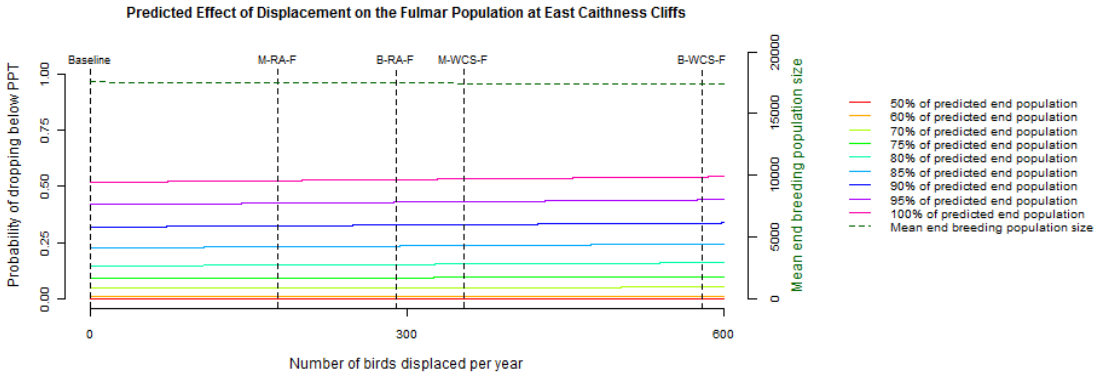


Figure C.21. Probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

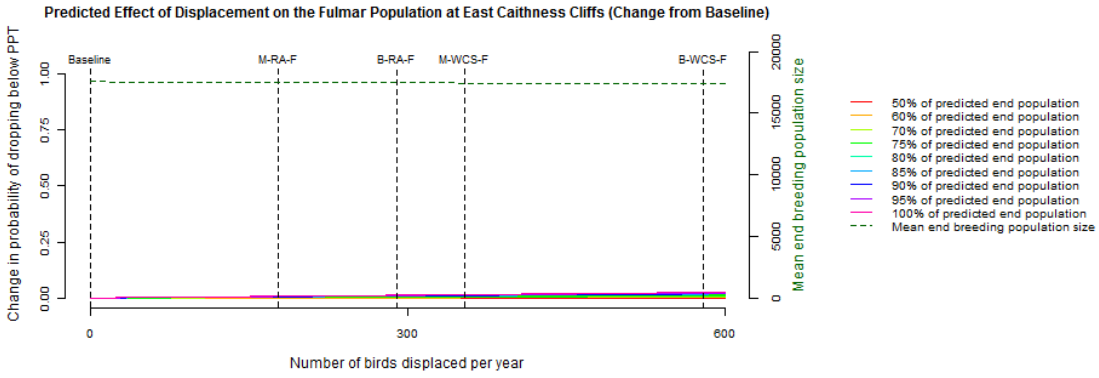


Figure C.22. Change in probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table C.11. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the fulmar population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0	0.103	0.261	0.366	0.470	0.581	0.673	0.756	0.826	14458
Whole site	100%	354	0	0.108	0.272	0.380	0.487	0.594	0.686	0.767	0.834	14344
Whole site	50%	177	0	0.105	0.266	0.373	0.479	0.587	0.679	0.761	0.830	14401
Sum of MacColl, Telford & Stevenson	100%	354	0	0.108	0.272	0.380	0.487	0.594	0.686	0.767	0.834	14344
Sum of MacColl, Telford & Stevenson	50%	177	0	0.105	0.266	0.373	0.479	0.587	0.679	0.761	0.830	14401
MacColl	100%	131	0	0.104	0.265	0.371	0.476	0.586	0.678	0.760	0.829	14416
MacColl	50%	66	0	0.103	0.263	0.369	0.473	0.583	0.675	0.758	0.828	14437
Telford	100%	123	0	0.104	0.265	0.371	0.476	0.585	0.677	0.760	0.829	14418
Telford	50%	62	0	0.103	0.263	0.368	0.473	0.583	0.675	0.758	0.827	14438
Stevenson	100%	99	0	0.104	0.264	0.370	0.475	0.584	0.677	0.759	0.828	14426
Stevenson	50%	50	0	0.103	0.262	0.368	0.473	0.583	0.675	0.757	0.827	14442
MacColl and Stevenson	100%	231	0	0.106	0.268	0.375	0.481	0.589	0.681	0.763	0.831	14384
MacColl and Stevenson	50%	115	0	0.104	0.264	0.370	0.476	0.585	0.677	0.760	0.829	14421
Stevenson and Telford	100%	223	0	0.106	0.268	0.375	0.481	0.589	0.681	0.763	0.831	14386
Stevenson and Telford	50%	111	0	0.104	0.264	0.370	0.476	0.585	0.677	0.759	0.829	14422
Telford and MacColl	100%	255	0	0.106	0.269	0.376	0.482	0.590	0.682	0.764	0.832	14376
Telford and MacColl	50%	127	0	0.104	0.265	0.371	0.476	0.585	0.678	0.760	0.829	14417
BOWL	100%	226	0	0.106	0.268	0.375	0.481	0.589	0.681	0.763	0.831	14385
BOWL	50%	113	0	0.104	0.264	0.370	0.476	0.585	0.677	0.759	0.829	14422
BOWL and MORL	100%	580	0	0.111	0.279	0.389	0.497	0.602	0.694	0.774	0.839	14271
BOWL and MORL	50%	290	0	0.107	0.270	0.377	0.484	0.592	0.684	0.765	0.832	14364

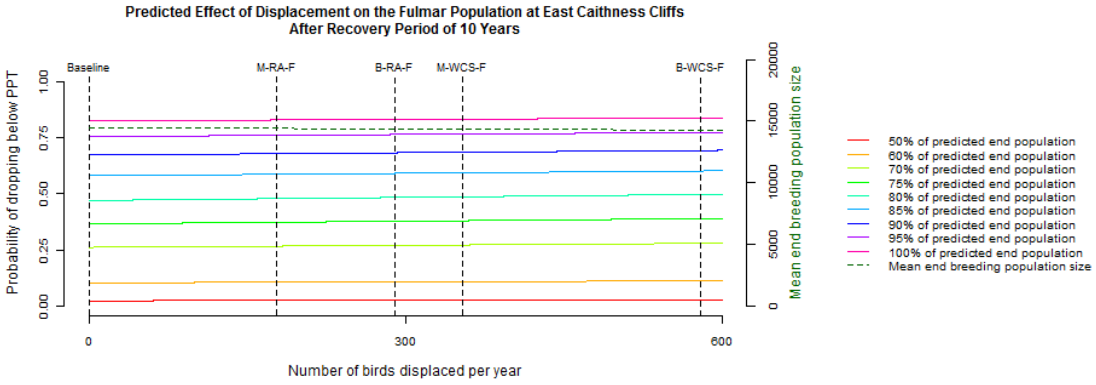


Figure C.23. Probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

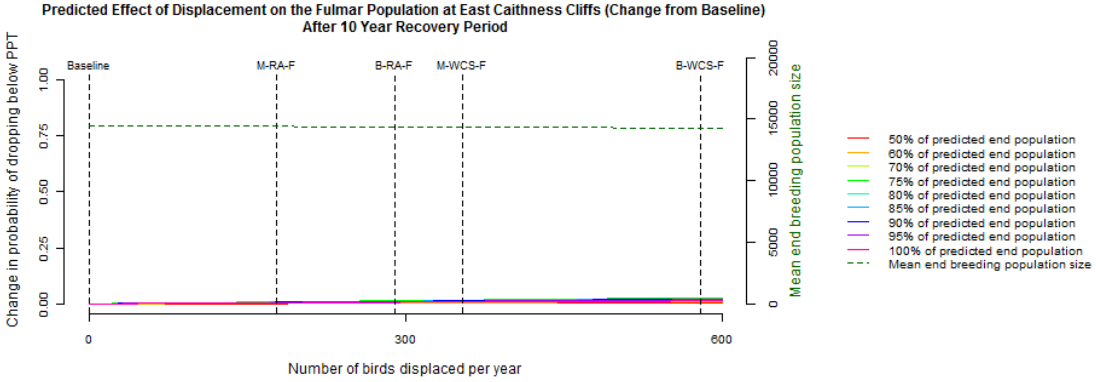


Figure C.24. Change in probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Collision

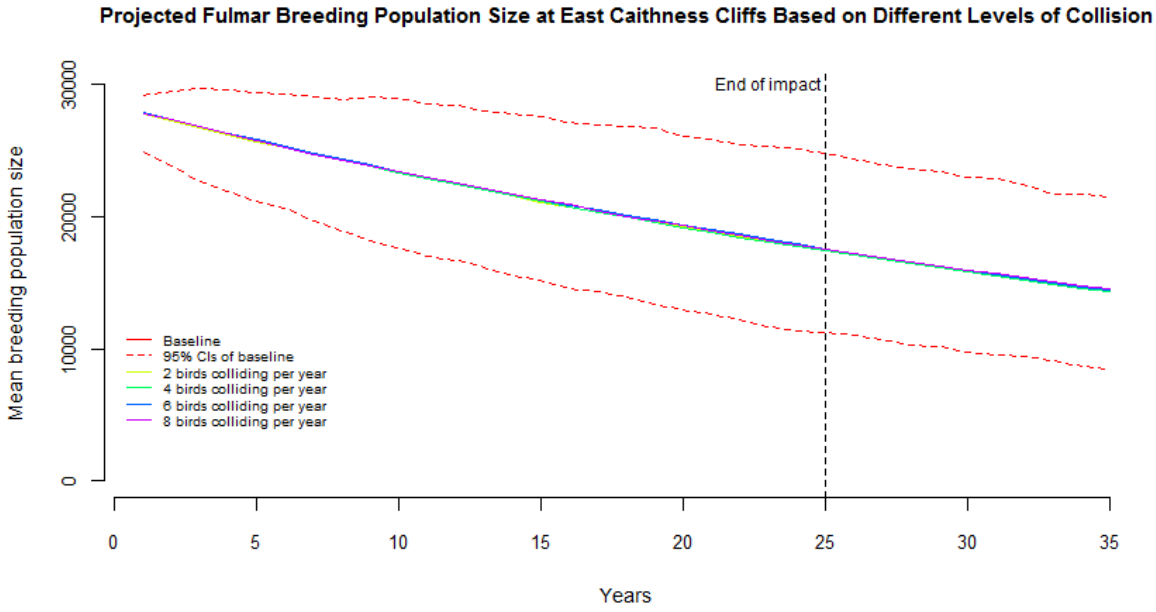


Figure C.25. Population projections for the fulmar population at East Caithness Cliffs at different levels of collision.

Table C.12. Modelled probabilities of dropping below current population size for the fulmar population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.186	0.510	0.802	0.895	0.952	0.978	0.993	0.998	1.000	17503
BOWL and MORL	95.0%	7	0.191	0.519	0.809	0.900	0.955	0.980	0.994	0.998	1.000	17432
BOWL and MORL	98.0%	3	0.189	0.514	0.805	0.897	0.953	0.979	0.993	0.998	1.000	17472
BOWL and MORL	98.5%	2	0.188	0.513	0.804	0.896	0.952	0.978	0.993	0.998	1.000	17483
BOWL and MORL	99.0%	1	0.187	0.512	0.803	0.895	0.952	0.978	0.993	0.998	1.000	17493
BOWL and MORL	99.5%	1	0.187	0.512	0.803	0.895	0.952	0.978	0.993	0.998	1.000	17493

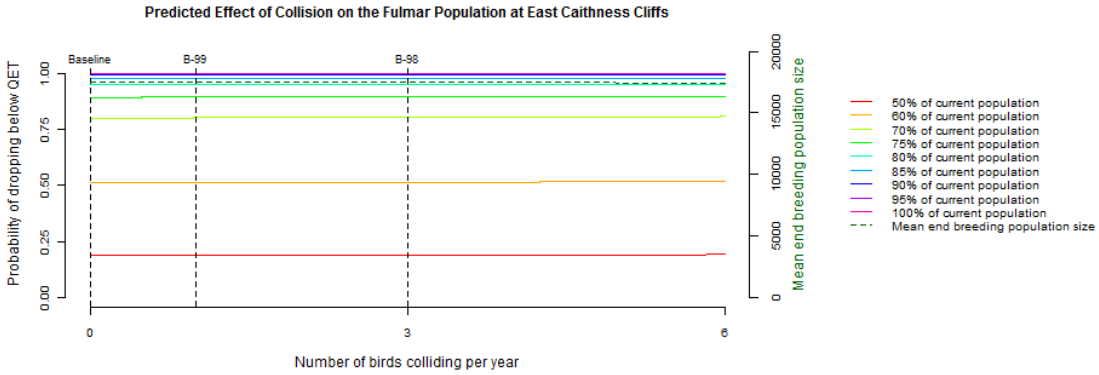


Figure C.26. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

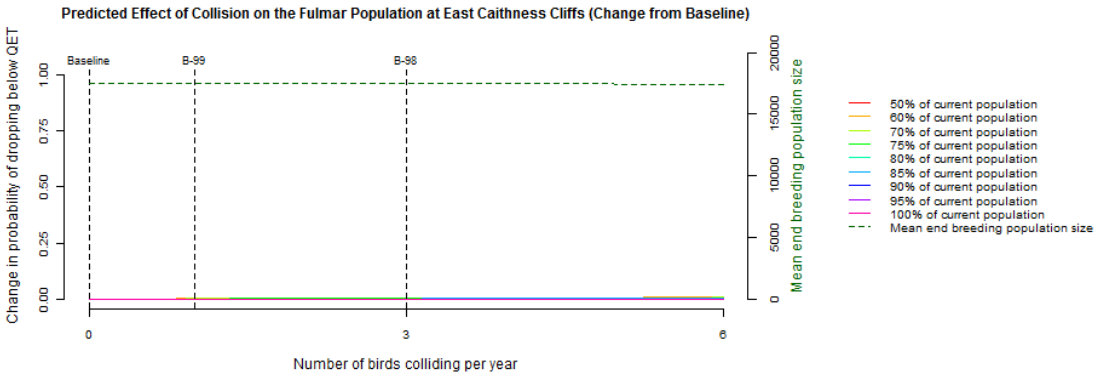


Figure C.27. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table C.13. Modelled probabilities of dropping below current population size for the fulmar population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.544	0.827	0.952	0.979	0.991	0.997	0.999	1.000	1.000	14435
BOWL and MORL	95.0%	7	0.551	0.831	0.955	0.981	0.992	0.997	0.999	1.000	1.000	14377
BOWL and MORL	98.0%	3	0.547	0.828	0.954	0.980	0.992	0.997	0.999	1.000	1.000	14410
BOWL and MORL	98.5%	2	0.546	0.828	0.953	0.980	0.992	0.997	0.999	1.000	1.000	14419
BOWL and MORL	99.0%	1	0.545	0.827	0.953	0.980	0.991	0.997	0.999	1.000	1.000	14427
BOWL and MORL	99.5%	1	0.545	0.827	0.953	0.980	0.991	0.997	0.999	1.000	1.000	14427

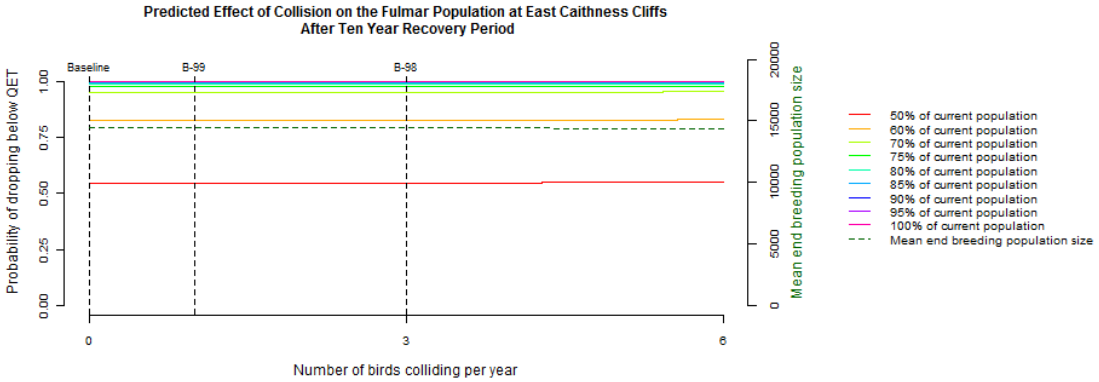


Figure C.28. Probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

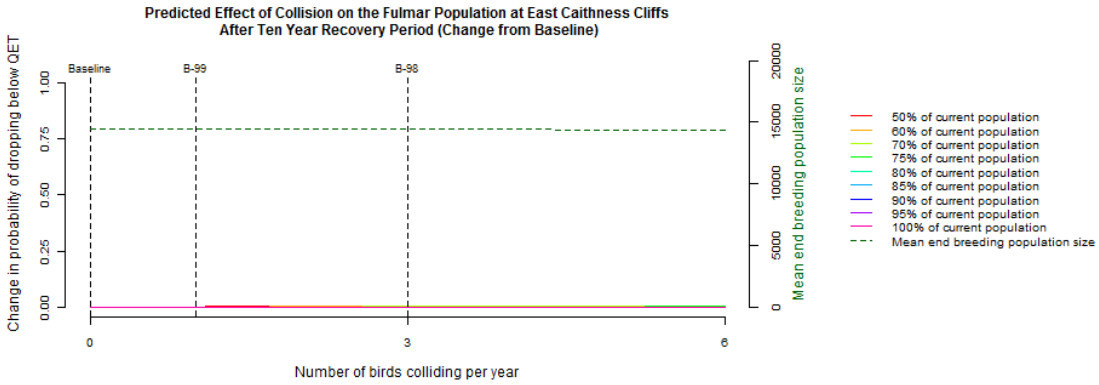


Figure C.29. Change in probability of the fulmar population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table C.14. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the fulmar population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.001	0.009	0.052	0.091	0.149	0.226	0.321	0.421	0.519	17503
BOWL and MORL	95.0%	7	0.001	0.009	0.053	0.093	0.153	0.232	0.327	0.428	0.528	17432
BOWL and MORL	98.0%	3	0.001	0.009	0.052	0.092	0.151	0.229	0.324	0.424	0.523	17472
BOWL and MORL	98.5%	2	0.001	0.009	0.052	0.091	0.150	0.228	0.323	0.423	0.521	17483
BOWL and MORL	99.0%	1	0.001	0.009	0.052	0.091	0.149	0.227	0.322	0.422	0.520	17493
BOWL and MORL	99.5%	1	0.001	0.009	0.052	0.091	0.149	0.227	0.322	0.422	0.520	17493

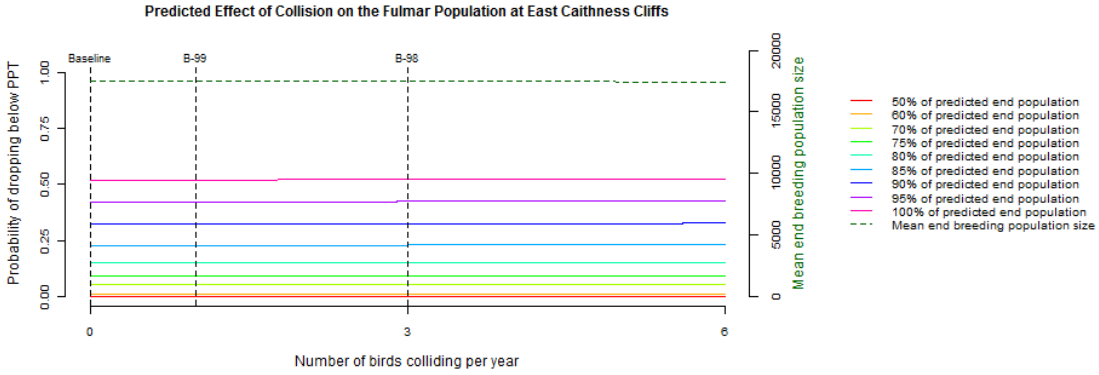


Figure C.30. Probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

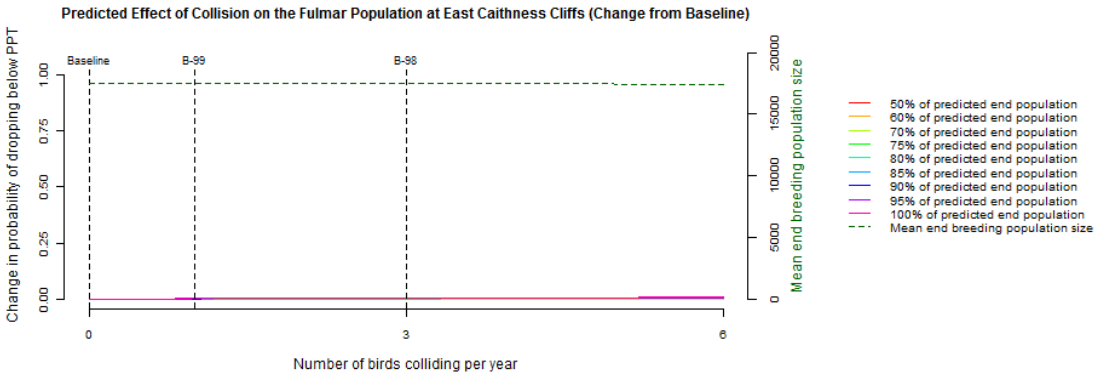


Figure C.31. Change in probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table C.15. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the fulmar population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.024	0.104	0.265	0.366	0.475	0.583	0.681	0.761	0.826	14435
BOWL and MORL	95.0%	7	0.026	0.107	0.271	0.373	0.482	0.589	0.686	0.765	0.829	14377
BOWL and MORL	98.0%	3	0.025	0.105	0.268	0.369	0.478	0.586	0.683	0.763	0.827	14410
BOWL and MORL	98.5%	2	0.025	0.105	0.267	0.368	0.477	0.585	0.682	0.762	0.827	14419
BOWL and MORL	99.0%	1	0.025	0.104	0.266	0.367	0.476	0.584	0.682	0.761	0.826	14427
BOWL and MORL	99.5%	1	0.025	0.104	0.266	0.367	0.476	0.584	0.682	0.761	0.826	14427

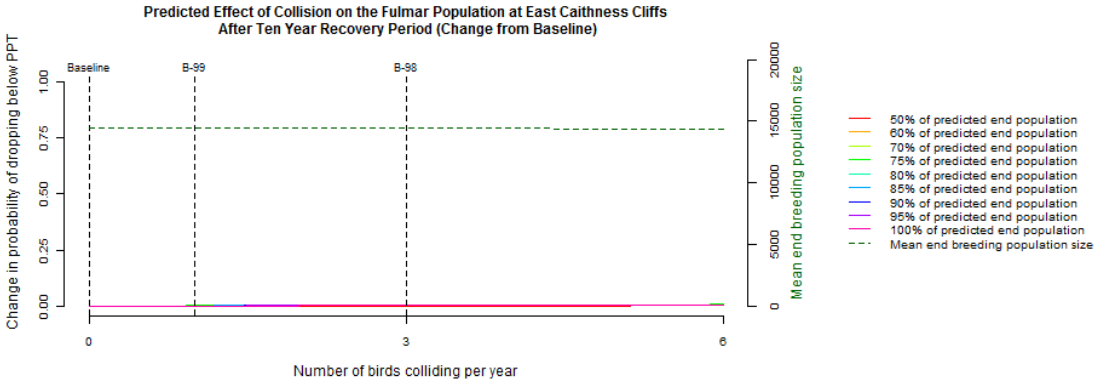


Figure C.32. Probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

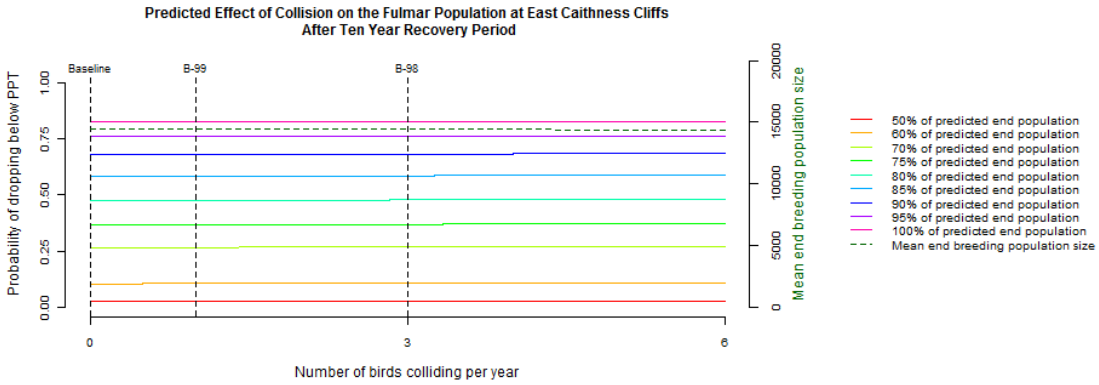


Figure C.33. Change in probability of the fulmar population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix D – PVA Outputs: Fulmar – North Caithness

Collision and displacement

Table D.1. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.184	0.507	0.805	0.896	0.950	0.979	0.992	0.998	1.000	17540
BOWL and MORL	50%	49	95.0%	25	0.203	0.546	0.834	0.915	0.961	0.984	0.994	0.998	1.000	17203
BOWL and MORL	50	49	98.0%	10	0.191	0.523	0.817	0.904	0.955	0.981	0.993	0.998	1.000	17405
BOWL and MORL	50	49	98.5%	7	0.189	0.518	0.814	0.902	0.953	0.980	0.993	0.998	1.000	17445
BOWL and MORL	50	49	99.0%	5	0.187	0.515	0.811	0.900	0.953	0.980	0.993	0.998	1.000	17472
BOWL and MORL	50	49	99.5%	2	0.185	0.511	0.808	0.898	0.951	0.979	0.992	0.998	1.000	17513

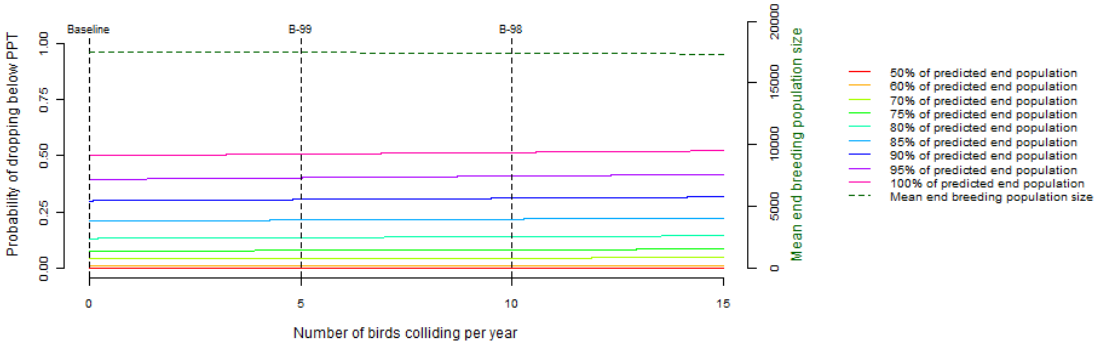


Figure D.1. Probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

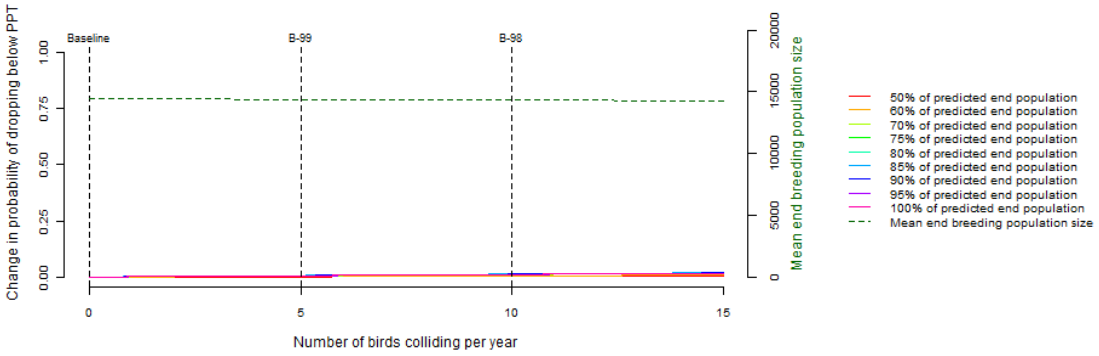


Figure D.2. Change in probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table D.2. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.539	0.821	0.953	0.981	0.991	0.995	0.998	0.999	1.000	14439
BOWL and MORL	50%	49	95.0%	25	0.570	0.846	0.961	0.985	0.994	0.998	0.999	1.000	1.000	14158
BOWL and MORL	50	49	98.0%	10	0.552	0.832	0.957	0.983	0.993	0.996	0.998	1.000	1.000	14326
BOWL and MORL	50	49	98.5%	7	0.548	0.828	0.956	0.982	0.992	0.996	0.998	1.000	1.000	14360
BOWL and MORL	50	49	99.0%	5	0.546	0.826	0.955	0.982	0.992	0.996	0.998	1.000	1.000	14383
BOWL and MORL	50	49	99.5%	2	0.542	0.823	0.954	0.981	0.991	0.995	0.998	0.999	1.000	14416

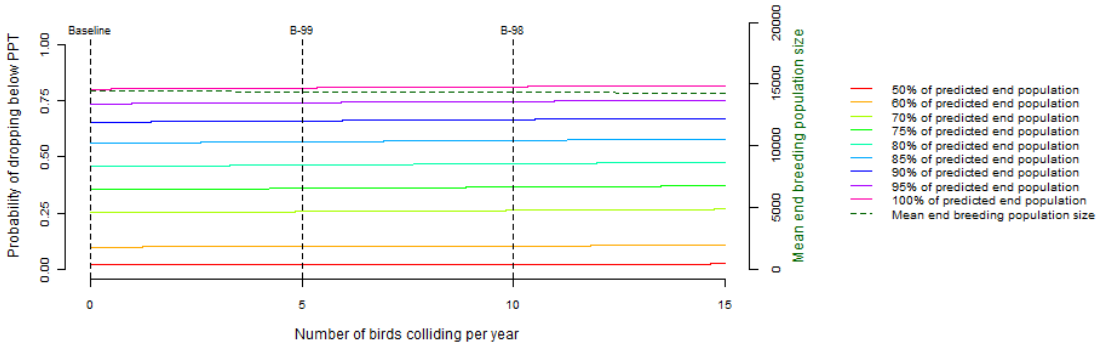


Figure D.3. Probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

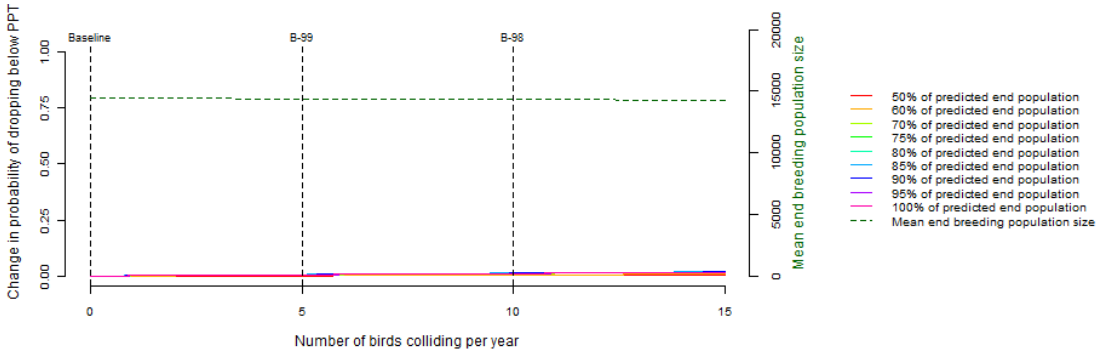


Figure D.4. Change in probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

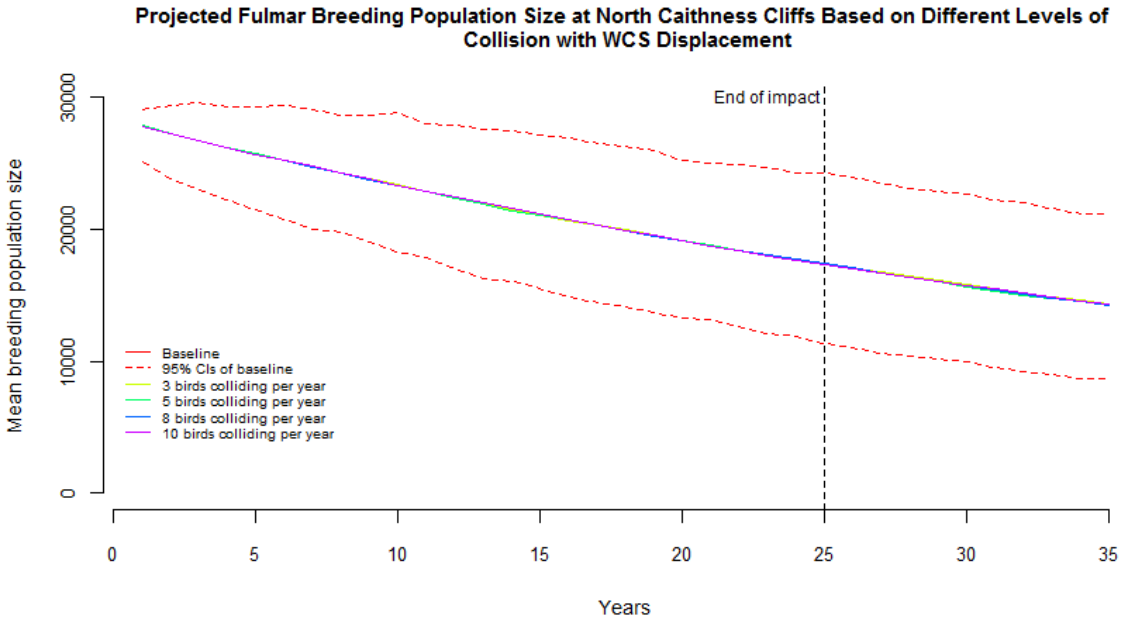


Figure D.5. Population projections for the fulmar population at North Caithness Cliffs at different levels of collision with a high level of displacement.

Table D.3. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.183	0.522	0.809	0.899	0.949	0.982	0.994	0.998	1.000	17449
BOWL and MORL	100%	161	95.0%	25	0.206	0.547	0.833	0.913	0.960	0.985	0.995	0.999	1.000	17187
BOWL and MORL	100%	161	98.0%	10	0.192	0.532	0.819	0.905	0.954	0.983	0.994	0.998	1.000	17344
BOWL and MORL	100%	161	98.5%	7	0.189	0.529	0.816	0.903	0.952	0.983	0.994	0.998	1.000	17375
BOWL and MORL	100%	161	99.0%	5	0.187	0.527	0.814	0.902	0.952	0.982	0.994	0.998	1.000	17396
BOWL and MORL	100%	161	99.5%	2	0.185	0.524	0.811	0.901	0.950	0.982	0.994	0.998	1.000	17428

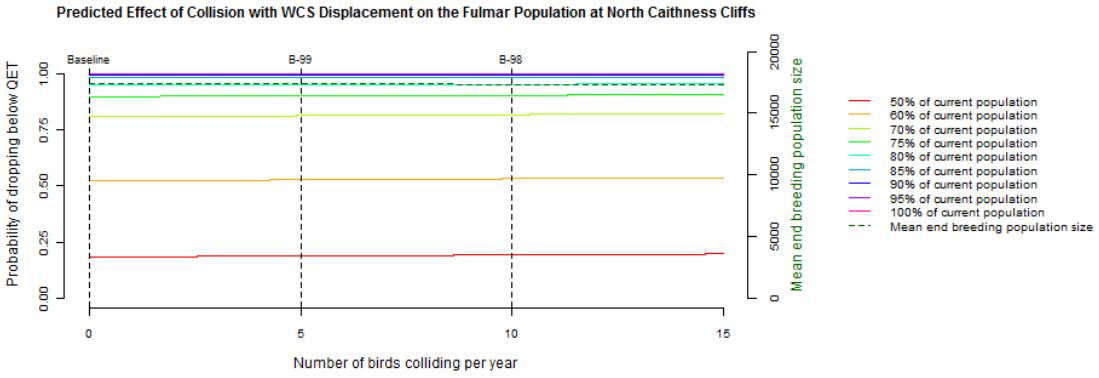


Figure D.6. Change in probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

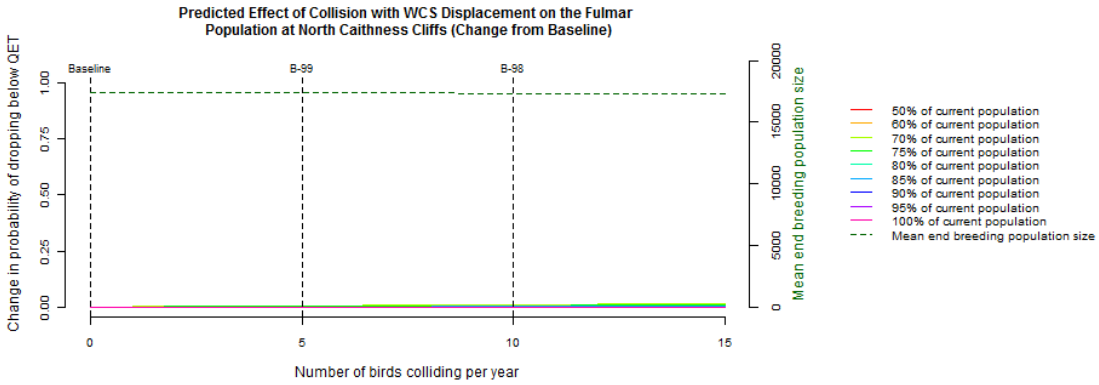


Figure D.7. Change in probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table D.4. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.550	0.827	0.958	0.981	0.994	0.998	1.000	1.000	1.000	14361
BOWL and MORL	100%	161	95.0%	25	0.572	0.846	0.963	0.984	0.995	0.998	1.000	1.000	1.000	14156
BOWL and MORL	100%	161	98.0%	10	0.559	0.835	0.960	0.982	0.995	0.998	1.000	1.000	1.000	14279
BOWL and MORL	100%	161	98.5%	7	0.556	0.833	0.960	0.982	0.994	0.998	1.000	1.000	1.000	14303
BOWL and MORL	100%	161	99.0%	5	0.555	0.831	0.959	0.982	0.994	0.998	1.000	1.000	1.000	14320
BOWL and MORL	100%	161	99.5%	2	0.552	0.829	0.959	0.981	0.994	0.998	1.000	1.000	1.000	14345

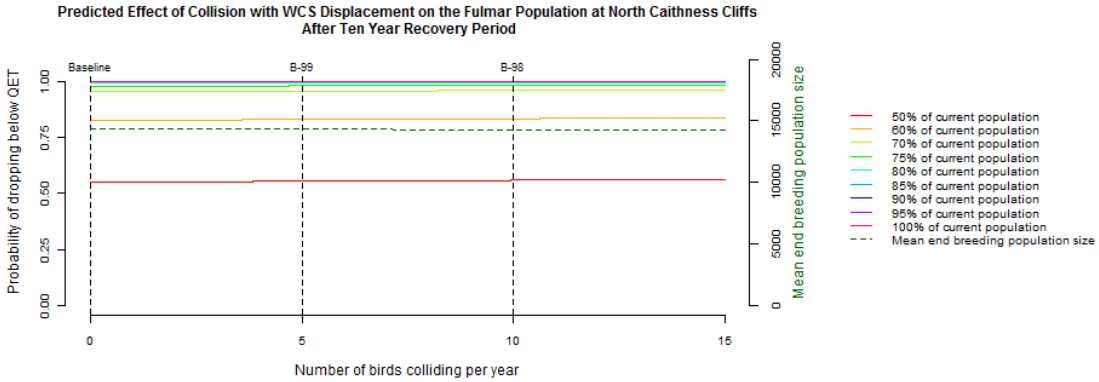


Figure D.8. Probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

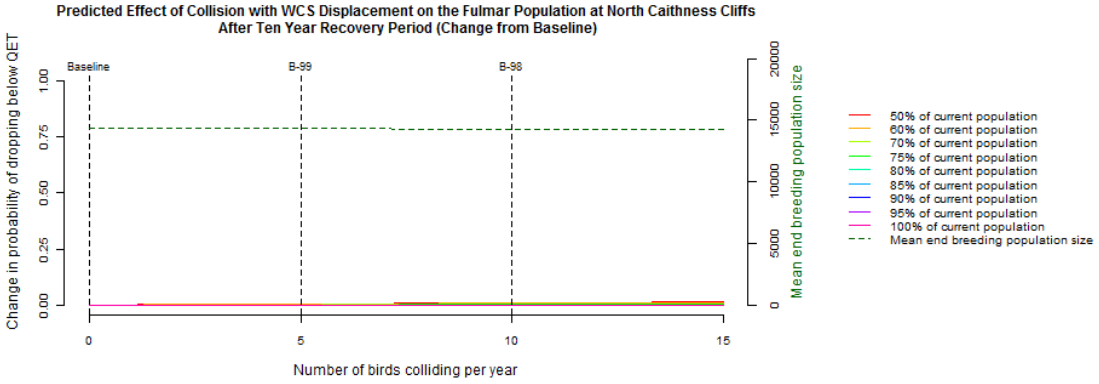


Figure D.9. Change in probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table D.5. Modelled probabilities of dropping below baseline predicted population size for the fulmar population at North Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.001	0.011	0.046	0.084	0.138	0.210	0.301	0.402	0.507	17449
BOWL and MORL	100%	161	95.0%	25	0.001	0.011	0.052	0.094	0.155	0.232	0.325	0.431	0.533	17187
BOWL and MORL	100%	161	98.0%	10	0.001	0.011	0.048	0.088	0.145	0.219	0.311	0.413	0.518	17344
BOWL and MORL	100%	161	98.5%	7	0.001	0.011	0.047	0.087	0.143	0.216	0.308	0.410	0.515	17375
BOWL and MORL	100%	161	99.0%	5	0.001	0.011	0.047	0.086	0.141	0.215	0.306	0.407	0.513	17396
BOWL and MORL	100%	161	99.5%	2	0.001	0.011	0.046	0.085	0.139	0.212	0.303	0.404	0.509	17428

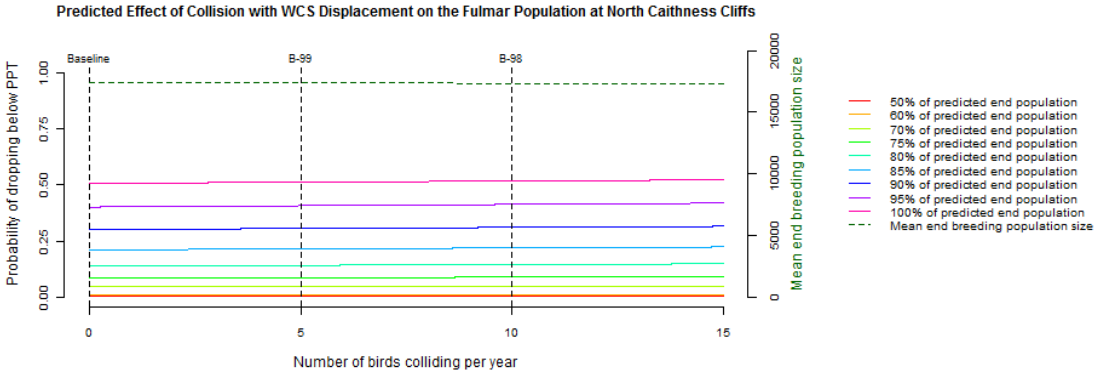


Figure D.10. Probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

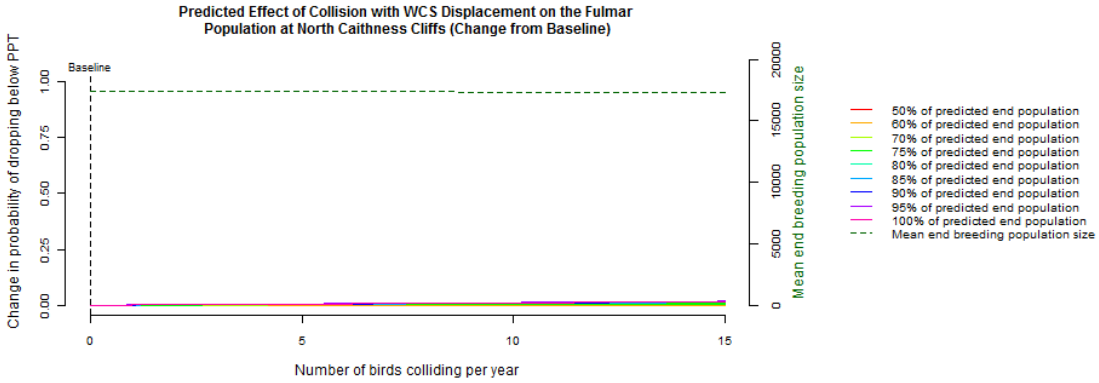


Figure D.11. Change in probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table D.6. Modelled probabilities of dropping below baseline predicted population size for the fulmar population at North Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.021	0.099	0.251	0.355	0.465	0.567	0.667	0.746	0.814	14361
BOWL and MORL	100%	161	95.0%	25	0.025	0.109	0.273	0.380	0.487	0.590	0.685	0.765	0.830	14156
BOWL and MORL	100%	161	98.0%	10	0.023	0.103	0.259	0.365	0.474	0.576	0.674	0.754	0.820	14279
BOWL and MORL	100%	161	98.5%	7	0.022	0.102	0.257	0.362	0.471	0.574	0.672	0.752	0.818	14303
BOWL and MORL	100%	161	99.0%	5	0.022	0.101	0.255	0.360	0.470	0.572	0.671	0.750	0.817	14320
BOWL and MORL	100%	161	99.5%	2	0.022	0.100	0.252	0.357	0.467	0.569	0.668	0.748	0.815	14345

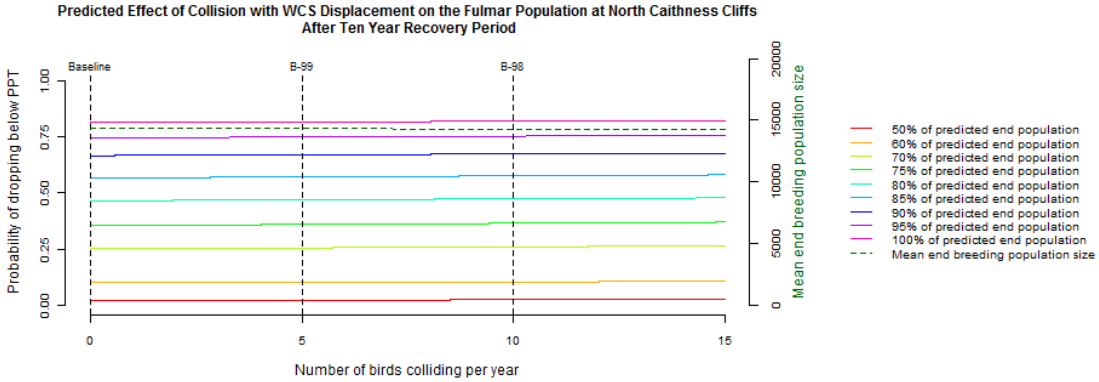


Figure D.12. Probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

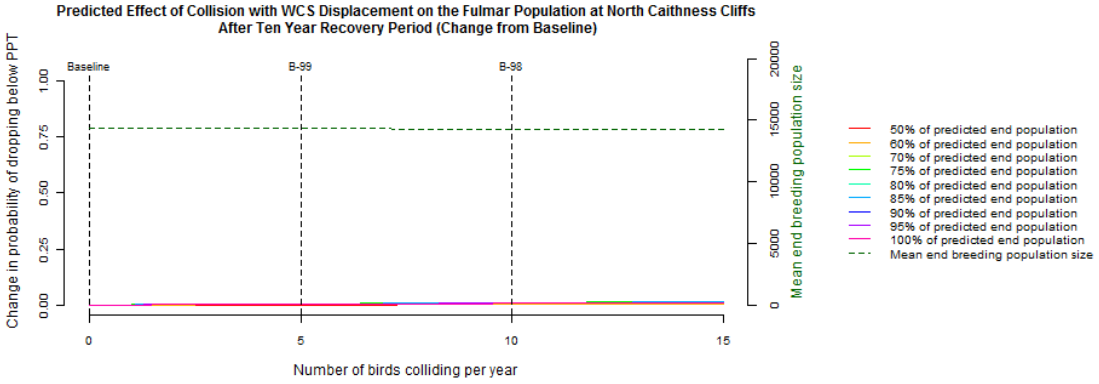


Figure D.13. Change in probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Displacement

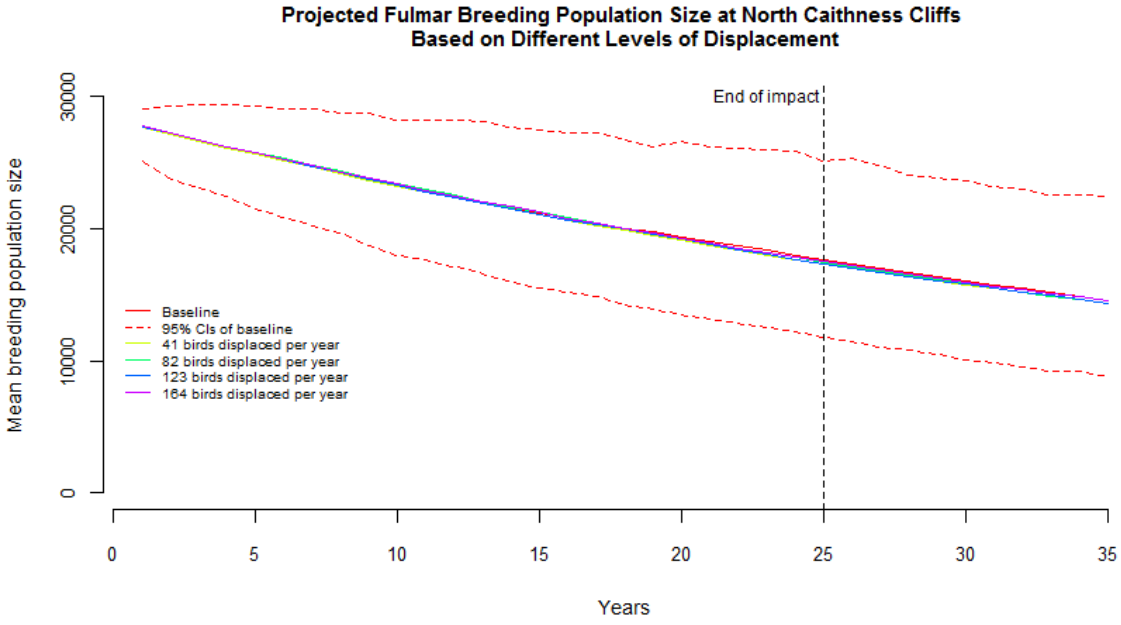


Figure D.14. Population projections for the fulmar population at North Caithness Cliffs at different levels of displacement.

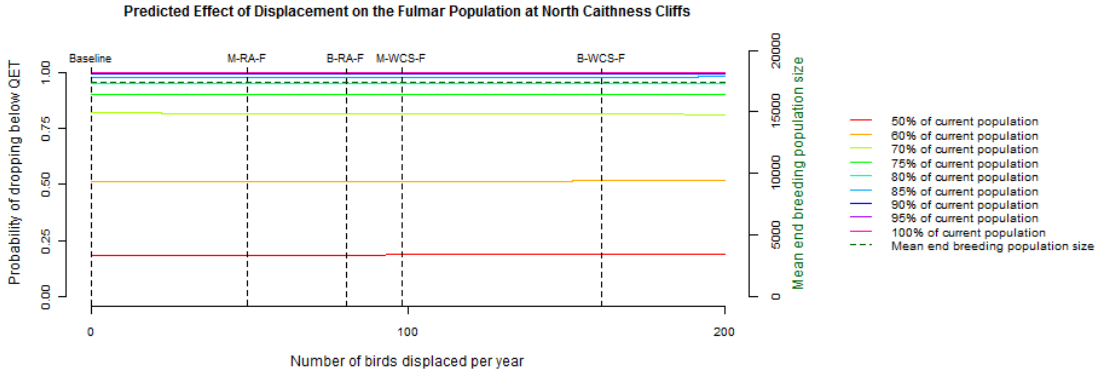


Figure D.15. Probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

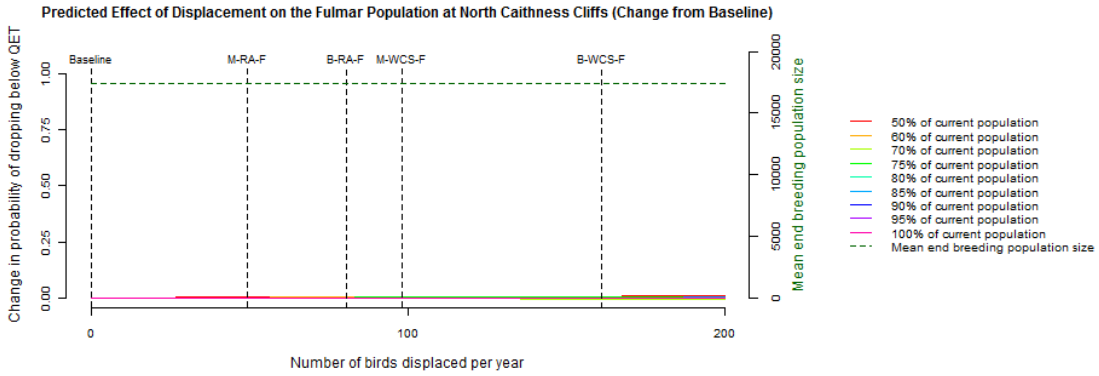


Figure D.16. Change in probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table D.7. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14406
Whole site	100%	98	0.546	0.829	0.955	0.980	0.992	0.997	0.999	1.000	1.000	14387
Whole site	50%	49	0.546	0.830	0.954	0.980	0.992	0.997	0.999	1.000	1.000	14396
Sum of MacColl, Telford & Stevenson	100%	98	0.546	0.829	0.955	0.980	0.992	0.997	0.999	1.000	1.000	14387
Sum of MacColl, Telford & Stevenson	50%	49	0.546	0.830	0.954	0.980	0.992	0.997	0.999	1.000	1.000	14396
MacColl	100%	37	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14399
MacColl	50%	18	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14402
Telford	100%	34	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14399
Telford	50%	17	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14403
Stevenson	100%	28	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14401
Stevenson	50%	14	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14403
MacColl and Stevenson	100%	64	0.546	0.830	0.954	0.980	0.992	0.997	0.999	1.000	1.000	14393
MacColl and Stevenson	50%	32	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14400
Stevenson and Telford	100%	62	0.546	0.830	0.954	0.980	0.992	0.997	0.999	1.000	1.000	14394
Stevenson and Telford	50%	31	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14400
Telford and MacColl	100%	71	0.546	0.830	0.954	0.980	0.992	0.997	0.999	1.000	1.000	14392
Telford and MacColl	50%	35	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14399
BOWL	100%	63	0.546	0.830	0.954	0.980	0.992	0.997	0.999	1.000	1.000	14394
BOWL	50%	31	0.546	0.830	0.954	0.980	0.992	0.997	1.000	1.000	1.000	14400
BOWL and MORL	100%	161	0.547	0.829	0.955	0.980	0.992	0.997	0.999	1.000	1.000	14374
BOWL and MORL	50%	81	0.546	0.830	0.954	0.980	0.992	0.997	0.999	1.000	1.000	14390

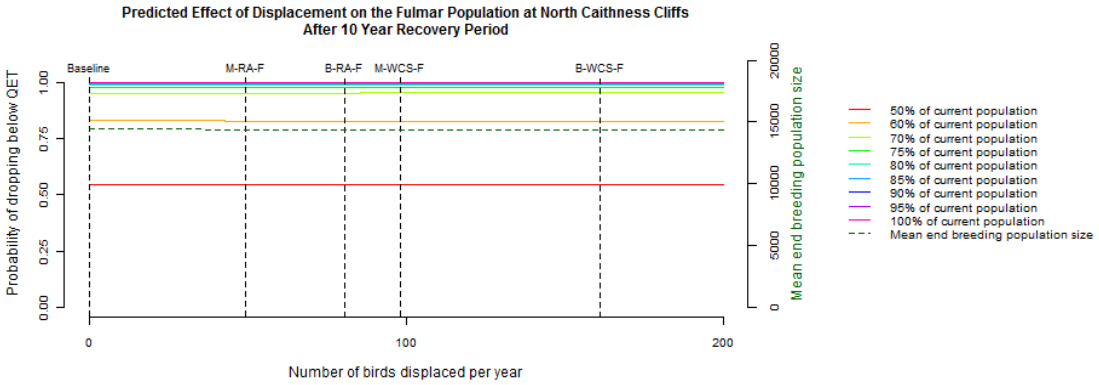


Figure D.17. Probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

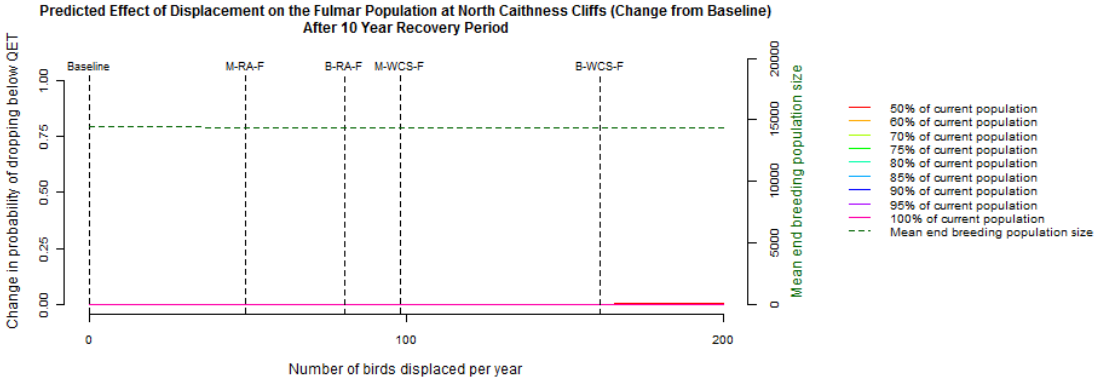


Figure D.18. Change in probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table D.8. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the fulmar population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years)

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.001	0.007	0.038	0.079	0.139	0.208	0.298	0.403	0.505	17433
Whole site	100%	98	0.001	0.007	0.040	0.080	0.140	0.211	0.302	0.404	0.506	17431
Whole site	50%	49	0.001	0.007	0.039	0.080	0.139	0.210	0.300	0.404	0.506	17432
Sum of MacColl, Telford & Stevenson	100%	98	0.001	0.007	0.040	0.080	0.140	0.211	0.302	0.404	0.506	17431
Sum of MacColl, Telford & Stevenson	50%	49	0.001	0.007	0.039	0.080	0.139	0.210	0.300	0.404	0.506	17432
MacColl	100%	37	0.001	0.007	0.039	0.080	0.139	0.210	0.300	0.403	0.506	17432
MacColl	50%	18	0.001	0.007	0.039	0.080	0.139	0.209	0.299	0.403	0.505	17433
Telford	100%	34	0.001	0.007	0.039	0.080	0.139	0.210	0.300	0.403	0.506	17432
Telford	50%	17	0.001	0.007	0.039	0.080	0.139	0.209	0.299	0.403	0.505	17433
Stevenson	100%	28	0.001	0.007	0.039	0.080	0.139	0.209	0.300	0.403	0.506	17432
Stevenson	50%	14	0.001	0.007	0.039	0.080	0.139	0.209	0.299	0.403	0.505	17433
MacColl and Stevenson	100%	64	0.001	0.007	0.039	0.080	0.140	0.210	0.301	0.404	0.506	17432
MacColl and Stevenson	50%	32	0.001	0.007	0.039	0.080	0.139	0.209	0.300	0.403	0.506	17432
Stevenson and Telford	100%	62	0.001	0.007	0.039	0.080	0.140	0.210	0.301	0.404	0.506	17432
Stevenson and Telford	50%	31	0.001	0.007	0.039	0.080	0.139	0.209	0.300	0.403	0.506	17432
Telford and MacColl	100%	71	0.001	0.007	0.039	0.080	0.140	0.211	0.301	0.404	0.506	17432
Telford and MacColl	50%	35	0.001	0.007	0.039	0.080	0.139	0.210	0.300	0.403	0.506	17432
BOWL	100%	63	0.001	0.007	0.039	0.080	0.140	0.210	0.301	0.404	0.506	17432
BOWL	50%	31	0.001	0.007	0.039	0.080	0.139	0.209	0.300	0.403	0.506	17432
BOWL and MORL	100%	161	0.001	0.007	0.041	0.081	0.141	0.213	0.305	0.405	0.506	17431
BOWL and MORL	50%	81	0.001	0.007	0.039	0.080	0.140	0.211	0.302	0.404	0.506	17432

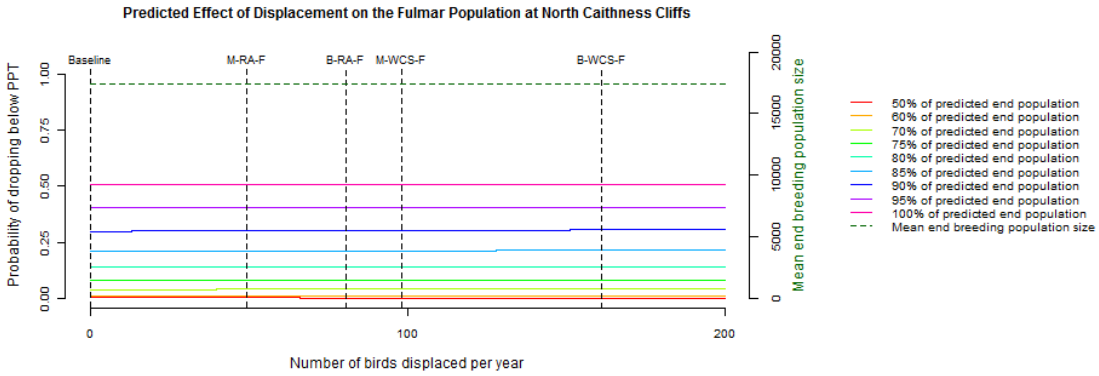


Figure D.19. Probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

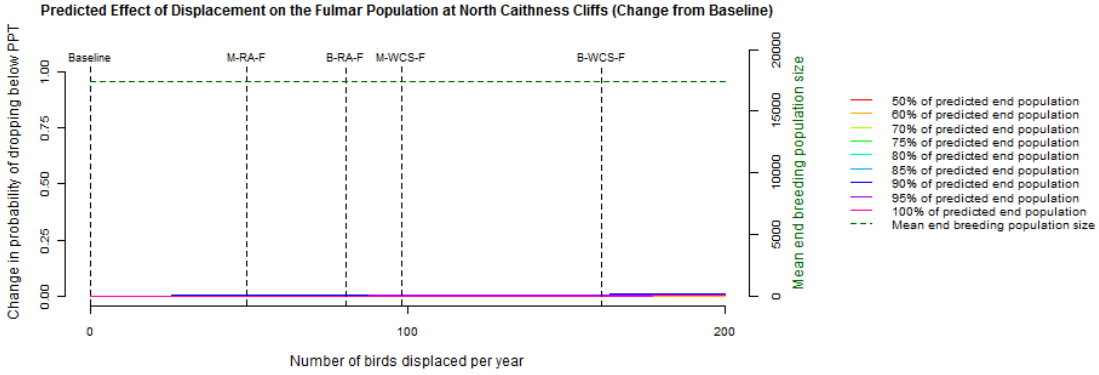


Figure D.20. Change in probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table D.9. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the fulmar population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.019	0.090	0.248	0.352	0.467	0.564	0.667	0.751	0.818	14406
Whole site	100%	98	0.020	0.093	0.252	0.356	0.467	0.567	0.667	0.750	0.817	14387
Whole site	50%	49	0.020	0.091	0.250	0.354	0.467	0.565	0.667	0.750	0.817	14396
Sum of MacColl, Telford & Stevenson	100%	98	0.020	0.093	0.252	0.356	0.467	0.567	0.667	0.750	0.817	14387
Sum of MacColl, Telford & Stevenson	50%	49	0.020	0.091	0.250	0.354	0.467	0.565	0.667	0.750	0.817	14396
MacColl	100%	37	0.020	0.091	0.250	0.353	0.467	0.565	0.667	0.750	0.817	14399
MacColl	50%	18	0.019	0.090	0.249	0.353	0.467	0.565	0.667	0.751	0.818	14402
Telford	100%	34	0.019	0.091	0.250	0.353	0.467	0.565	0.667	0.750	0.817	14399
Telford	50%	17	0.019	0.090	0.249	0.353	0.467	0.565	0.667	0.751	0.818	14403
Stevenson	100%	28	0.019	0.091	0.249	0.353	0.467	0.565	0.667	0.751	0.818	14401
Stevenson	50%	14	0.019	0.090	0.249	0.353	0.467	0.565	0.667	0.751	0.818	14403
MacColl and Stevenson	100%	64	0.020	0.092	0.251	0.354	0.467	0.566	0.667	0.750	0.817	14393
MacColl and Stevenson	50%	32	0.019	0.091	0.249	0.353	0.467	0.565	0.667	0.751	0.818	14400
Stevenson and Telford	100%	62	0.020	0.092	0.251	0.354	0.467	0.566	0.667	0.750	0.817	14394
Stevenson and Telford	50%	31	0.019	0.091	0.249	0.353	0.467	0.565	0.667	0.751	0.818	14400
Telford and MacColl	100%	71	0.020	0.092	0.251	0.355	0.467	0.566	0.667	0.750	0.817	14392
Telford and MacColl	50%	35	0.019	0.091	0.250	0.353	0.467	0.565	0.667	0.750	0.817	14399
BOWL	100%	63	0.020	0.092	0.251	0.354	0.467	0.566	0.667	0.750	0.817	14394
BOWL	50%	31	0.019	0.091	0.249	0.353	0.467	0.565	0.667	0.751	0.818	14400
BOWL and MORL	100%	161	0.021	0.095	0.255	0.358	0.467	0.568	0.667	0.749	0.816	14374
BOWL and MORL	50%	81	0.020	0.092	0.252	0.355	0.467	0.566	0.667	0.750	0.817	14390

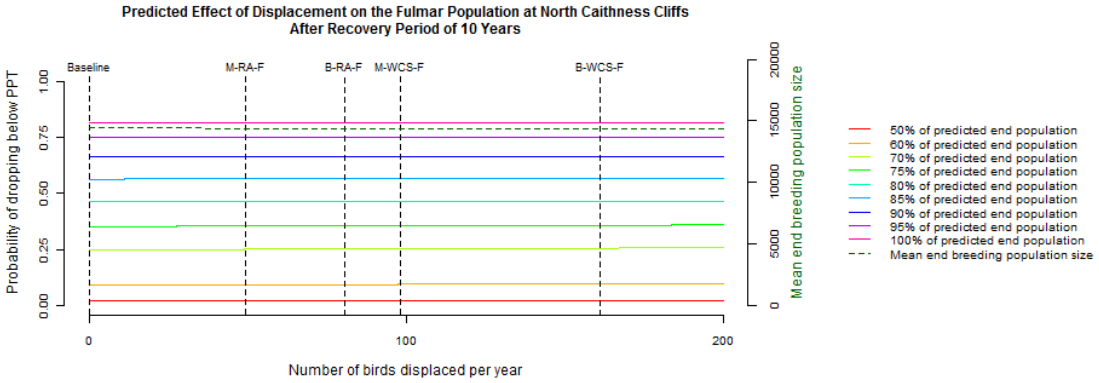


Figure D.21. Probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

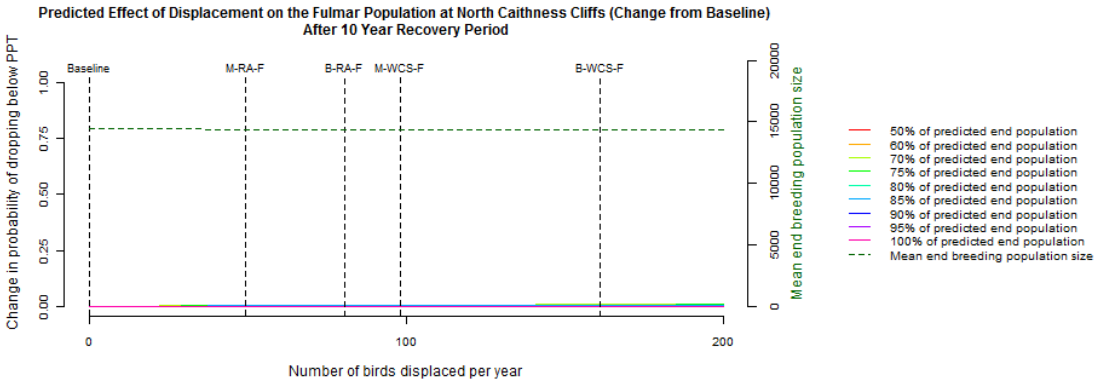


Figure D.22. Change in probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Collision

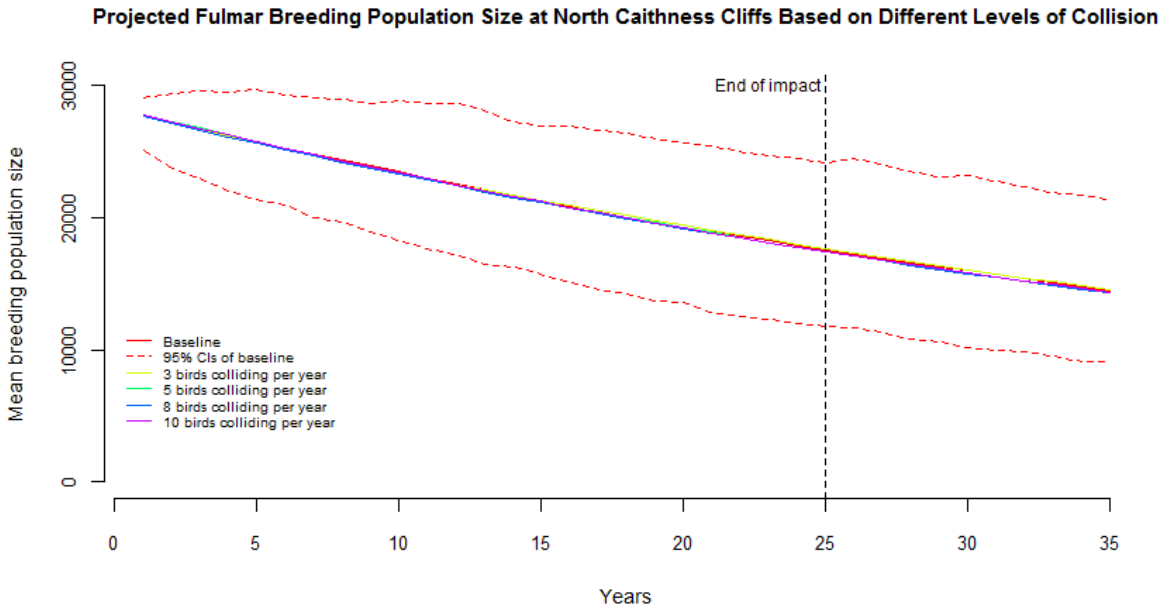


Figure D.23. Population projections for the fulmar population at North Caithness Cliffs at different levels of collision.

Table D.10. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size.

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.171	0.489	0.803	0.900	0.949	0.976	0.991	0.997	1.000	17591
BOWL and MORL	95%	25	0.198	0.537	0.830	0.913	0.958	0.983	0.994	0.998	1.000	17250
BOWL and MORL	98%	10	0.182	0.508	0.814	0.905	0.953	0.979	0.993	0.998	1.000	17454
BOWL and MORL	98.50%	7	0.178	0.502	0.811	0.904	0.951	0.978	0.992	0.997	1.000	17495
BOWL and MORL	99%	5	0.176	0.498	0.809	0.903	0.951	0.978	0.992	0.997	1.000	17522
BOWL and MORL	99.50%	2	0.173	0.493	0.805	0.902	0.950	0.977	0.992	0.997	1.000	17564

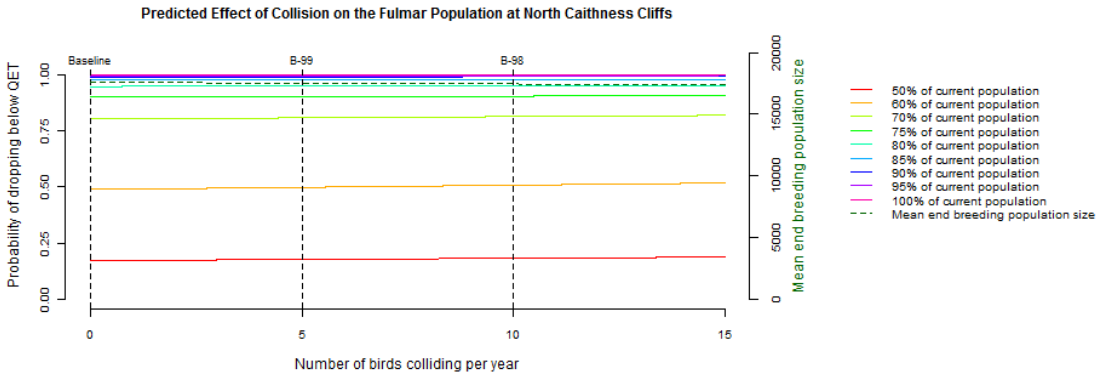


Figure D.24. Probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

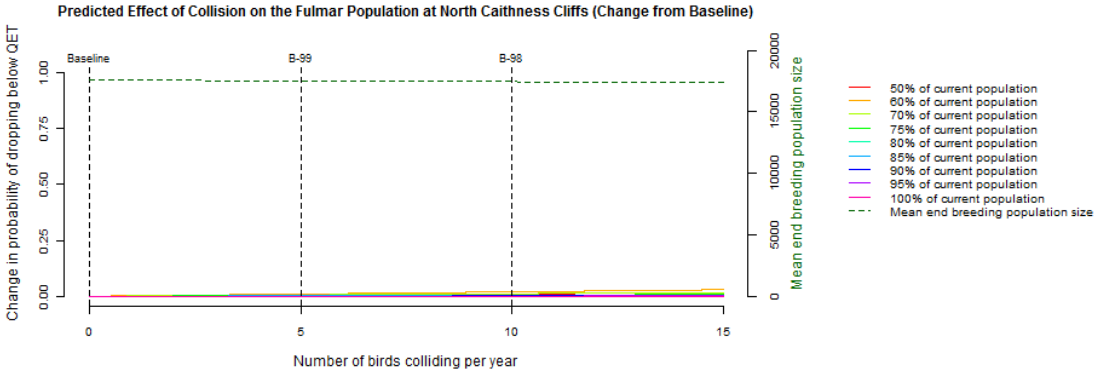


Figure D.25. Change in probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table D.11. Modelled probabilities of dropping below current population size for the fulmar population at North Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.000	0.007	0.038	0.077	0.131	0.194	0.282	0.381	0.479	17591
BOWL and MORL	95%	25	0.001	0.010	0.047	0.091	0.150	0.225	0.319	0.422	0.527	17250
BOWL and MORL	98%	10	0.000	0.008	0.042	0.082	0.138	0.206	0.297	0.397	0.498	17454
BOWL and MORL	98.50%	7	0.000	0.008	0.040	0.081	0.136	0.202	0.292	0.392	0.493	17495
BOWL and MORL	99%	5	0.000	0.008	0.040	0.080	0.134	0.200	0.290	0.389	0.489	17522
BOWL and MORL	99.50%	2	0.000	0.007	0.039	0.078	0.132	0.197	0.285	0.384	0.483	17564

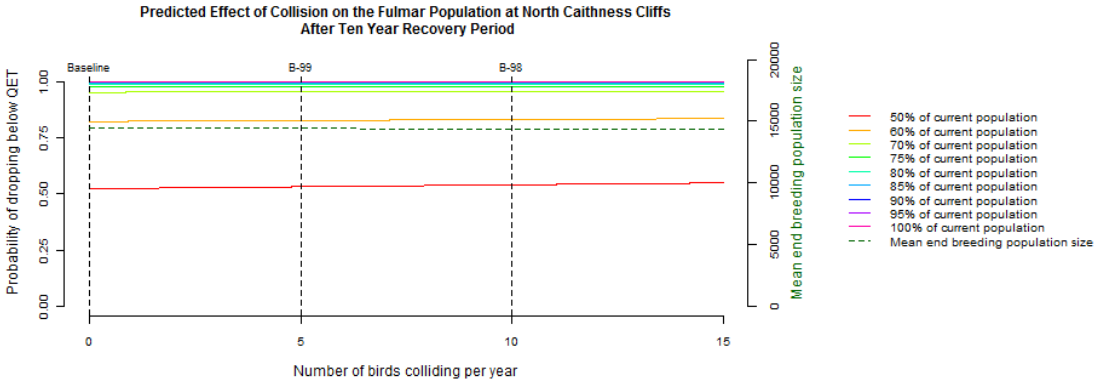


Figure D.26. Probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

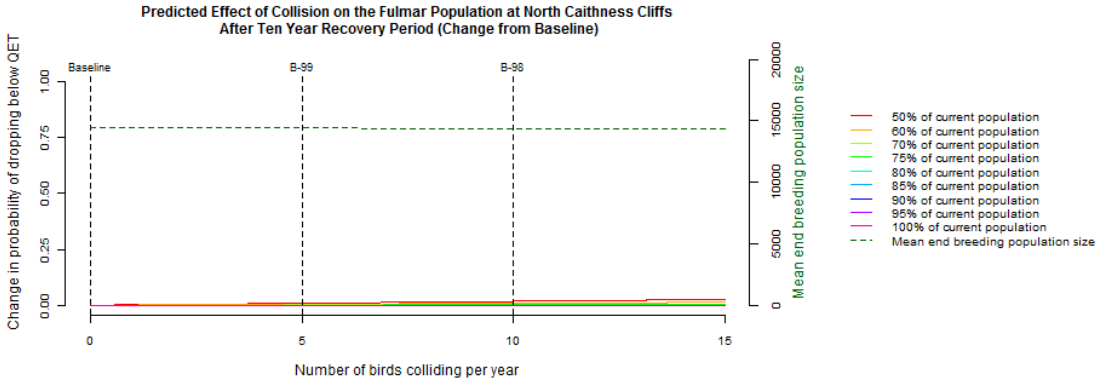


Figure D.27. Change in probability of the fulmar population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table D.12. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the fulmar population at North Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.000	0.007	0.038	0.077	0.131	0.194	0.282	0.381	0.479	17591
BOWL and MORL	95%	25	0.001	0.010	0.047	0.091	0.150	0.225	0.319	0.422	0.527	17250
BOWL and MORL	98%	10	0.000	0.008	0.042	0.082	0.138	0.206	0.297	0.397	0.498	17454
BOWL and MORL	98.50%	7	0.000	0.008	0.040	0.081	0.136	0.202	0.292	0.392	0.493	17495
BOWL and MORL	99%	5	0.000	0.008	0.040	0.080	0.134	0.200	0.290	0.389	0.489	17522
BOWL and MORL	99.50%	2	0.000	0.007	0.039	0.078	0.132	0.197	0.285	0.384	0.483	17564

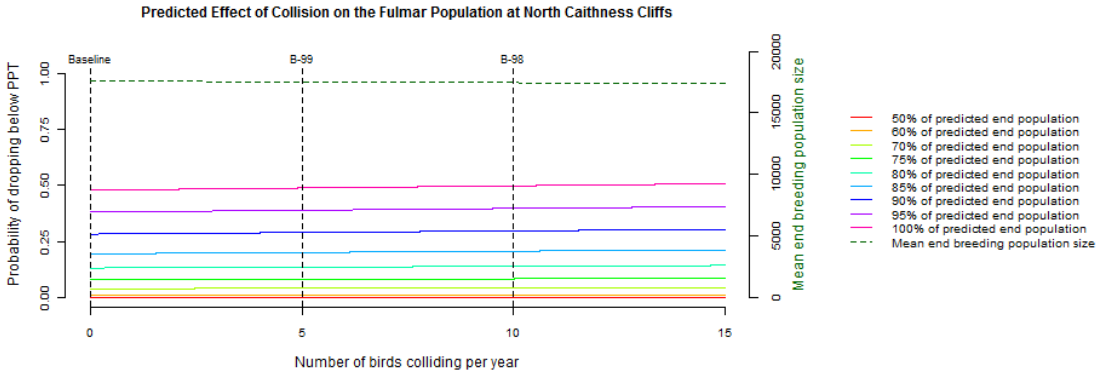


Figure D.28. Probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

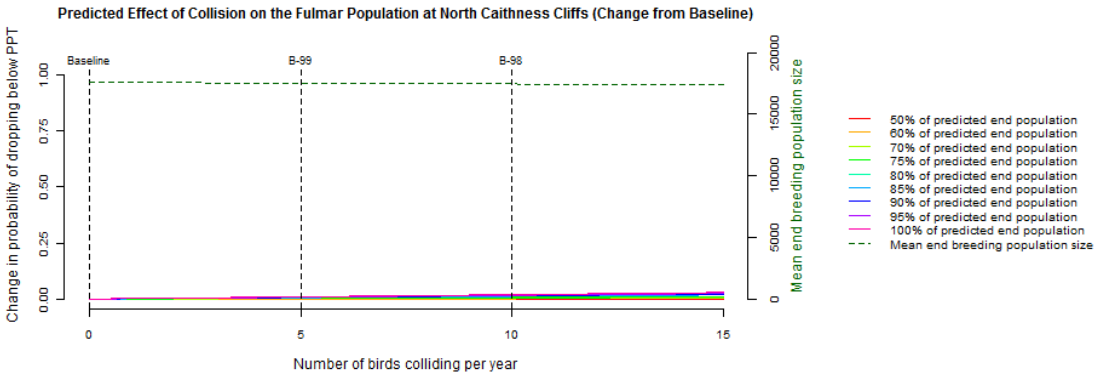


Figure D.29. Change in probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table D.13. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the fulmar population at North Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.022	0.092	0.246	0.340	0.445	0.548	0.643	0.737	0.807	14465
BOWL and MORL	95%	25	0.025	0.108	0.273	0.376	0.483	0.590	0.684	0.767	0.830	14195
BOWL and MORL	98%	10	0.023	0.098	0.257	0.354	0.460	0.565	0.660	0.749	0.817	14357
BOWL and MORL	98.50%	7	0.023	0.096	0.253	0.350	0.455	0.560	0.655	0.746	0.814	14389
BOWL and MORL	99%	5	0.022	0.095	0.251	0.347	0.452	0.556	0.652	0.743	0.812	14411
BOWL and MORL	99.50%	2	0.022	0.093	0.248	0.343	0.448	0.551	0.647	0.740	0.809	14444

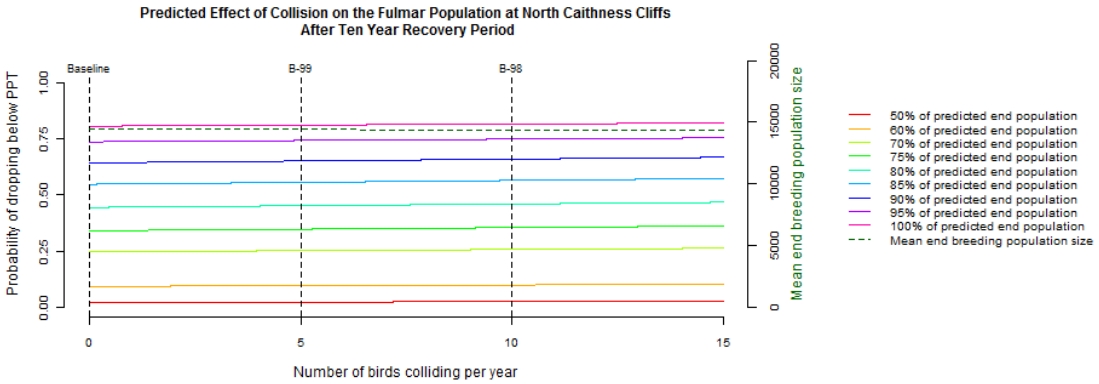


Figure D.30. Probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

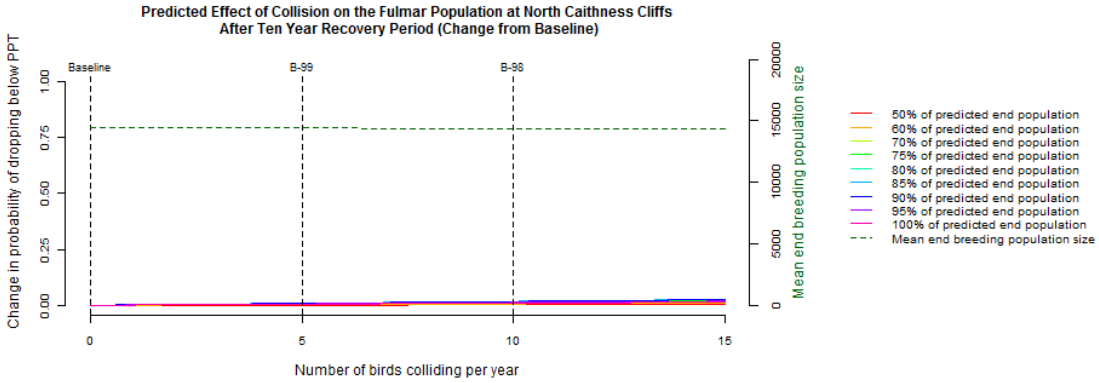


Figure D.31. Change in probability of the fulmar population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix E – PVA Outputs: Gannet – Troup Head

Collision and displacement

Table E.1. Modelled probabilities of dropping below baseline predicted population size for the gannet population at Troup Head with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.000	0.000	0.001	0.002	0.010	0.031	0.118	0.312	0.564	4083
Whole site	50%	30	95.0%	131	0.974	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4082
Whole site	50%	30	98.0%	53	0.000	0.021	0.452	0.829	0.953	0.990	0.995	0.999	1.000	4083
Whole site	50%	30	98.5%	39	0.000	0.003	0.116	0.402	0.750	0.928	0.970	0.993	0.998	4083
Whole site	50%	30	99.0%	26	0.000	0.000	0.021	0.085	0.309	0.635	0.837	0.954	0.987	4083
Whole site	50%	30	99.5%	13	0.000	0.000	0.003	0.013	0.062	0.190	0.454	0.754	0.909	4083
Sum of MacColl, Telford & Stevenson	50%	30	95.0%	157	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4082
Sum of MacColl, Telford & Stevenson	50%	30	98.0%	63	0.002	0.091	0.777	0.958	0.989	0.998	0.999	1.000	1.000	4083
Sum of MacColl, Telford & Stevenson	50%	30	98.5%	47	0.000	0.009	0.279	0.682	0.902	0.977	0.989	0.998	0.999	4083
Sum of MacColl, Telford & Stevenson	50%	30	99.0%	31	0.000	0.001	0.041	0.168	0.485	0.792	0.913	0.978	0.994	4083
Sum of MacColl, Telford & Stevenson	50%	30	99.5%	16	0.000	0.000	0.005	0.019	0.088	0.258	0.543	0.817	0.937	4083
MacColl	50%	30	95.0%	89	0.072	0.831	0.992	0.999	1.000	1.000	1.000	1.000	1.000	4083
MacColl	50%	30	98.0%	36	0.000	0.002	0.071	0.273	0.631	0.877	0.949	0.988	0.997	4083
MacColl	50%	30	98.5%	27	0.000	0.000	0.022	0.090	0.321	0.648	0.844	0.957	0.988	4083
MacColl	50%	30	99.0%	18	0.000	0.000	0.006	0.025	0.115	0.322	0.612	0.858	0.953	4083
MacColl	50%	30	99.5%	9	0.000	0.000	0.002	0.007	0.035	0.110	0.315	0.623	0.837	4083
Stevenson	50%	30	95.0%	33	0.000	0.001	0.053	0.210	0.551	0.834	0.931	0.983	0.996	4083
Stevenson	50%	30	98.0%	13	0.000	0.000	0.003	0.013	0.064	0.194	0.459	0.759	0.911	4083
Stevenson	50%	30	98.5%	10	0.000	0.000	0.002	0.008	0.040	0.127	0.349	0.660	0.859	4083
Stevenson	50%	30	99.0%	7	0.000	0.000	0.001	0.005	0.025	0.080	0.252	0.544	0.784	4083
Stevenson	50%	30	99.5%	3	0.000	0.000	0.001	0.003	0.016	0.050	0.175	0.424	0.684	4083
Telford	50%	30	95.0%	35	0.000	0.002	0.067	0.259	0.615	0.869	0.946	0.987	0.997	4083
Telford	50%	30	98.0%	14	0.000	0.000	0.004	0.015	0.070	0.212	0.484	0.778	0.920	4083
Telford	50%	30	98.5%	11	0.000	0.000	0.002	0.009	0.044	0.136	0.366	0.677	0.869	4083
Telford	50%	30	99.0%	7	0.000	0.000	0.001	0.005	0.027	0.085	0.262	0.557	0.794	4083
Telford	50%	30	99.5%	4	0.000	0.000	0.001	0.003	0.016	0.051	0.179	0.430	0.690	4083
MacColl and Stevenson	50%	30	95.0%	122	0.908	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4082
MacColl and Stevenson	50%	30	98.0%	49	0.000	0.012	0.329	0.735	0.922	0.982	0.992	0.998	1.000	4083
MacColl and Stevenson	50%	30	98.5%	37	0.000	0.002	0.082	0.307	0.667	0.894	0.956	0.990	0.997	4083
MacColl and Stevenson	50%	30	99.0%	24	0.000	0.000	0.016	0.066	0.255	0.567	0.799	0.941	0.983	4083
MacColl and Stevenson	50%	30	99.5%	12	0.000	0.000	0.003	0.011	0.055	0.169	0.422	0.729	0.896	4083
Telford and MacColl	50%	30	95.0%	124	0.927	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4082
Telford and MacColl	50%	30	98.0%	50	0.000	0.014	0.352	0.756	0.929	0.984	0.992	0.998	1.000	4083
Telford and MacColl	50%	30	98.5%	37	0.000	0.002	0.088	0.324	0.684	0.901	0.959	0.990	0.998	4083
Telford and MacColl	50%	30	99.0%	25	0.000	0.000	0.017	0.069	0.265	0.581	0.807	0.944	0.984	4083
Telford and MacColl	50%	30	99.5%	12	0.000	0.000	0.003	0.011	0.056	0.173	0.428	0.734	0.899	4083
Stevenson and Telford	50%	30	95.0%	68	0.004	0.185	0.882	0.981	0.995	0.999	0.999	1.000	1.000	4083
Stevenson and Telford	50%	30	98.0%	27	0.000	0.000	0.024	0.098	0.342	0.671	0.856	0.960	0.989	4083
Stevenson and Telford	50%	30	98.5%	20	0.000	0.000	0.009	0.038	0.162	0.419	0.697	0.900	0.969	4083
Stevenson and Telford	50%	30	99.0%	14	0.000	0.000	0.004	0.014	0.067	0.203	0.472	0.768	0.915	4083
Stevenson and Telford	50%	30	99.5%	7	0.000	0.000	0.001	0.005	0.026	0.083	0.257	0.551	0.789	4083
BOWL	50%	30	95.0%	63	0.002	0.093	0.781	0.959	0.989	0.998	0.999	1.000	1.000	4083
BOWL	50%	30	98.0%	25	0.000	0.000	0.017	0.072	0.271	0.589	0.812	0.945	0.984	4083
BOWL	50%	30	98.5%	19	0.000	0.000	0.008	0.030	0.135	0.365	0.652	0.878	0.961	4083
BOWL	50%	30	99.0%	13	0.000	0.000	0.003	0.013	0.061	0.187	0.449	0.751	0.907	4083
BOWL	50%	30	99.5%	6	0.000	0.000	0.001	0.004	0.023	0.073	0.236	0.521	0.767	4083
BOWL and MORL	50%	30	95.0%	194	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4081
BOWL and MORL	50%	30	98.0%	78	0.015	0.483	0.965	0.995	0.999	1.000	1.000	1.000	1.000	4083
BOWL and MORL	50%	30	98.5%	58	0.001	0.048	0.649	0.920	0.979	0.996	0.998	1.000	1.000	4083
BOWL and MORL	50%	30	99.0%	39	0.000	0.003	0.109	0.383	0.735	0.922	0.967	0.992	0.998	4083
BOWL and MORL	50%	30	99.5%	19	0.000	0.000	0.008	0.032	0.142	0.380	0.666	0.885	0.964	4083

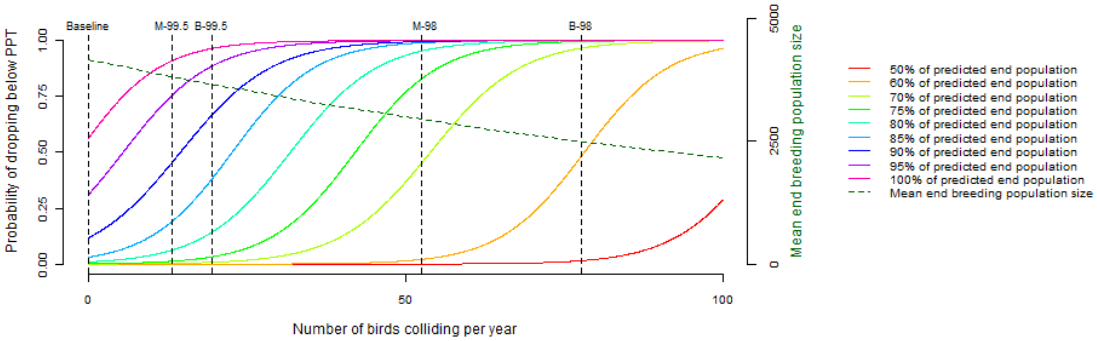


Figure E.1. Probability of the gannet population at Troup Head dropping below population percentage thresholds (up to end of impact).

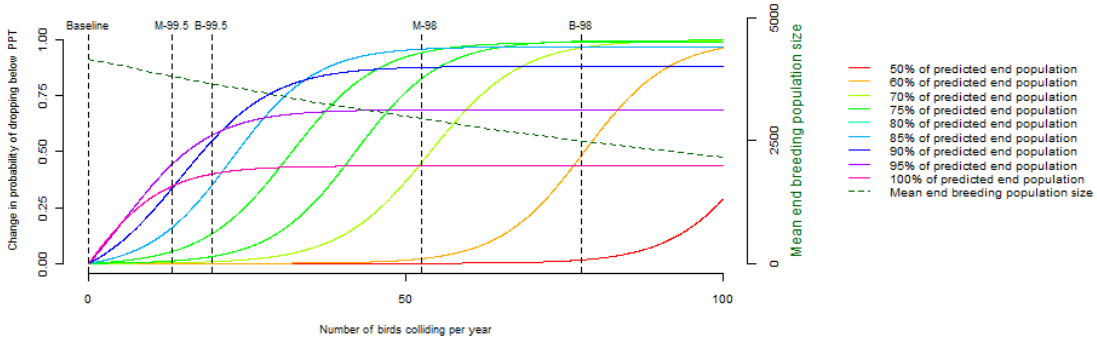


Figure E.2. Change in probability of the gannet population at Troup Head dropping below population percentage thresholds (up to end of impact).

Table E.2. Modelled probabilities of dropping below baseline predicted population size for the gannet population at Troup Head with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.000	0.000	0.000	0.001	0.002	0.006	0.020	0.050	0.123	4665
Whole site	50%	30	95.0%	131	0.679	0.988	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1977
Whole site	50%	30	98.0%	53	0.000	0.003	0.072	0.254	0.542	0.815	0.931	0.971	0.989	3309
Whole site	50%	30	98.5%	39	0.000	0.001	0.015	0.063	0.189	0.457	0.727	0.871	0.946	3606
Whole site	50%	30	99.0%	26	0.000	0.000	0.003	0.013	0.044	0.138	0.344	0.573	0.779	3929
Whole site	50%	30	99.5%	13	0.000	0.000	0.001	0.003	0.009	0.030	0.094	0.211	0.413	4281
Sum of MacColl, Telford & Stevenson	50%	30	95.0%	157	0.982	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1670
Sum of MacColl, Telford & Stevenson	50%	30	98.0%	63	0.000	0.013	0.223	0.548	0.809	0.942	0.980	0.992	0.997	3093
Sum of MacColl, Telford & Stevenson	50%	30	98.5%	47	0.000	0.002	0.038	0.149	0.377	0.690	0.874	0.946	0.978	3428
Sum of MacColl, Telford & Stevenson	50%	30	99.0%	31	0.000	0.000	0.005	0.025	0.080	0.235	0.498	0.716	0.869	3799
Sum of MacColl, Telford & Stevenson	50%	30	99.5%	16	0.000	0.000	0.001	0.004	0.012	0.041	0.125	0.268	0.491	4209
MacColl	50%	30	95.0%	89	0.009	0.267	0.884	0.967	0.991	0.998	0.999	1.000	1.000	2610
MacColl	50%	30	98.0%	36	0.000	0.000	0.009	0.040	0.126	0.340	0.623	0.807	0.916	3698
MacColl	50%	30	98.5%	27	0.000	0.000	0.003	0.014	0.046	0.144	0.355	0.584	0.787	3919
MacColl	50%	30	99.0%	18	0.000	0.000	0.001	0.005	0.016	0.052	0.155	0.321	0.554	4153
MacColl	50%	30	99.5%	9	0.000	0.000	0.000	0.002	0.005	0.018	0.058	0.137	0.295	4402
Stevenson	50%	30	95.0%	33	0.000	0.000	0.007	0.031	0.098	0.279	0.554	0.759	0.892	3754
Stevenson	50%	30	98.0%	13	0.000	0.000	0.001	0.003	0.009	0.030	0.095	0.214	0.418	4277
Stevenson	50%	30	98.5%	10	0.000	0.000	0.000	0.002	0.006	0.020	0.065	0.153	0.323	4370
Stevenson	50%	30	99.0%	7	0.000	0.000	0.000	0.001	0.004	0.013	0.044	0.107	0.241	4466
Stevenson	50%	30	99.5%	3	0.000	0.000	0.000	0.001	0.003	0.009	0.030	0.074	0.175	4565
Telford	50%	30	95.0%	35	0.000	0.000	0.008	0.038	0.120	0.327	0.609	0.798	0.912	3710
Telford	50%	30	98.0%	14	0.000	0.000	0.001	0.003	0.010	0.033	0.103	0.229	0.440	4256
Telford	50%	30	98.5%	11	0.000	0.000	0.000	0.002	0.006	0.022	0.070	0.162	0.338	4355
Telford	50%	30	99.0%	7	0.000	0.000	0.000	0.001	0.004	0.014	0.046	0.112	0.249	4456
Telford	50%	30	99.5%	4	0.000	0.000	0.000	0.001	0.003	0.009	0.030	0.076	0.178	4559
MacColl and Stevenson	50%	30	95.0%	122	0.393	0.963	0.998	0.999	1.000	1.000	1.000	1.000	1.000	2100
MacColl and Stevenson	50%	30	98.0%	49	0.000	0.002	0.047	0.178	0.428	0.734	0.895	0.955	0.982	3390
MacColl and Stevenson	50%	30	98.5%	37	0.000	0.000	0.010	0.046	0.142	0.372	0.654	0.827	0.926	3672
MacColl and Stevenson	50%	30	99.0%	24	0.000	0.000	0.002	0.011	0.035	0.113	0.295	0.516	0.737	3977
MacColl and Stevenson	50%	30	99.5%	12	0.000	0.000	0.000	0.002	0.008	0.027	0.084	0.192	0.386	4307
Telford and MacColl	50%	30	95.0%	124	0.450	0.970	0.998	1.000	1.000	1.000	1.000	1.000	1.000	2076
Telford and MacColl	50%	30	98.0%	50	0.000	0.002	0.051	0.191	0.450	0.751	0.904	0.959	0.984	3374
Telford and MacColl	50%	30	98.5%	37	0.000	0.000	0.011	0.049	0.150	0.388	0.669	0.836	0.930	3659
Telford and MacColl	50%	30	99.0%	25	0.000	0.000	0.002	0.011	0.037	0.117	0.304	0.527	0.746	3967
Telford and MacColl	50%	30	99.5%	12	0.000	0.000	0.000	0.002	0.008	0.027	0.086	0.196	0.391	4302
Stevenson and Telford	50%	30	95.0%	68	0.001	0.026	0.363	0.703	0.892	0.970	0.990	0.996	0.998	2985
Stevenson and Telford	50%	30	98.0%	27	0.000	0.000	0.003	0.015	0.050	0.155	0.374	0.604	0.800	3902
Stevenson and Telford	50%	30	98.5%	20	0.000	0.000	0.001	0.007	0.022	0.072	0.204	0.397	0.634	4080
Stevenson and Telford	50%	30	99.0%	14	0.000	0.000	0.001	0.003	0.010	0.032	0.099	0.222	0.429	4266
Stevenson and Telford	50%	30	99.5%	7	0.000	0.000	0.000	0.001	0.004	0.014	0.045	0.110	0.245	4461
BOWL	50%	30	95.0%	63	0.000	0.013	0.226	0.553	0.812	0.943	0.980	0.992	0.997	3090
BOWL	50%	30	98.0%	25	0.000	0.000	0.002	0.011	0.038	0.121	0.310	0.535	0.751	3961
BOWL	50%	30	98.5%	19	0.000	0.000	0.001	0.005	0.018	0.060	0.176	0.355	0.591	4120
BOWL	50%	30	99.0%	13	0.000	0.000	0.001	0.003	0.009	0.029	0.092	0.208	0.409	4285
BOWL	50%	30	99.5%	6	0.000	0.000	0.000	0.001	0.004	0.012	0.041	0.100	0.227	4485
BOWL and MORL	50%	30	95.0%	194	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1309
BOWL and MORL	50%	30	98.0%	78	0.002	0.081	0.653	0.883	0.964	0.991	0.997	0.999	0.999	2806
BOWL and MORL	50%	30	98.5%	58	0.000	0.007	0.139	0.409	0.707	0.901	0.965	0.986	0.994	3186
BOWL and MORL	50%	30	99.0%	39	0.000	0.001	0.014	0.060	0.179	0.440	0.714	0.863	0.943	3618
BOWL and MORL	50%	30	99.5%	19	0.000	0.000	0.001	0.006	0.019	0.064	0.184	0.367	0.604	4108

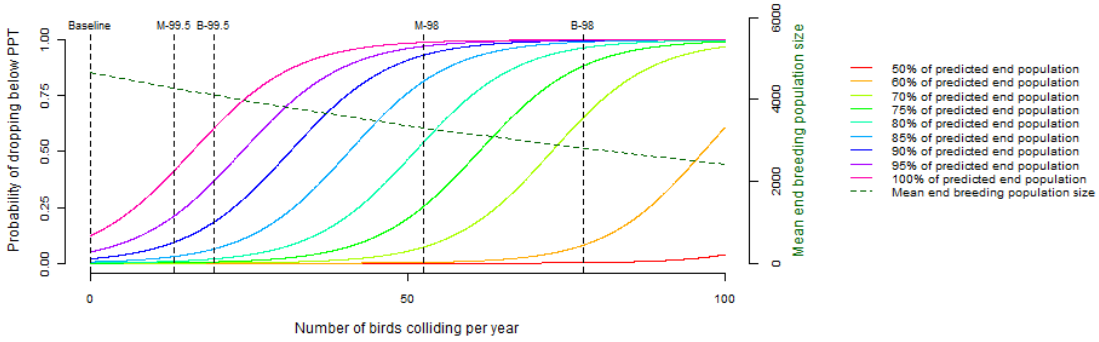


Figure E.3. Probability of the gannet population at Troup Head dropping below population percentage thresholds (after 10 year recovery period).

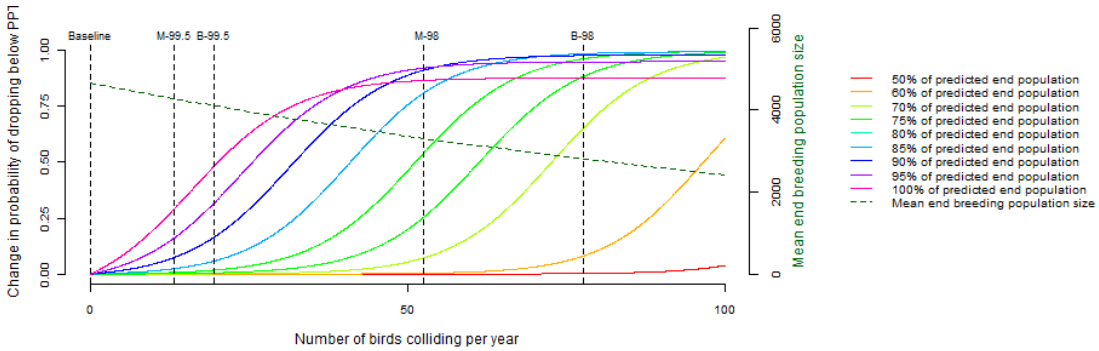


Figure E.4. Change in probability of the gannet population Troup Head dropping below population percentage thresholds (up to end of impact).

Displacement

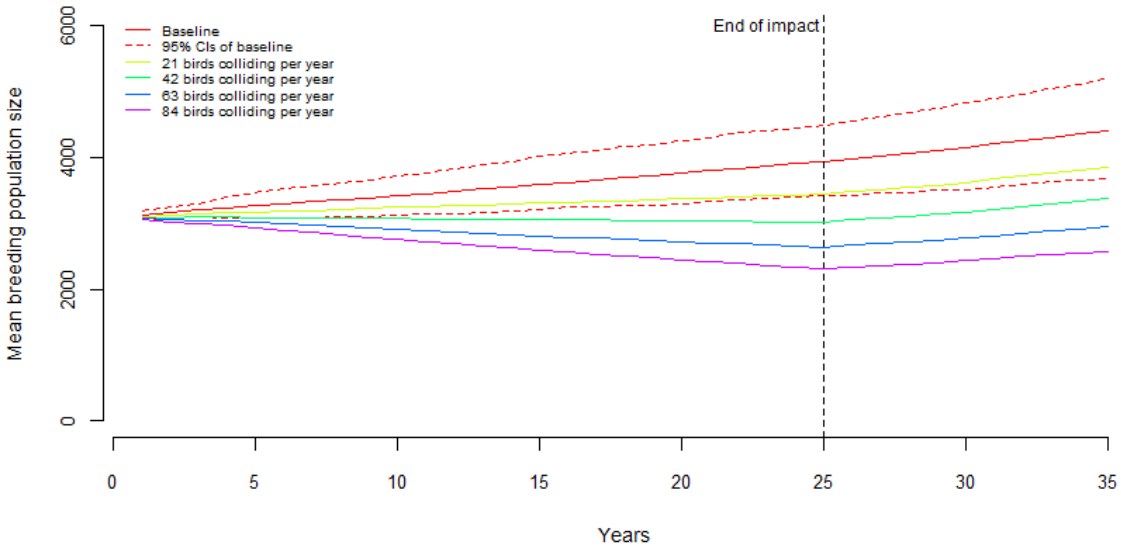


Figure E.5. Population projections for the gannet population at Troup Head at different levels of collision with a high level of displacement.

Table E.3. Modelled probabilities of dropping below current population size for the gannet population at Troup Head with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.018	0.561	4024
Whole site	100%	97	95.0%	131	0.124	0.901	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1688
Whole site	100%	97	98.0%	53	0.000	0.000	0.005	0.020	0.082	0.264	0.638	0.891	0.981	2843
Whole site	100%	97	98.5%	39	0.000	0.000	0.001	0.003	0.014	0.048	0.222	0.641	0.953	3101
Whole site	100%	97	99.0%	26	0.000	0.000	0.000	0.000	0.002	0.007	0.044	0.280	0.890	3382
Whole site	100%	97	99.5%	13	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.079	0.762	3689
Sum of MacColl, Telford & Stevenson	100%	97	95.0%	157	0.860	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1424
Sum of MacColl, Telford & Stevenson	100%	97	98.0%	63	0.000	0.000	0.020	0.080	0.281	0.627	0.880	0.964	0.991	2655
Sum of MacColl, Telford & Stevenson	100%	97	98.5%	47	0.000	0.000	0.002	0.009	0.040	0.138	0.455	0.813	0.972	2946
Sum of MacColl, Telford & Stevenson	100%	97	99.0%	31	0.000	0.000	0.000	0.001	0.004	0.015	0.086	0.414	0.921	3269
Sum of MacColl, Telford & Stevenson	100%	97	99.5%	16	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.103	0.794	3626
MacColl	100%	97	95.0%	89	0.000	0.019	0.432	0.773	0.941	0.988	0.996	0.998	0.998	2236
MacColl	100%	97	98.0%	36	0.000	0.000	0.000	0.002	0.008	0.027	0.143	0.532	0.939	3181
MacColl	100%	97	98.5%	27	0.000	0.000	0.000	0.001	0.002	0.007	0.046	0.289	0.892	3373
MacColl	100%	97	99.0%	18	0.000	0.000	0.000	0.000	0.001	0.002	0.014	0.127	0.816	3578
MacColl	100%	97	99.5%	9	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.050	0.704	3794
Stevenson	100%	97	95.0%	33	0.000	0.000	0.000	0.001	0.006	0.019	0.108	0.466	0.929	3230
Stevenson	100%	97	98.0%	13	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.080	0.764	3685
Stevenson	100%	97	98.5%	10	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.056	0.720	3767
Stevenson	100%	97	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.039	0.671	3850
Stevenson	100%	97	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.027	0.617	3936
Telford	100%	97	95.0%	35	0.000	0.000	0.000	0.002	0.007	0.025	0.135	0.518	0.937	3191
Telford	100%	97	98.0%	14	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.086	0.773	3667
Telford	100%	97	98.5%	11	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.059	0.727	3753
Telford	100%	97	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.040	0.676	3841
Telford	100%	97	99.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.027	0.620	3931
MacColl and Stevenson	100%	97	95.0%	122	0.035	0.706	0.988	0.997	0.999	1.000	1.000	1.000	1.000	1795
MacColl and Stevenson	100%	97	98.0%	49	0.000	0.000	0.003	0.012	0.050	0.170	0.513	0.841	0.975	2913
MacColl and Stevenson	100%	97	98.5%	37	0.000	0.000	0.001	0.002	0.009	0.032	0.163	0.563	0.943	3158
MacColl and Stevenson	100%	97	99.0%	24	0.000	0.000	0.000	0.000	0.002	0.005	0.035	0.239	0.876	3424
MacColl and Stevenson	100%	97	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.071	0.750	3712
Telford and MacColl	100%	97	95.0%	124	0.045	0.757	0.990	0.998	1.000	1.000	1.000	1.000	1.000	1774
Telford and MacColl	100%	97	98.0%	50	0.000	0.000	0.003	0.013	0.055	0.186	0.538	0.852	0.976	2899
Telford and MacColl	100%	97	98.5%	37	0.000	0.000	0.001	0.002	0.010	0.034	0.173	0.579	0.945	3147
Telford and MacColl	100%	97	99.0%	25	0.000	0.000	0.000	0.000	0.002	0.006	0.036	0.247	0.879	3415
Telford and MacColl	100%	97	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.072	0.753	3707
Stevenson and Telford	100%	97	95.0%	68	0.000	0.001	0.041	0.158	0.459	0.792	0.940	0.981	0.994	2562
Stevenson and Telford	100%	97	98.0%	27	0.000	0.000	0.000	0.001	0.002	0.008	0.051	0.305	0.897	3359
Stevenson and Telford	100%	97	98.5%	20	0.000	0.000	0.000	0.000	0.001	0.003	0.020	0.166	0.843	3514
Stevenson and Telford	100%	97	99.0%	14	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.083	0.769	3676
Stevenson and Telford	100%	97	99.5%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.039	0.673	3846
BOWL	100%	97	95.0%	63	0.000	0.000	0.020	0.082	0.286	0.633	0.883	0.965	0.991	2652
BOWL	100%	97	98.0%	25	0.000	0.000	0.000	0.000	0.002	0.006	0.037	0.252	0.881	3410
BOWL	100%	97	98.5%	19	0.000	0.000	0.000	0.000	0.001	0.002	0.017	0.144	0.829	3548
BOWL	100%	97	99.0%	13	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.077	0.761	3692
BOWL	100%	97	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.036	0.660	3867
BOWL and MORL	100%	97	95.0%	194	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1113
BOWL and MORL	100%	97	98.0%	78	0.000	0.004	0.139	0.417	0.766	0.940	0.983	0.993	0.997	2406
BOWL and MORL	100%	97	98.5%	58	0.000	0.000	0.010	0.044	0.170	0.460	0.797	0.941	0.987	2736
BOWL and MORL	100%	97	99.0%	39	0.000	0.000	0.001	0.003	0.013	0.044	0.210	0.626	0.951	3111
BOWL and MORL	100%	97	99.5%	19	0.000	0.000	0.000	0.000	0.001	0.002	0.018	0.150	0.833	3538

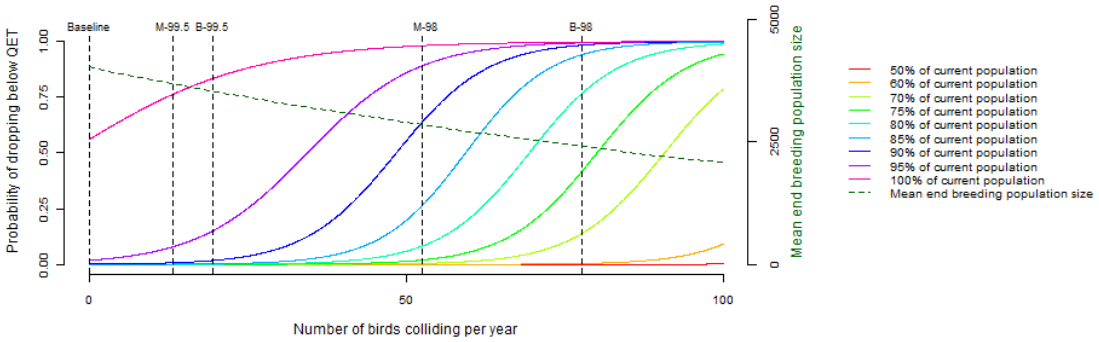


Figure E.6. Probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (up to end of impact).

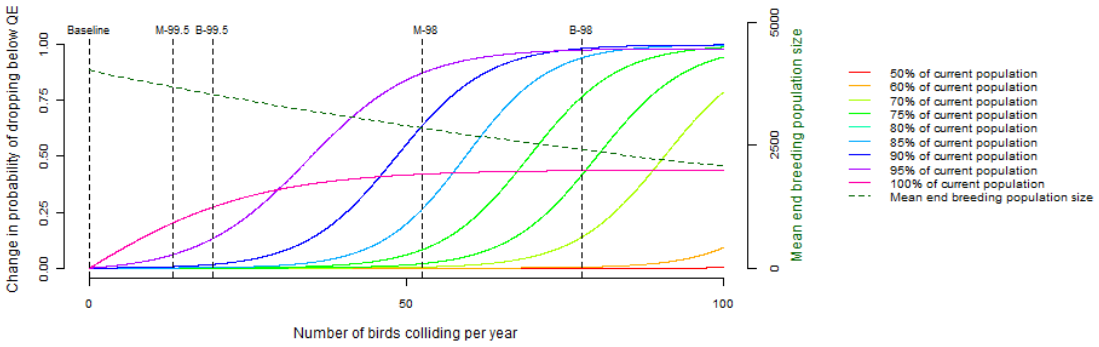


Figure E.7. Change in probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (up to end of impact).

Table E.4. Modelled probabilities of dropping below current population size for the gannet population at Troup Head with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.018	0.561	4488
Whole site	100%	97	95.0%	131	0.138	0.915	0.997	0.999	1.000	1.000	1.000	1.000	1.000	1894
Whole site	100%	97	98.0%	53	0.000	0.000	0.005	0.021	0.087	0.277	0.653	0.892	0.981	3178
Whole site	100%	97	98.5%	39	0.000	0.000	0.001	0.003	0.014	0.051	0.231	0.644	0.954	3465
Whole site	100%	97	99.0%	26	0.000	0.000	0.000	0.001	0.002	0.008	0.046	0.283	0.891	3777
Whole site	100%	97	99.5%	13	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.079	0.764	4117
Sum of MacColl, Telford & Stevenson	100%	97	95.0%	157	0.870	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1599
Sum of MacColl, Telford & Stevenson	100%	97	98.0%	63	0.000	0.001	0.021	0.084	0.294	0.639	0.888	0.965	0.991	2970
Sum of MacColl, Telford & Stevenson	100%	97	98.5%	47	0.000	0.000	0.002	0.010	0.042	0.146	0.469	0.816	0.973	3293
Sum of MacColl, Telford & Stevenson	100%	97	99.0%	31	0.000	0.000	0.000	0.001	0.005	0.016	0.090	0.417	0.922	3651
Sum of MacColl, Telford & Stevenson	100%	97	99.5%	16	0.000	0.000	0.000	0.000	0.000	0.002	0.011	0.104	0.795	4048
MacColl	100%	97	95.0%	89	0.000	0.023	0.452	0.788	0.945	0.988	0.997	0.998	0.999	2504
MacColl	100%	97	98.0%	36	0.000	0.000	0.000	0.002	0.008	0.029	0.149	0.535	0.940	3554
MacColl	100%	97	98.5%	27	0.000	0.000	0.000	0.001	0.002	0.008	0.048	0.292	0.894	3767
MacColl	100%	97	99.0%	18	0.000	0.000	0.000	0.000	0.001	0.002	0.014	0.128	0.818	3994
MacColl	100%	97	99.5%	9	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.050	0.705	4234
Stevenson	100%	97	95.0%	33	0.000	0.000	0.000	0.001	0.006	0.021	0.113	0.469	0.931	3608
Stevenson	100%	97	98.0%	13	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.081	0.766	4113
Stevenson	100%	97	98.5%	10	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.056	0.721	4204
Stevenson	100%	97	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.039	0.671	4296
Stevenson	100%	97	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.027	0.618	4391
Telford	100%	97	95.0%	35	0.000	0.000	0.000	0.002	0.008	0.027	0.141	0.521	0.938	3565
Telford	100%	97	98.0%	14	0.000	0.000	0.000	0.000	0.000	0.001	0.009	0.087	0.775	4093
Telford	100%	97	98.5%	11	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.060	0.729	4189
Telford	100%	97	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.041	0.677	4286
Telford	100%	97	99.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.027	0.621	4386
MacColl and Stevenson	100%	97	95.0%	122	0.040	0.738	0.989	0.998	0.999	1.000	1.000	1.000	1.000	2013
MacColl and Stevenson	100%	97	98.0%	49	0.000	0.000	0.003	0.012	0.053	0.180	0.528	0.843	0.976	3257
MacColl and Stevenson	100%	97	98.5%	37	0.000	0.000	0.001	0.002	0.010	0.034	0.169	0.567	0.945	3529
MacColl and Stevenson	100%	97	99.0%	24	0.000	0.000	0.000	0.000	0.002	0.006	0.036	0.241	0.878	3823
MacColl and Stevenson	100%	97	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.072	0.752	4142
Telford and MacColl	100%	97	95.0%	124	0.051	0.786	0.991	0.998	1.000	1.000	1.000	1.000	1.000	1989
Telford and MacColl	100%	97	98.0%	50	0.000	0.000	0.003	0.014	0.059	0.197	0.553	0.854	0.977	3241
Telford and MacColl	100%	97	98.5%	37	0.000	0.000	0.001	0.002	0.010	0.037	0.180	0.582	0.947	3516
Telford and MacColl	100%	97	99.0%	25	0.000	0.000	0.000	0.000	0.002	0.006	0.038	0.249	0.880	3814
Telford and MacColl	100%	97	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.073	0.754	4137
Stevenson and Telford	100%	97	95.0%	68	0.000	0.001	0.044	0.166	0.475	0.799	0.944	0.981	0.994	2866
Stevenson and Telford	100%	97	98.0%	27	0.000	0.000	0.000	0.001	0.003	0.009	0.053	0.308	0.898	3751
Stevenson and Telford	100%	97	98.5%	20	0.000	0.000	0.000	0.000	0.001	0.003	0.021	0.168	0.845	3923
Stevenson and Telford	100%	97	99.0%	14	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.084	0.770	4103
Stevenson and Telford	100%	97	99.5%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.040	0.674	4291
BOWL	100%	97	95.0%	63	0.000	0.001	0.021	0.086	0.299	0.645	0.890	0.965	0.991	2967
BOWL	100%	97	98.0%	25	0.000	0.000	0.000	0.000	0.002	0.006	0.039	0.254	0.882	3808
BOWL	100%	97	98.5%	19	0.000	0.000	0.000	0.000	0.001	0.003	0.017	0.145	0.830	3961
BOWL	100%	97	99.0%	13	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.078	0.762	4121
BOWL	100%	97	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.036	0.661	4315
BOWL and MORL	100%	97	95.0%	194	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1252
BOWL and MORL	100%	97	98.0%	78	0.000	0.005	0.147	0.434	0.778	0.942	0.984	0.994	0.997	2693
BOWL and MORL	100%	97	98.5%	58	0.000	0.000	0.011	0.046	0.179	0.474	0.808	0.942	0.988	3060
BOWL and MORL	100%	97	99.0%	39	0.000	0.000	0.001	0.003	0.013	0.048	0.218	0.629	0.952	3477
BOWL and MORL	100%	97	99.5%	19	0.000	0.000	0.000	0.000	0.001	0.003	0.018	0.151	0.835	3950

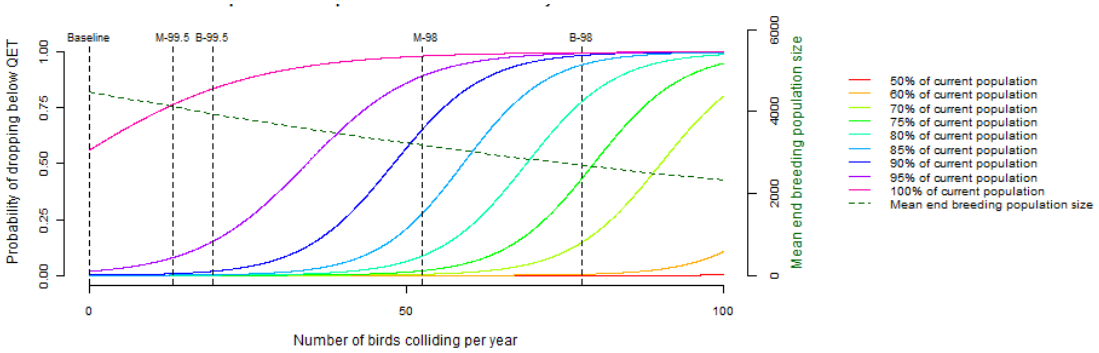


Figure E.8. Probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (after 10 year recovery period).

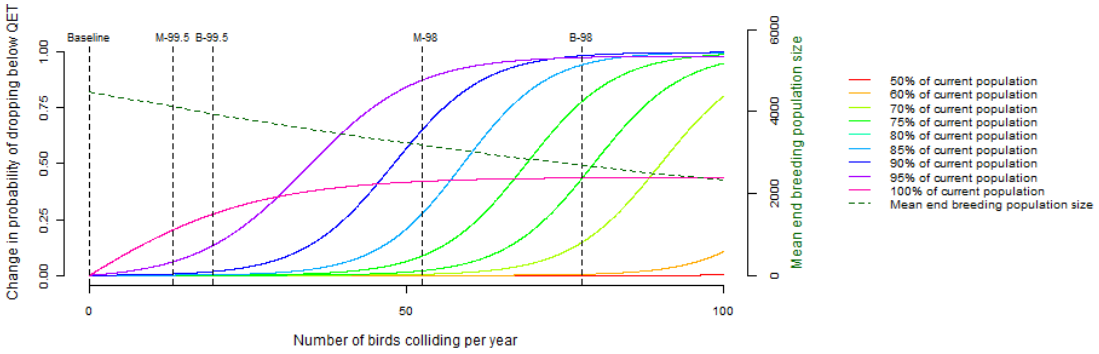


Figure E.9. Change in probability of the gannet population Troup Head dropping below quasi-extinction thresholds (after 10 year recovery period).

Table E.5. Modelled probabilities of dropping below baseline predicted population size for the gannet population at Troup Head with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Collision	Number colliding	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	0.000	0.000	0.001	0.002	0.017	0.094	0.286	0.574	0.799	4176
Whole site	100%	97	1.0	146	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1542
Whole site	100%	97	1.0	58	0.000	0.063	0.855	0.974	0.990	0.997	1.000	1.000	1.000	2811
Whole site	100%	97	1.0	44	0.000	0.003	0.413	0.786	0.928	0.980	0.997	0.999	1.000	3093
Whole site	100%	97	1.0	29	0.000	0.000	0.067	0.232	0.576	0.859	0.973	0.990	1.000	3426
Whole site	100%	97	1.0	15	0.000	0.000	0.009	0.029	0.143	0.461	0.804	0.927	1.000	3770
Sum of MacColl, Telford & Stevenson	100%	97	1.0	173	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1283
Sum of MacColl, Telford & Stevenson	100%	97	1.0	69	0.002	0.422	0.969	0.996	0.998	0.999	1.000	1.000	1.000	2608
Sum of MacColl, Telford & Stevenson	100%	97	1.0	52	0.000	0.018	0.703	0.933	0.977	0.994	0.999	1.000	1.000	2929
Sum of MacColl, Telford & Stevenson	100%	97	1.0	35	0.000	0.000	0.152	0.451	0.769	0.934	0.989	0.996	1.000	3289
Sum of MacColl, Telford & Stevenson	100%	97	1.0	17	0.000	0.000	0.012	0.039	0.184	0.531	0.848	0.945	1.000	3719
MacColl	100%	97	1.0	98	0.334	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2140
MacColl	100%	97	1.0	39	0.000	0.001	0.248	0.615	0.858	0.961	0.994	0.998	1.000	3200
MacColl	100%	97	1.0	29	0.000	0.000	0.067	0.232	0.576	0.859	0.973	0.990	1.000	3426
MacColl	100%	97	1.0	20	0.000	0.000	0.018	0.063	0.261	0.633	0.899	0.964	1.000	3643
MacColl	100%	97	1.0	10	0.000	0.000	0.004	0.013	0.073	0.298	0.653	0.857	0.999	3901
Telford	100%	97	1.0	36	0.000	0.001	0.173	0.493	0.795	0.942	0.991	0.997	1.000	3267
Telford	100%	97	1.0	15	0.000	0.000	0.009	0.029	0.143	0.461	0.804	0.927	1.000	3770
Telford	100%	97	1.0	11	0.000	0.000	0.005	0.015	0.084	0.328	0.688	0.875	0.999	3874
Telford	100%	97	1.0	7	0.000	0.000	0.003	0.008	0.048	0.218	0.542	0.793	0.994	3981
Telford	100%	97	1.0	4	0.000	0.000	0.002	0.005	0.031	0.155	0.427	0.710	0.970	4064
Stevenson	100%	97	1.0	38	0.000	0.001	0.220	0.575	0.839	0.956	0.993	0.997	1.000	3222
Stevenson	100%	97	1.0	15	0.000	0.000	0.009	0.029	0.143	0.461	0.804	0.927	1.000	3770
Stevenson	100%	97	1.0	12	0.000	0.000	0.005	0.018	0.096	0.360	0.720	0.890	1.000	3848
Stevenson	100%	97	1.0	8	0.000	0.000	0.003	0.009	0.055	0.243	0.580	0.817	0.996	3954
Stevenson	100%	97	1.0	4	0.000	0.000	0.002	0.005	0.031	0.155	0.427	0.710	0.970	4064
MacColl and Stevenson	100%	97	1.0	134	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1674
MacColl and Stevenson	100%	97	1.0	54	0.000	0.027	0.762	0.951	0.983	0.995	0.999	1.000	1.000	2889
MacColl and Stevenson	100%	97	1.0	40	0.000	0.001	0.277	0.654	0.876	0.966	0.995	0.998	1.000	3179
MacColl and Stevenson	100%	97	1.0	27	0.000	0.000	0.051	0.178	0.502	0.822	0.963	0.987	1.000	3474
MacColl and Stevenson	100%	97	1.0	13	0.000	0.000	0.006	0.021	0.110	0.393	0.750	0.904	1.000	3822
Stevenson and Telford	100%	97	1.0	136	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1651
Stevenson and Telford	100%	97	1.0	54	0.000	0.027	0.762	0.951	0.983	0.995	0.999	1.000	1.000	2889
Stevenson and Telford	100%	97	1.0	41	0.000	0.002	0.308	0.691	0.891	0.970	0.996	0.998	1.000	3157
Stevenson and Telford	100%	97	1.0	27	0.000	0.000	0.051	0.178	0.502	0.822	0.963	0.987	1.000	3474
Stevenson and Telford	100%	97	1.0	14	0.000	0.000	0.007	0.024	0.126	0.427	0.778	0.916	1.000	3796
Telford and MacColl	100%	97	1.0	75	0.006	0.729	0.987	0.998	0.999	1.000	1.000	1.000	1.000	2503
Telford and MacColl	100%	97	1.0	30	0.000	0.000	0.078	0.263	0.612	0.875	0.977	0.992	1.000	3403
Telford and MacColl	100%	97	1.0	22	0.000	0.000	0.024	0.086	0.323	0.696	0.924	0.973	1.000	3594
Telford and MacColl	100%	97	1.0	15	0.000	0.000	0.009	0.029	0.143	0.461	0.804	0.927	1.000	3770
Telford and MacColl	100%	97	1.0	7	0.000	0.000	0.003	0.008	0.048	0.218	0.542	0.793	0.994	3981
BOWL	100%	97	1.0	63	0.001	0.166	0.926	0.989	0.995	0.999	1.000	1.000	1.000	2717
BOWL	100%	97	1.0	25	0.000	0.000	0.038	0.135	0.427	0.777	0.951	0.983	1.000	3521
BOWL	100%	97	1.0	19	0.000	0.000	0.016	0.054	0.233	0.600	0.884	0.958	1.000	3668
BOWL	100%	97	1.0	13	0.000	0.000	0.006	0.021	0.110	0.393	0.750	0.904	1.000	3822
BOWL	100%	97	1.0	6	0.000	0.000	0.002	0.007	0.042	0.195	0.504	0.768	0.989	4009
BOWL and MORL	100%	97	1.0	209	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1003
BOWL and MORL	100%	97	1.0	83	0.028	0.939	0.996	1.000	1.000	1.000	1.000	1.000	1.000	2370
BOWL and MORL	100%	97	1.0	63	0.001	0.166	0.926	0.989	0.995	0.999	1.000	1.000	1.000	2717
BOWL and MORL	100%	97	1.0	42	0.000	0.002	0.342	0.725	0.905	0.974	0.996	0.999	1.000	3136
BOWL and MORL	100%	97	1.0	21	0.000	0.000	0.021	0.074	0.291	0.665	0.912	0.969	1.000	3619

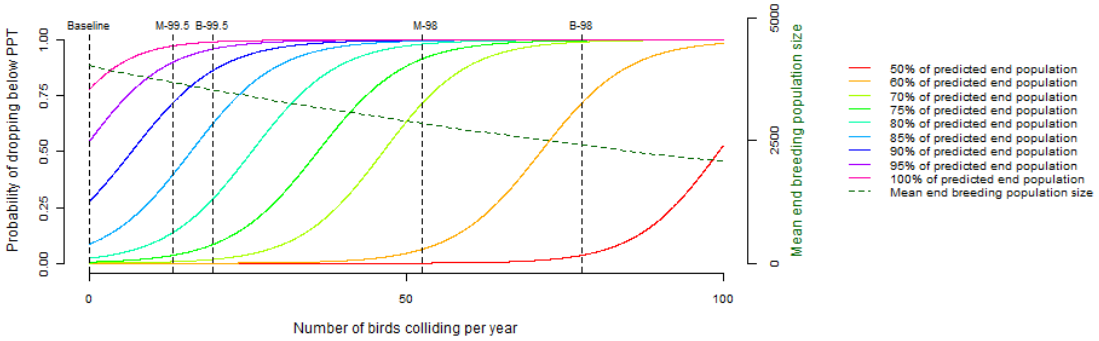


Figure E.10. Probability of the gannet population at Troup Head dropping below population percentage thresholds (up to end of impact).

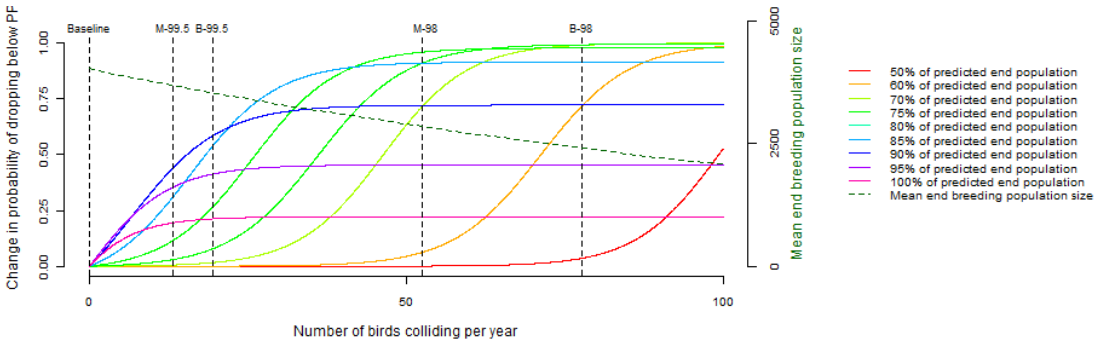


Figure E.11. Change in probability of the gannet population at Troup Head dropping below population percentage thresholds (up to end of impact).

Table E.6. Modelled probabilities of dropping below baseline predicted population size for the gannet population at Troup Head with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Collision	Number colliding	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	NA	0	<0.001	<0.001	<0.001	0.001	0.003	0.005	0.032	0.128	0.260	4654
Whole site	100%	97	1.0	146	0.957	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1731
Whole site	100%	97	1.0	58	0.001	0.023	0.263	0.588	0.860	0.963	0.982	0.992	0.997	3142
Whole site	100%	97	1.0	44	<0.001	0.004	0.050	0.198	0.500	0.770	0.900	0.959	0.985	3455
Whole site	100%	97	1.0	29	<0.001	0.001	0.007	0.036	0.125	0.272	0.570	0.806	0.918	3824
Whole site	100%	97	1.0	15	<0.001	<0.001	0.001	0.006	0.023	0.046	0.182	0.452	0.679	4204
Sum of MacColl, Telford & Stevenson	100%	97	1.0	173	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1442
Sum of MacColl, Telford & Stevenson	100%	97	1.0	69	0.003	0.080	0.616	0.850	0.963	0.992	0.995	0.998	0.999	2917
Sum of MacColl, Telford & Stevenson	100%	97	1.0	52	<0.001	0.011	0.136	0.402	0.739	0.915	0.961	0.983	0.994	3272
Sum of MacColl, Telford & Stevenson	100%	97	1.0	35	<0.001	0.001	0.015	0.074	0.237	0.473	0.740	0.892	0.958	3672
Sum of MacColl, Telford & Stevenson	100%	97	1.0	17	<0.001	<0.001	0.001	0.008	0.029	0.061	0.223	0.510	0.728	4148
MacColl	100%	97	1.0	98	0.076	0.741	0.988	0.995	0.999	1.000	1.000	1.000	1.000	2397
MacColl	100%	97	1.0	39	<0.001	0.002	0.026	0.117	0.343	0.617	0.826	0.929	0.974	3574
MacColl	100%	97	1.0	29	<0.001	0.001	0.007	0.036	0.125	0.272	0.570	0.806	0.918	3824
MacColl	100%	97	1.0	20	<0.001	<0.001	0.002	0.012	0.042	0.091	0.296	0.595	0.793	4064
MacColl	100%	97	1.0	10	<0.001	<0.001	0.001	0.003	0.012	0.023	0.105	0.317	0.537	4349
Telford	100%	97	1.0	36	<0.001	0.002	0.017	0.083	0.261	0.510	0.764	0.903	0.963	3647
Telford	100%	97	1.0	15	<0.001	<0.001	0.001	0.006	0.023	0.046	0.182	0.452	0.679	4204
Telford	100%	97	1.0	11	<0.001	<0.001	0.001	0.004	0.014	0.026	0.118	0.342	0.567	4320
Telford	100%	97	1.0	7	<0.001	<0.001	<0.001	0.002	0.008	0.015	0.074	0.247	0.448	4438
Telford	100%	97	1.0	4	<0.001	<0.001	<0.001	0.002	0.006	0.010	0.052	0.189	0.362	4529
Stevenson	100%	97	1.0	38	<0.001	0.002	0.023	0.104	0.315	0.582	0.807	0.921	0.971	3598
Stevenson	100%	97	1.0	15	<0.001	<0.001	0.001	0.006	0.023	0.046	0.182	0.452	0.679	4204
Stevenson	100%	97	1.0	12	<0.001	<0.001	0.001	0.004	0.015	0.030	0.132	0.369	0.596	4290
Stevenson	100%	97	1.0	8	<0.001	<0.001	<0.001	0.003	0.009	0.017	0.084	0.269	0.478	4408
Stevenson	100%	97	1.0	4	<0.001	<0.001	<0.001	0.002	0.006	0.010	0.052	0.189	0.362	4529
MacColl and Stevenson	100%	97	1.0	134	0.846	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1878
MacColl and Stevenson	100%	97	1.0	54	<0.001	0.014	0.171	0.463	0.786	0.935	0.970	0.987	0.996	3228
MacColl and Stevenson	100%	97	1.0	40	<0.001	0.003	0.030	0.130	0.373	0.651	0.843	0.937	0.977	3549
MacColl and Stevenson	100%	97	1.0	27	<0.001	0.001	0.005	0.029	0.099	0.218	0.507	0.767	0.898	3876
MacColl and Stevenson	100%	97	1.0	13	<0.001	<0.001	0.001	0.005	0.018	0.035	0.147	0.396	0.624	4262
Stevenson and Telford	100%	97	1.0	136	0.874	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1853
Stevenson and Telford	100%	97	1.0	54	<0.001	0.014	0.171	0.463	0.786	0.935	0.970	0.987	0.996	3228
Stevenson and Telford	100%	97	1.0	41	<0.001	0.003	0.034	0.145	0.404	0.684	0.860	0.943	0.979	3525
Stevenson and Telford	100%	97	1.0	27	<0.001	0.001	0.005	0.029	0.099	0.218	0.507	0.767	0.898	3876
Stevenson and Telford	100%	97	1.0	14	<0.001	<0.001	0.001	0.006	0.020	0.040	0.164	0.424	0.652	4233
Telford and MacColl	100%	97	1.0	75	0.006	0.152	0.785	0.923	0.982	0.997	0.998	0.999	1.000	2800
Telford and MacColl	100%	97	1.0	30	<0.001	0.001	0.008	0.041	0.140	0.302	0.601	0.823	0.927	3798
Telford and MacColl	100%	97	1.0	22	<0.001	<0.001	0.003	0.015	0.054	0.118	0.352	0.649	0.830	4010
Telford and MacColl	100%	97	1.0	15	<0.001	<0.001	0.001	0.006	0.023	0.046	0.182	0.452	0.679	4204
Telford and MacColl	100%	97	1.0	7	<0.001	<0.001	<0.001	0.002	0.008	0.015	0.074	0.247	0.448	4438
BOWL	100%	97	1.0	63	0.001	0.041	0.414	0.727	0.922	0.982	0.990	0.995	0.998	3037
BOWL	100%	97	1.0	25	<0.001	<0.001	0.004	0.022	0.078	0.172	0.443	0.724	0.875	3929
BOWL	100%	97	1.0	19	<0.001	<0.001	0.002	0.011	0.037	0.080	0.270	0.567	0.773	4092
BOWL	100%	97	1.0	13	<0.001	<0.001	0.001	0.005	0.018	0.035	0.147	0.396	0.624	4262
BOWL	100%	97	1.0	6	<0.001	<0.001	<0.001	0.002	0.007	0.013	0.066	0.226	0.419	4468
BOWL and MORL	100%	97	1.0	209	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1130
BOWL and MORL	100%	97	1.0	83	0.014	0.320	0.916	0.970	0.994	0.999	0.999	1.000	1.000	2653
BOWL and MORL	100%	97	1.0	63	0.001	0.041	0.414	0.727	0.922	0.982	0.990	0.995	0.998	3037
BOWL and MORL	100%	97	1.0	42	<0.001	0.003	0.039	0.161	0.436	0.715	0.874	0.949	0.982	3502
BOWL and MORL	100%	97	1.0	21	<0.001	<0.001	0.002	0.014	0.048	0.104	0.324	0.623	0.812	4037

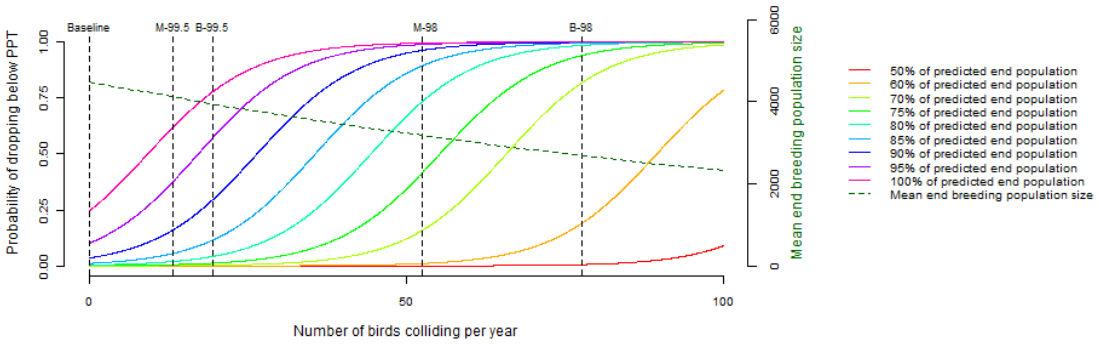


Figure E.12. Probability of the gannet population at Troup Head dropping below population percentage thresholds (after 10 year recovery period).

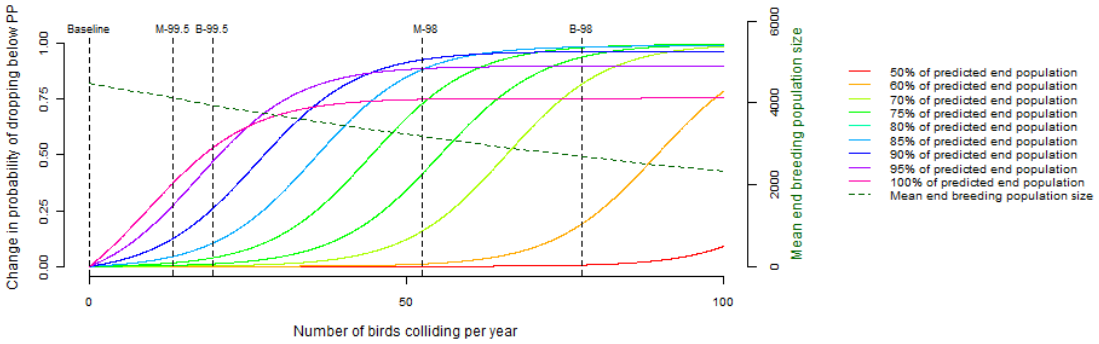


Figure E.13. Change in probability of the gannet population at Troup Head dropping below population percentage thresholds (after 10 year recovery period).

Displacement

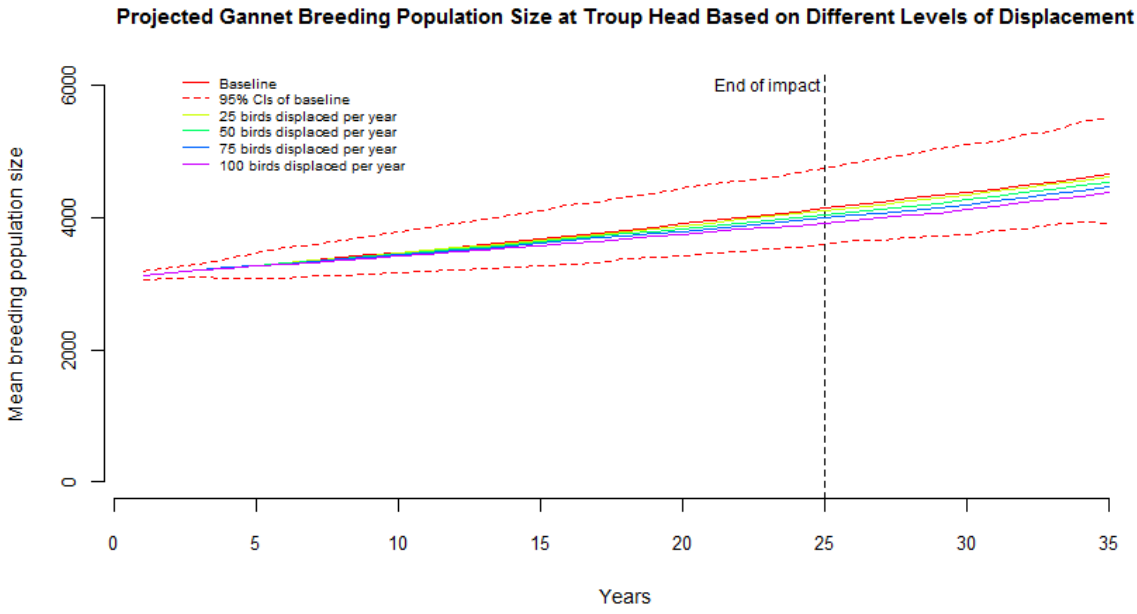


Figure E.14. Population projections for the gannet population at Troup Head at different levels of displacement.

Table E.7. Modelled probabilities of dropping below current population size for the gannet population at Troup Head with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	0.409	4151
Whole site	100%	59	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.016	0.511	4029
Whole site	50%	30	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	0.461	4088
Sum of MacColl, Telford & Stevenson	100%	59	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.016	0.511	4029
Sum of MacColl, Telford & Stevenson	50%	30	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	0.461	4088
MacColl	100%	34	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	0.468	4080
MacColl	50%	17	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.438	4115
Telford	100%	13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.432	4124
Telford	50%	7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	0.421	4136
Stevenson	100%	13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.432	4124
Stevenson	50%	6	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	0.420	4138
MacColl and Stevenson	100%	46	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	0.489	4055
MacColl and Stevenson	50%	23	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.449	4103
Stevenson and Telford	100%	26	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.454	4097
Stevenson and Telford	50%	13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.432	4124
Telford and MacColl	100%	47	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	0.490	4053
Telford and MacColl	50%	23	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.449	4103
BOWL	100%	38	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013	0.475	4072
BOWL	50%	19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.442	4111
BOWL and MORL	100%	97	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.025	0.577	3952
BOWL and MORL	50%	49	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	0.494	4049

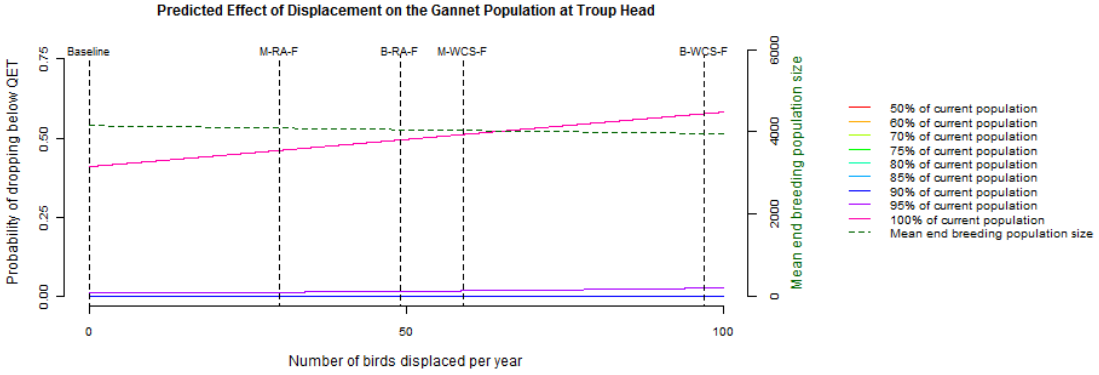


Figure E.15. Probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (up to end of impact).

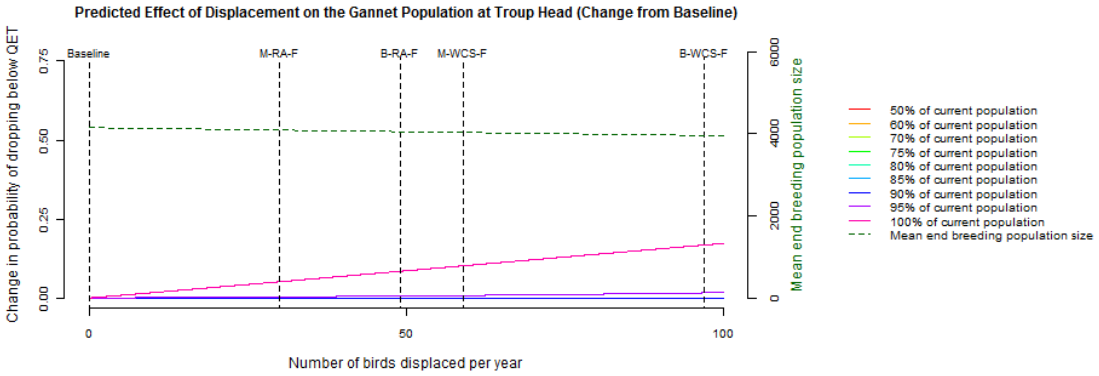


Figure E.16. Change in probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (up to end of impact).

Table E.8. Modelled probabilities of dropping below current population size for the gannet population at Troup Head with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.008	0.409	4667
Whole site	100%	59	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.016	0.511	4510
Whole site	50%	30	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	0.461	4587
Sum of MacColl, Telford & Stevenson	100%	59	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.016	0.511	4510
Sum of MacColl, Telford & Stevenson	50%	30	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	0.461	4587
MacColl	100%	34	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	0.468	4576
MacColl	50%	17	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.438	4621
Telford	100%	13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.431	4632
Telford	50%	7	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	0.421	4648
Stevenson	100%	13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.431	4632
Stevenson	50%	6	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	0.419	4651
MacColl and Stevenson	100%	46	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	0.489	4544
MacColl and Stevenson	50%	23	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.449	4605
Stevenson and Telford	100%	26	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.454	4597
Stevenson and Telford	50%	13	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.431	4632
Telford and MacColl	100%	47	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.014	0.490	4541
Telford and MacColl	50%	23	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.449	4605
BOWL	100%	38	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.013	0.475	4565
BOWL	50%	19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.442	4616
BOWL and MORL	100%	97	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.025	0.577	4411
BOWL and MORL	50%	49	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.015	0.494	4536

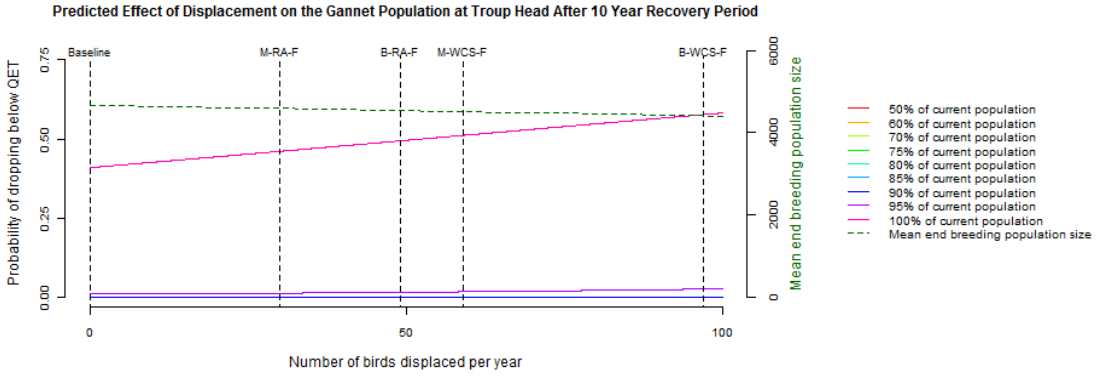


Figure E.17. Probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (after 10 year recovery period).

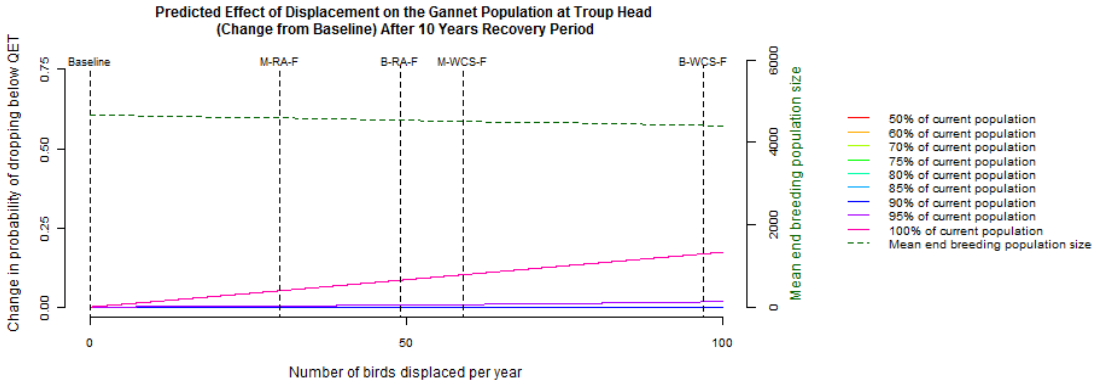


Figure E.18. Change in probability of the gannet population Troup Head dropping below quasi-extinction thresholds (after 10 year recovery period).

Table E.9. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the gannet population at Troup Head with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	<0.001	<0.001	<0.001	<0.001	0.004	0.023	0.086	0.227	0.465	4151
Whole site	100%	59	<0.001	<0.001	<0.001	0.001	0.011	0.053	0.176	0.404	0.677	4029
Whole site	50%	30	<0.001	<0.001	<0.001	0.001	0.007	0.035	0.125	0.310	0.576	4088
Sum of MacColl, Telford & Stevenson	100%	59	<0.001	<0.001	<0.001	0.001	0.011	0.053	0.176	0.404	0.677	4029
Sum of MacColl, Telford & Stevenson	50%	30	<0.001	<0.001	<0.001	0.001	0.007	0.035	0.125	0.310	0.576	4088
MacColl	100%	34	<0.001	<0.001	<0.001	0.001	0.007	0.037	0.131	0.322	0.591	4080
MacColl	50%	17	<0.001	<0.001	<0.001	0.001	0.006	0.029	0.107	0.272	0.528	4115
Telford	100%	13	<0.001	<0.001	<0.001	0.001	0.005	0.028	0.102	0.261	0.513	4124
Telford	50%	7	<0.001	<0.001	<0.001	<0.001	0.005	0.026	0.094	0.245	0.491	4136
Stevenson	100%	13	<0.001	<0.001	<0.001	0.001	0.005	0.028	0.102	0.261	0.513	4124
Stevenson	50%	6	<0.001	<0.001	<0.001	<0.001	0.005	0.025	0.093	0.242	0.487	4138
MacColl and Stevenson	100%	46	<0.001	<0.001	<0.001	0.001	0.009	0.044	0.151	0.360	0.634	4055
MacColl and Stevenson	50%	23	<0.001	<0.001	<0.001	0.001	0.006	0.032	0.115	0.289	0.551	4103
Stevenson and Telford	100%	26	<0.001	<0.001	<0.001	0.001	0.006	0.033	0.119	0.298	0.562	4097
Stevenson and Telford	50%	13	<0.001	<0.001	<0.001	0.001	0.005	0.028	0.102	0.261	0.513	4124
Telford and MacColl	100%	47	<0.001	<0.001	<0.001	0.001	0.009	0.045	0.153	0.364	0.637	4053
Telford and MacColl	50%	23	<0.001	<0.001	<0.001	0.001	0.006	0.032	0.115	0.289	0.551	4103
BOWL	100%	38	<0.001	<0.001	<0.001	0.001	0.008	0.039	0.138	0.335	0.605	4072
BOWL	50%	19	<0.001	<0.001	<0.001	0.001	0.006	0.030	0.109	0.278	0.536	4111
BOWL and MORL	100%	97	<0.001	<0.001	<0.001	0.002	0.019	0.087	0.264	0.536	0.788	3952
BOWL and MORL	50%	49	<0.001	<0.001	<0.001	0.001	0.009	0.046	0.157	0.370	0.644	4049

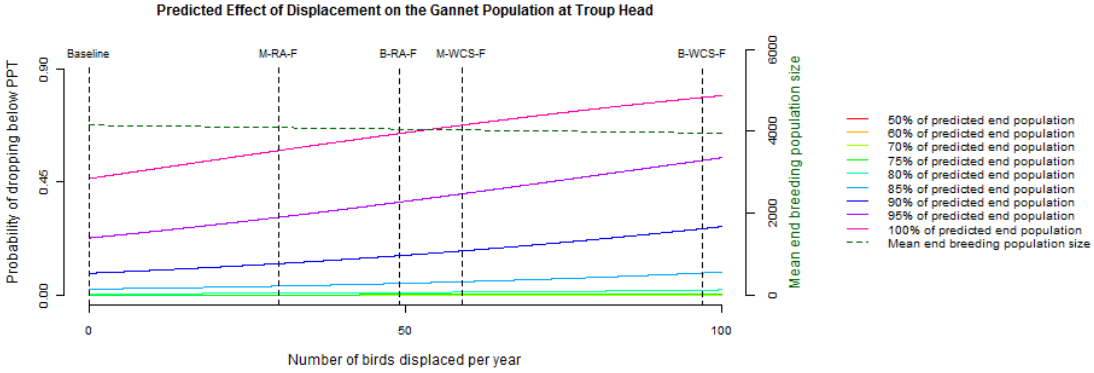


Figure E.19. Probability of the gannet population at Troup Head dropping below population percentage thresholds (up to end of impact).

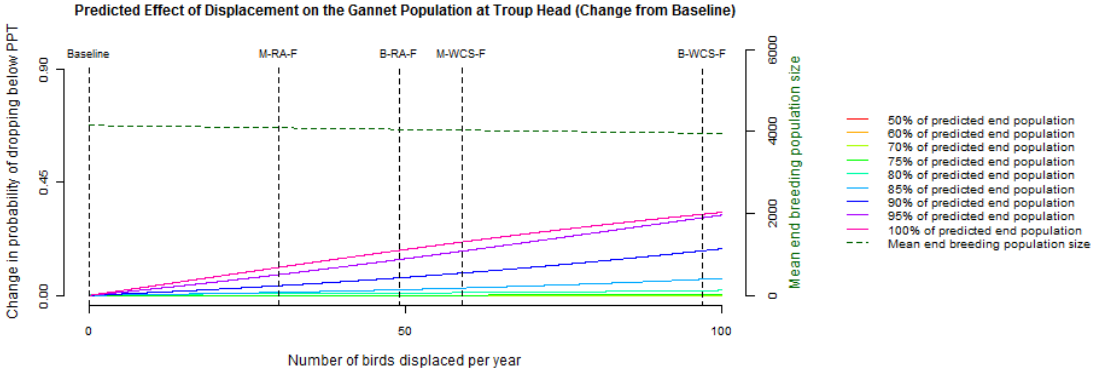


Figure E.20. Change in probability of the gannet population at Troup Head dropping below population percentage thresholds (up to end of impact).

Table E.10. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the gannet population at Troup Head with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.011	0.038	0.105	4667
Whole site	100%	59	<0.001	<0.001	<0.001	<0.001	0.001	0.005	0.022	0.071	0.179	4510
Whole site	50%	30	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.016	0.052	0.138	4587
Sum of MacColl, Telford & Stevenson	100%	59	<0.001	<0.001	<0.001	<0.001	0.001	0.005	0.022	0.071	0.179	4510
Sum of MacColl, Telford & Stevenson	50%	30	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.016	0.052	0.138	4587
MacColl	100%	34	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.016	0.055	0.144	4576
MacColl	50%	17	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.013	0.046	0.123	4621
Telford	100%	13	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.013	0.044	0.119	4632
Telford	50%	7	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.012	0.041	0.112	4648
Stevenson	100%	13	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.013	0.044	0.119	4632
Stevenson	50%	6	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.012	0.040	0.111	4651
MacColl and Stevenson	100%	46	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.019	0.062	0.160	4544
MacColl and Stevenson	50%	23	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.014	0.049	0.130	4605
Stevenson and Telford	100%	26	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.015	0.050	0.134	4597
Stevenson and Telford	50%	13	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.013	0.044	0.119	4632
Telford and MacColl	100%	47	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.019	0.063	0.161	4541
Telford and MacColl	50%	23	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.014	0.049	0.130	4605
BOWL	100%	38	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.017	0.057	0.149	4565
BOWL	50%	19	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.014	0.047	0.125	4616
BOWL and MORL	100%	97	<0.001	<0.001	<0.001	<0.001	0.001	0.008	0.034	0.105	0.245	4411
BOWL and MORL	50%	49	<0.001	<0.001	<0.001	<0.001	0.001	0.004	0.019	0.064	0.164	4536

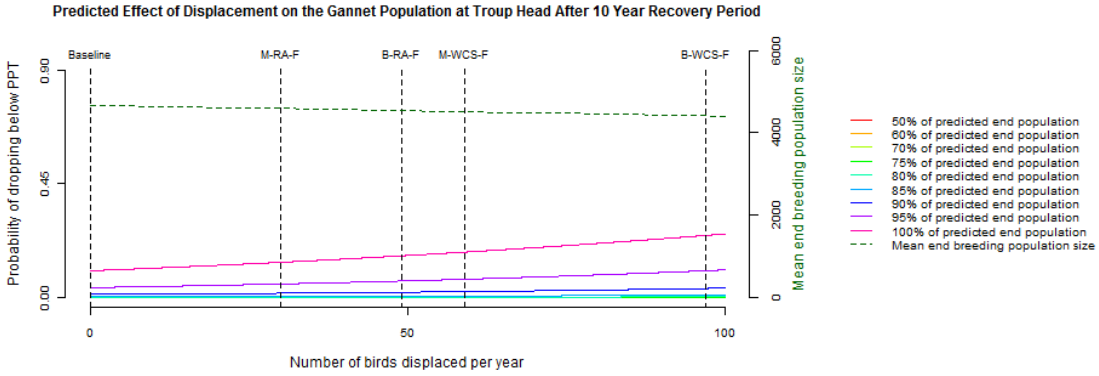


Figure E.21. Probability of the gannet population at Troup Head dropping below population percentage thresholds (after 10 year recovery period).

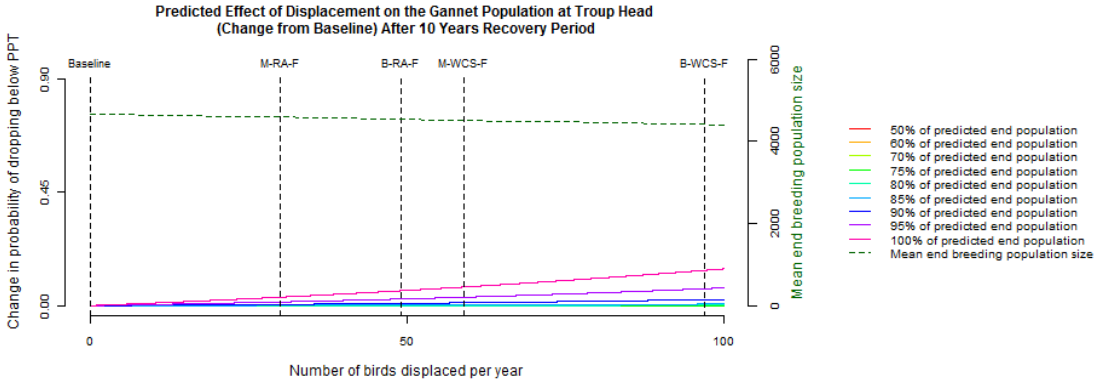


Figure E.22. Change in probability of the gannet population at Troup Head dropping below population percentage thresholds (after 10 year recovery period).

Collision

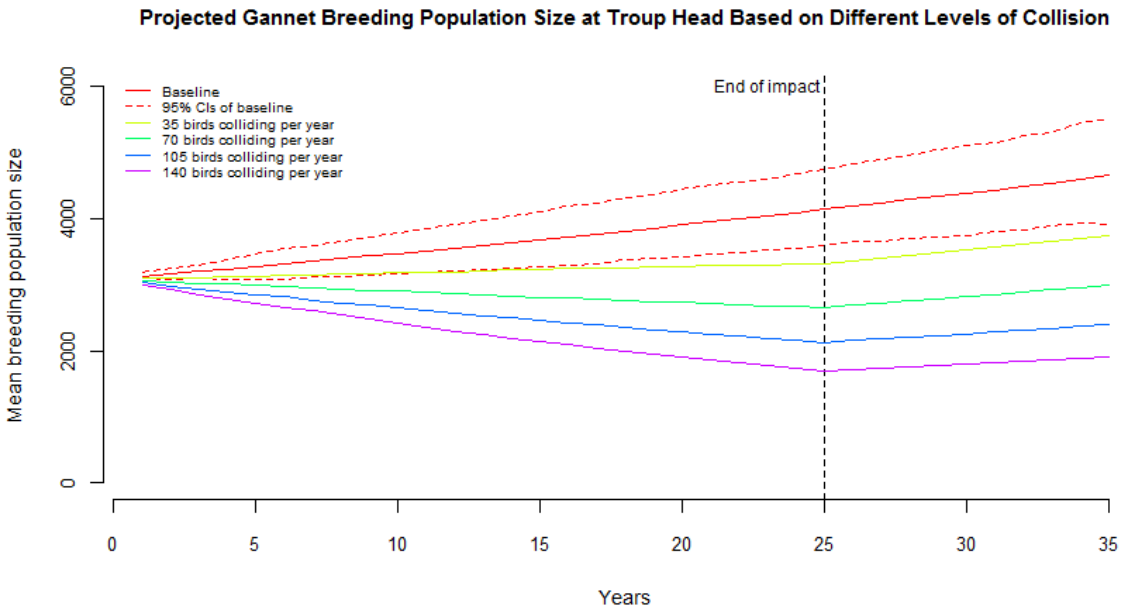


Figure E.23. Population projections for the gannet population at Troup Head at different levels of collision.

Table E.11. Modelled probabilities of dropping below current population size for the gannet population at Troup Head with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.396	4373
Whole site	95.0%	131	0.037	0.695	0.984	0.998	0.999	1.000	1.000	1.000	1.000	1782
Whole site	98.0%	53	0.000	0.000	0.001	0.004	0.018	0.084	0.284	0.694	0.943	2992
Whole site	98.5%	39	0.000	0.000	0.000	0.001	0.003	0.015	0.063	0.331	0.877	3262
Whole site	99.0%	26	0.000	0.000	0.000	0.000	0.000	0.002	0.011	0.097	0.755	3556
Whole site	99.5%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.023	0.571	3876
Sum of MacColl, Telford & Stevenson	95.0%	157	0.605	0.991	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1504
Sum of MacColl, Telford & Stevenson	98.0%	63	0.000	0.000	0.005	0.017	0.075	0.276	0.615	0.882	0.970	2796
Sum of MacColl, Telford & Stevenson	98.5%	47	0.000	0.000	0.001	0.002	0.009	0.042	0.160	0.548	0.921	3100
Sum of MacColl, Telford & Stevenson	99.0%	31	0.000	0.000	0.000	0.000	0.001	0.005	0.022	0.164	0.811	3437
Sum of MacColl, Telford & Stevenson	99.5%	16	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.031	0.611	3811
MacColl	95.0%	89	0.000	0.004	0.143	0.447	0.770	0.932	0.982	0.994	0.994	2357
MacColl	98.0%	36	0.000	0.000	0.000	0.000	0.002	0.009	0.038	0.240	0.848	3346
MacColl	98.5%	27	0.000	0.000	0.000	0.000	0.000	0.003	0.012	0.101	0.759	3547
MacColl	99.0%	18	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.039	0.641	3760
MacColl	99.5%	9	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.014	0.503	3986
Stevenson	95.0%	33	0.000	0.000	0.000	0.000	0.001	0.006	0.028	0.195	0.828	3397
Stevenson	98.0%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.023	0.573	3872
Stevenson	98.5%	10	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.016	0.521	3958
Stevenson	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.468	4045
Stevenson	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.007	0.415	4135
Telford	95.0%	35	0.000	0.000	0.000	0.000	0.002	0.008	0.036	0.230	0.844	3356
Telford	98.0%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.025	0.585	3854
Telford	98.5%	11	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.017	0.529	3944
Telford	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.473	4036
Telford	99.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.418	4130
MacColl and Stevenson	95.0%	122	0.010	0.359	0.943	0.991	0.997	0.999	1.000	1.000	0.999	1894
MacColl and Stevenson	98.0%	49	0.000	0.000	0.001	0.002	0.011	0.052	0.193	0.596	0.929	3066
MacColl and Stevenson	98.5%	37	0.000	0.000	0.000	0.000	0.002	0.010	0.044	0.264	0.856	3322
MacColl and Stevenson	99.0%	24	0.000	0.000	0.000	0.000	0.000	0.002	0.009	0.080	0.732	3599
MacColl and Stevenson	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.021	0.556	3900
Telford and MacColl	95.0%	124	0.013	0.424	0.955	0.993	0.998	0.999	1.000	1.000	0.999	1872
Telford and MacColl	98.0%	50	0.000	0.000	0.001	0.003	0.012	0.057	0.209	0.616	0.932	3051
Telford and MacColl	98.5%	37	0.000	0.000	0.000	0.000	0.002	0.011	0.047	0.276	0.861	3310
Telford and MacColl	99.0%	25	0.000	0.000	0.000	0.000	0.000	0.002	0.009	0.083	0.737	3591
Telford and MacColl	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.021	0.559	3896
Stevenson and Telford	95.0%	68	0.000	0.000	0.010	0.038	0.151	0.446	0.770	0.934	0.978	2698
Stevenson and Telford	98.0%	27	0.000	0.000	0.000	0.000	0.001	0.003	0.013	0.108	0.767	3531
Stevenson and Telford	98.5%	20	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.052	0.680	3694
Stevenson and Telford	99.0%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.024	0.579	3863
Stevenson and Telford	99.5%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.471	4041
BOWL	95.0%	63	0.000	0.000	0.005	0.018	0.077	0.280	0.621	0.884	0.970	2793
BOWL	98.0%	25	0.000	0.000	0.000	0.000	0.000	0.002	0.009	0.085	0.740	3585
BOWL	98.5%	19	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.044	0.659	3730
BOWL	99.0%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.023	0.569	3880
BOWL	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.010	0.457	4063
BOWL and MORL	95.0%	194	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1178
BOWL and MORL	98.0%	78	0.000	0.001	0.035	0.137	0.407	0.748	0.923	0.977	0.988	2535
BOWL and MORL	98.5%	58	0.000	0.000	0.002	0.009	0.041	0.169	0.464	0.816	0.960	2880
BOWL and MORL	99.0%	39	0.000	0.000	0.000	0.001	0.003	0.014	0.059	0.317	0.873	3273
BOWL and MORL	99.5%	19	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.046	0.665	3719

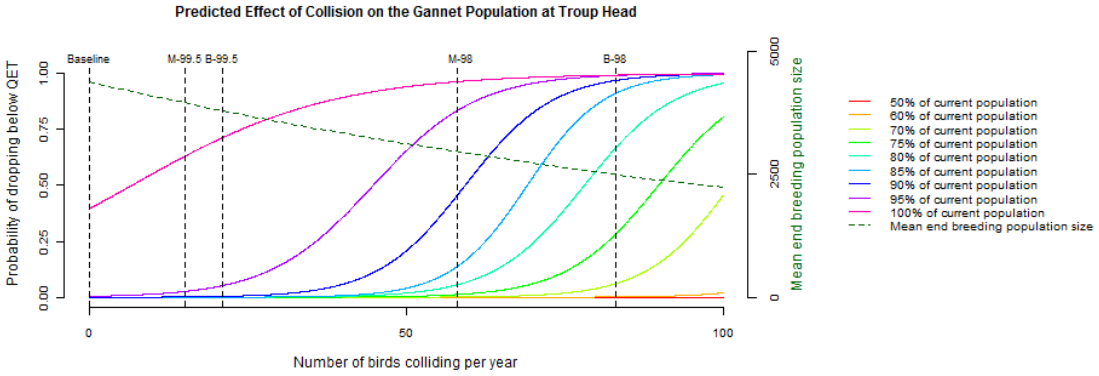


Figure E.24. Probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (up to end of impact).

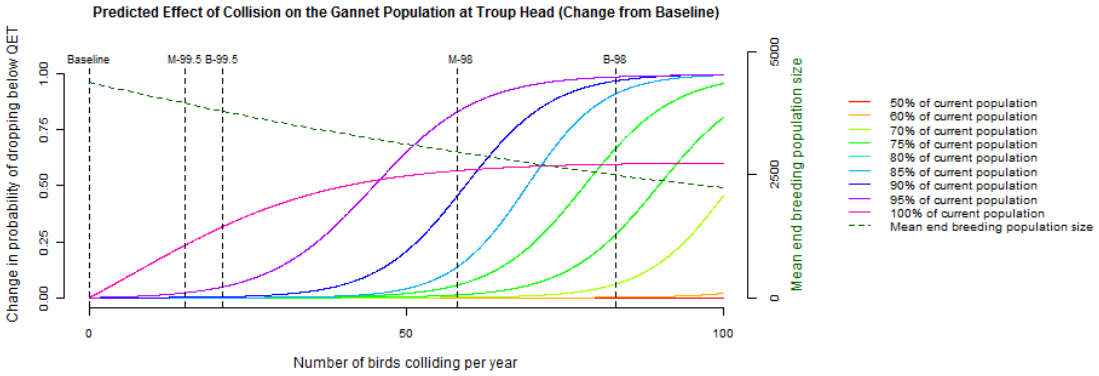


Figure E.25. Change in probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (up to end of impact).

Table E.12. Modelled probabilities of dropping below current population size for the gannet population at Troup Head with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.365	4747
Whole site	95.0%	131	0.041	0.723	0.986	0.998	0.999	1.000	1.000	1.000	1.000	2015
Whole site	98.0%	53	0.000	0.000	0.001	0.004	0.020	0.089	0.293	0.698	0.943	3370
Whole site	98.5%	39	0.000	0.000	0.000	0.001	0.003	0.016	0.064	0.335	0.878	3671
Whole site	99.0%	26	0.000	0.000	0.000	0.000	0.000	0.003	0.011	0.099	0.756	4000
Whole site	99.5%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.023	0.571	4358
Sum of MacColl, Telford & Stevenson	95.0%	157	0.634	0.992	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1703
Sum of MacColl, Telford & Stevenson	98.0%	63	0.000	0.000	0.005	0.020	0.083	0.288	0.629	0.884	0.970	3151
Sum of MacColl, Telford & Stevenson	98.5%	47	0.000	0.000	0.001	0.002	0.010	0.044	0.165	0.552	0.922	3491
Sum of MacColl, Telford & Stevenson	99.0%	31	0.000	0.000	0.000	0.000	0.001	0.005	0.023	0.166	0.811	3867
Sum of MacColl, Telford & Stevenson	99.5%	16	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.031	0.611	4285
MacColl	95.0%	89	0.000	0.004	0.162	0.472	0.787	0.936	0.983	0.994	0.994	2659
MacColl	98.0%	36	0.000	0.000	0.000	0.000	0.002	0.009	0.039	0.243	0.848	3765
MacColl	98.5%	27	0.000	0.000	0.000	0.000	0.001	0.003	0.012	0.103	0.760	3990
MacColl	99.0%	18	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.039	0.642	4228
MacColl	99.5%	9	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.014	0.504	4480
Stevenson	95.0%	33	0.000	0.000	0.000	0.000	0.001	0.007	0.029	0.197	0.829	3822
Stevenson	98.0%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.024	0.574	4353
Stevenson	98.5%	10	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.016	0.521	4448
Stevenson	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.468	4546
Stevenson	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.415	4646
Telford	95.0%	35	0.000	0.000	0.000	0.000	0.002	0.009	0.037	0.233	0.844	3777
Telford	98.0%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.026	0.585	4332
Telford	98.5%	11	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.017	0.530	4433
Telford	99.0%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.012	0.474	4535
Telford	99.5%	4	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.418	4640
MacColl and Stevenson	95.0%	122	0.011	0.392	0.951	0.991	0.998	0.999	1.000	1.000	0.999	2141
MacColl and Stevenson	98.0%	49	0.000	0.000	0.001	0.003	0.012	0.055	0.200	0.600	0.929	3452
MacColl and Stevenson	98.5%	37	0.000	0.000	0.000	0.000	0.002	0.011	0.045	0.267	0.857	3739
MacColl and Stevenson	99.0%	24	0.000	0.000	0.000	0.000	0.000	0.002	0.009	0.081	0.733	4048
MacColl and Stevenson	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.021	0.557	4384
Telford and MacColl	95.0%	124	0.014	0.458	0.961	0.993	0.998	0.999	1.000	1.000	0.999	2116
Telford and MacColl	98.0%	50	0.000	0.000	0.001	0.003	0.013	0.061	0.216	0.620	0.932	3436
Telford and MacColl	98.5%	37	0.000	0.000	0.000	0.000	0.002	0.012	0.048	0.279	0.861	3725
Telford and MacColl	99.0%	25	0.000	0.000	0.000	0.000	0.000	0.002	0.009	0.084	0.738	4039
Telford and MacColl	99.5%	12	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.021	0.560	4379
Stevenson and Telford	95.0%	68	0.000	0.000	0.011	0.043	0.165	0.461	0.781	0.935	0.979	3041
Stevenson and Telford	98.0%	27	0.000	0.000	0.000	0.000	0.001	0.003	0.013	0.110	0.768	3973
Stevenson and Telford	98.5%	20	0.000	0.000	0.000	0.000	0.000	0.001	0.005	0.053	0.681	4154
Stevenson and Telford	99.0%	14	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.025	0.580	4343
Stevenson and Telford	99.5%	7	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.011	0.471	4541
BOWL	95.0%	63	0.000	0.000	0.005	0.020	0.085	0.293	0.634	0.886	0.970	3147
BOWL	98.0%	25	0.000	0.000	0.000	0.000	0.000	0.002	0.010	0.086	0.740	4033
BOWL	98.5%	19	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.045	0.660	4194
BOWL	99.0%	13	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.023	0.569	4361
BOWL	99.5%	6	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.010	0.458	4565
BOWL and MORL	95.0%	194	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1336
BOWL and MORL	98.0%	78	0.000	0.001	0.040	0.151	0.432	0.759	0.929	0.977	0.988	2859
BOWL and MORL	98.5%	58	0.000	0.000	0.003	0.010	0.045	0.178	0.477	0.818	0.960	3245
BOWL and MORL	99.0%	39	0.000	0.000	0.000	0.001	0.003	0.015	0.060	0.321	0.874	3684
BOWL and MORL	99.5%	19	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.047	0.666	4182

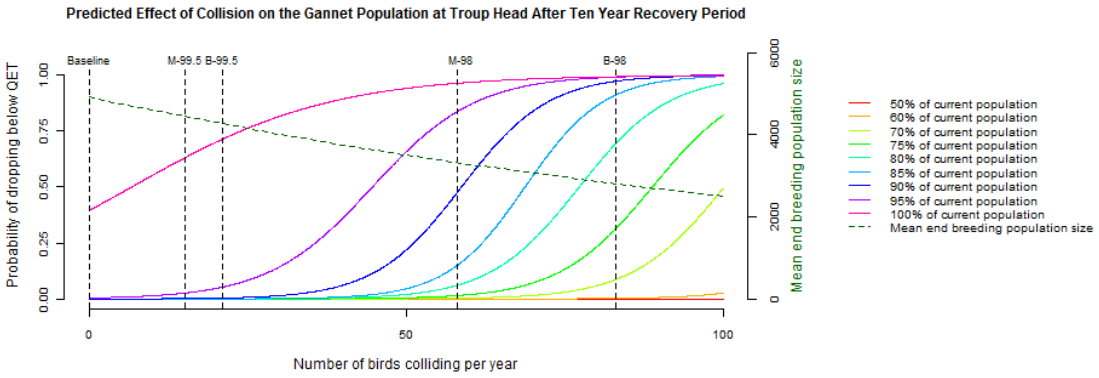


Figure E.26. Probability of the gannet population at Troup Head dropping below quasi-extinction thresholds (after 10 year recovery period).

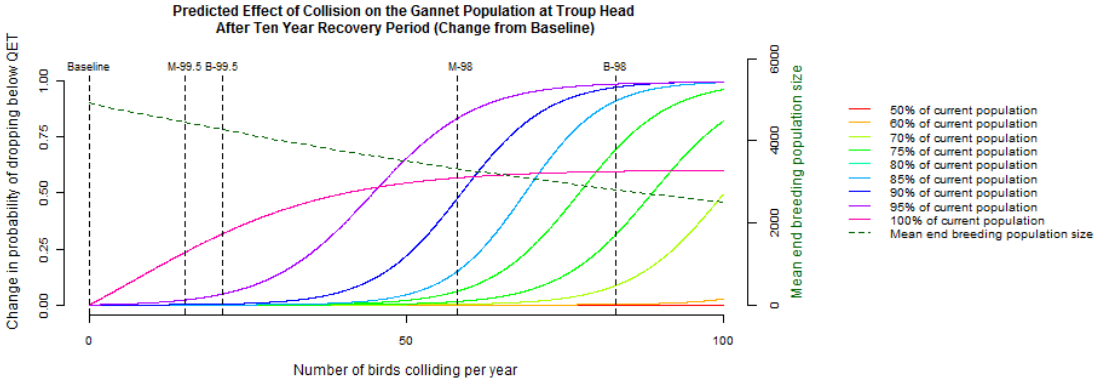


Figure E.27. Change in probability of the gannet population Troup Head dropping below quasi-extinction thresholds (after 10 year recovery period).

Table E.13. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the gannet population at Troup Head with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.000	0.000	0.000	0.001	0.006	0.020	0.085	0.269	0.490	4226
Whole site	95.0%	131	0.949	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1782
Whole site	98.0%	53	0.000	0.013	0.334	0.708	0.919	0.980	0.994	0.997	0.999	2992
Whole site	98.5%	39	0.000	0.002	0.069	0.268	0.636	0.877	0.961	0.985	0.997	3262
Whole site	99.0%	26	0.000	0.000	0.011	0.052	0.211	0.502	0.793	0.921	0.978	3556
Whole site	99.5%	13	0.000	0.000	0.002	0.008	0.039	0.125	0.374	0.674	0.866	3876
Sum of MacColl, Telford & Stevenson	95.0%	157	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1504
Sum of MacColl, Telford & Stevenson	98.0%	63	0.002	0.055	0.692	0.914	0.980	0.996	0.999	0.999	1.000	2796
Sum of MacColl, Telford & Stevenson	98.5%	47	0.000	0.006	0.186	0.526	0.840	0.957	0.986	0.995	0.999	3100
Sum of MacColl, Telford & Stevenson	99.0%	31	0.000	0.001	0.023	0.104	0.358	0.685	0.888	0.958	0.989	3437
Sum of MacColl, Telford & Stevenson	99.5%	16	0.000	0.000	0.002	0.012	0.056	0.174	0.462	0.744	0.904	3811
MacColl	95.0%	89	0.053	0.730	0.990	0.998	1.000	1.000	1.000	1.000	1.000	2357
MacColl	98.0%	36	0.000	0.001	0.041	0.173	0.501	0.800	0.934	0.975	0.994	3346
MacColl	98.5%	27	0.000	0.000	0.012	0.055	0.220	0.516	0.801	0.925	0.979	3547
MacColl	99.0%	18	0.000	0.000	0.003	0.016	0.074	0.222	0.535	0.792	0.927	3760
MacColl	99.5%	9	0.000	0.000	0.001	0.004	0.022	0.071	0.247	0.542	0.777	3986
Stevenson	95.0%	33	0.000	0.001	0.029	0.131	0.420	0.740	0.911	0.967	0.992	3397
Stevenson	98.0%	13	0.000	0.000	0.002	0.008	0.040	0.128	0.379	0.679	0.869	3872
Stevenson	98.5%	10	0.000	0.000	0.001	0.005	0.025	0.082	0.276	0.577	0.804	3958
Stevenson	99.0%	7	0.000	0.000	0.001	0.003	0.016	0.052	0.193	0.469	0.716	4045
Stevenson	99.5%	3	0.000	0.000	0.000	0.002	0.010	0.032	0.130	0.363	0.609	4135
Telford	95.0%	35	0.000	0.001	0.038	0.163	0.484	0.788	0.930	0.974	0.994	3356
Telford	98.0%	14	0.000	0.000	0.002	0.009	0.044	0.140	0.403	0.699	0.880	3854
Telford	98.5%	11	0.000	0.000	0.001	0.006	0.027	0.088	0.292	0.595	0.816	3944
Telford	99.0%	7	0.000	0.000	0.001	0.003	0.017	0.054	0.201	0.480	0.727	4036
Telford	99.5%	4	0.000	0.000	0.000	0.002	0.010	0.033	0.133	0.368	0.615	4130
MacColl and Stevenson	95.0%	122	0.840	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1894
MacColl and Stevenson	98.0%	49	0.000	0.007	0.226	0.586	0.870	0.967	0.989	0.996	0.999	3066
MacColl and Stevenson	98.5%	37	0.000	0.001	0.047	0.197	0.540	0.825	0.943	0.979	0.995	3322
MacColl and Stevenson	99.0%	24	0.000	0.000	0.008	0.040	0.170	0.434	0.746	0.901	0.971	3599
MacColl and Stevenson	99.5%	12	0.000	0.000	0.001	0.007	0.035	0.111	0.344	0.647	0.850	3900
Telford and MacColl	95.0%	124	0.870	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1872
Telford and MacColl	98.0%	50	0.000	0.008	0.245	0.612	0.881	0.970	0.990	0.996	0.999	3051
Telford and MacColl	98.5%	37	0.000	0.001	0.051	0.209	0.559	0.836	0.947	0.980	0.995	3310
Telford and MacColl	99.0%	25	0.000	0.000	0.009	0.043	0.178	0.447	0.756	0.905	0.972	3591
Telford and MacColl	99.5%	12	0.000	0.000	0.001	0.007	0.036	0.114	0.349	0.652	0.853	3896
Stevenson and Telford	95.0%	68	0.003	0.115	0.832	0.959	0.991	0.998	0.999	1.000	1.000	2698
Stevenson and Telford	98.0%	27	0.000	0.000	0.013	0.060	0.237	0.541	0.816	0.930	0.981	3531
Stevenson and Telford	98.5%	20	0.000	0.000	0.005	0.023	0.105	0.299	0.628	0.845	0.950	3694
Stevenson and Telford	99.0%	14	0.000	0.000	0.002	0.009	0.042	0.134	0.391	0.689	0.875	3863
Stevenson and Telford	99.5%	7	0.000	0.000	0.001	0.003	0.016	0.053	0.197	0.474	0.722	4041
BOWL	95.0%	63	0.002	0.056	0.697	0.916	0.981	0.996	0.999	0.999	1.000	2793
BOWL	98.0%	25	0.000	0.000	0.009	0.044	0.183	0.455	0.762	0.908	0.973	3585
BOWL	98.5%	19	0.000	0.000	0.004	0.019	0.087	0.255	0.578	0.818	0.938	3730
BOWL	99.0%	13	0.000	0.000	0.002	0.008	0.039	0.123	0.369	0.670	0.864	3880
BOWL	99.5%	6	0.000	0.000	0.001	0.003	0.015	0.047	0.179	0.447	0.697	4063
BOWL and MORL	95.0%	194	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1178
BOWL and MORL	98.0%	78	0.012	0.344	0.951	0.989	0.998	1.000	1.000	1.000	1.000	2535
BOWL and MORL	98.5%	58	0.001	0.029	0.537	0.847	0.963	0.992	0.997	0.999	1.000	2880
BOWL and MORL	99.0%	39	0.000	0.002	0.064	0.253	0.618	0.868	0.958	0.984	0.996	3273
BOWL and MORL	99.5%	19	0.000	0.000	0.004	0.020	0.092	0.268	0.593	0.826	0.942	3719

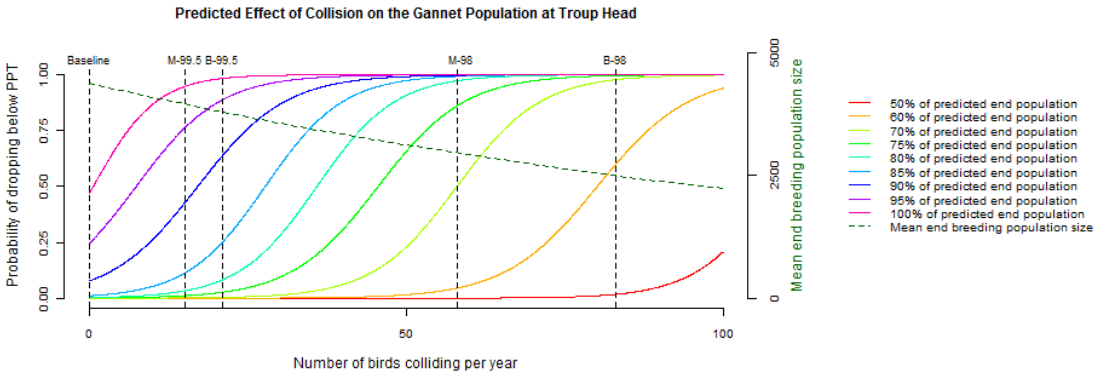


Figure E.28. Probability of the gannet population at Troup Head dropping below population percentage thresholds (up to end of impact).

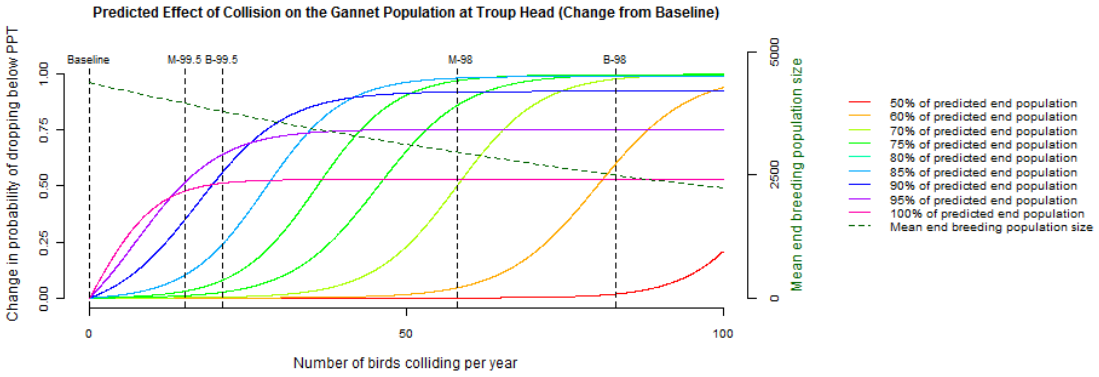


Figure E.29. Change in probability of the gannet population at Troup Head dropping below population percentage thresholds (up to end of impact).

Table E.14. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the gannet population at Troup Head with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.000	0.000	0.000	0.000	0.001	0.004	0.014	0.042	0.107	4747
Whole site	95.0%	131	0.594	0.974	0.999	1.000	1.000	1.000	1.000	1.000	1.000	2015
Whole site	98.0%	53	0.000	0.004	0.051	0.179	0.440	0.720	0.892	0.961	0.983	3370
Whole site	98.5%	39	0.000	0.001	0.010	0.041	0.137	0.333	0.626	0.834	0.926	3671
Whole site	99.0%	26	0.000	0.000	0.002	0.008	0.031	0.089	0.253	0.509	0.727	4000
Whole site	99.5%	13	0.000	0.000	0.000	0.002	0.007	0.019	0.064	0.176	0.360	4358
Sum of MacColl, Telford & Stevenson	95.0%	157	0.973	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1703
Sum of MacColl, Telford & Stevenson	98.0%	63	0.000	0.014	0.162	0.439	0.733	0.903	0.966	0.988	0.995	3151
Sum of MacColl, Telford & Stevenson	98.5%	47	0.000	0.002	0.026	0.100	0.289	0.567	0.810	0.927	0.969	3491
Sum of MacColl, Telford & Stevenson	99.0%	31	0.000	0.000	0.004	0.016	0.057	0.156	0.388	0.658	0.830	3867
Sum of MacColl, Telford & Stevenson	99.5%	16	0.000	0.000	0.001	0.002	0.009	0.025	0.086	0.225	0.433	4285
MacColl	95.0%	89	0.007	0.217	0.833	0.952	0.985	0.996	0.999	0.999	1.000	2659
MacColl	98.0%	36	0.000	0.001	0.006	0.026	0.091	0.236	0.511	0.759	0.888	3765
MacColl	98.5%	27	0.000	0.000	0.002	0.009	0.033	0.093	0.262	0.520	0.736	3990
MacColl	99.0%	18	0.000	0.000	0.001	0.003	0.011	0.033	0.108	0.271	0.493	4228
MacColl	99.5%	9	0.000	0.000	0.000	0.001	0.004	0.011	0.039	0.113	0.254	4480
Stevenson	95.0%	33	0.000	0.000	0.005	0.019	0.070	0.188	0.441	0.705	0.858	3822
Stevenson	98.0%	13	0.000	0.000	0.000	0.002	0.007	0.019	0.065	0.178	0.365	4353
Stevenson	98.5%	10	0.000	0.000	0.000	0.001	0.004	0.013	0.045	0.127	0.279	4448
Stevenson	99.0%	7	0.000	0.000	0.000	0.001	0.003	0.008	0.030	0.089	0.207	4546
Stevenson	99.5%	3	0.000	0.000	0.000	0.000	0.002	0.006	0.020	0.061	0.150	4646
Telford	95.0%	35	0.000	0.001	0.006	0.024	0.086	0.225	0.496	0.748	0.882	3777
Telford	98.0%	14	0.000	0.000	0.000	0.002	0.007	0.021	0.071	0.192	0.385	4332
Telford	98.5%	11	0.000	0.000	0.000	0.001	0.005	0.013	0.048	0.134	0.292	4433
Telford	99.0%	7	0.000	0.000	0.000	0.001	0.003	0.009	0.032	0.092	0.215	4535
Telford	99.5%	4	0.000	0.000	0.000	0.000	0.002	0.006	0.021	0.063	0.153	4640
MacColl and Stevenson	95.0%	122	0.316	0.927	0.997	0.999	1.000	1.000	1.000	1.000	1.000	2141
MacColl and Stevenson	98.0%	49	0.000	0.003	0.033	0.121	0.333	0.618	0.840	0.940	0.975	3452
MacColl and Stevenson	98.5%	37	0.000	0.001	0.007	0.029	0.102	0.261	0.544	0.782	0.900	3739
MacColl and Stevenson	99.0%	24	0.000	0.000	0.002	0.007	0.025	0.072	0.213	0.453	0.681	4048
MacColl and Stevenson	99.5%	12	0.000	0.000	0.000	0.001	0.006	0.017	0.058	0.160	0.335	4384
Telford and MacColl	95.0%	124	0.367	0.940	0.997	0.999	1.000	1.000	1.000	1.000	1.000	2116
Telford and MacColl	98.0%	50	0.000	0.003	0.035	0.130	0.353	0.639	0.851	0.945	0.977	3436
Telford and MacColl	98.5%	37	0.000	0.001	0.008	0.031	0.108	0.274	0.560	0.793	0.906	3725
Telford and MacColl	99.0%	25	0.000	0.000	0.002	0.007	0.026	0.075	0.220	0.464	0.690	4039
Telford and MacColl	99.5%	12	0.000	0.000	0.000	0.001	0.006	0.017	0.059	0.163	0.340	4379
Stevenson and Telford	95.0%	68	0.001	0.025	0.276	0.605	0.842	0.948	0.982	0.994	0.997	3041
Stevenson and Telford	98.0%	27	0.000	0.000	0.002	0.009	0.035	0.100	0.278	0.540	0.751	3973
Stevenson and Telford	98.5%	20	0.000	0.000	0.001	0.004	0.016	0.045	0.144	0.340	0.573	4154
Stevenson and Telford	99.0%	14	0.000	0.000	0.000	0.002	0.007	0.020	0.068	0.185	0.375	4343
Stevenson and Telford	99.5%	7	0.000	0.000	0.000	0.001	0.003	0.009	0.031	0.091	0.211	4541
BOWL	95.0%	63	0.000	0.014	0.165	0.444	0.737	0.905	0.967	0.989	0.995	3147
BOWL	98.0%	25	0.000	0.000	0.002	0.007	0.027	0.077	0.225	0.471	0.696	4033
BOWL	98.5%	19	0.000	0.000	0.001	0.003	0.013	0.038	0.123	0.301	0.530	4194
BOWL	99.0%	13	0.000	0.000	0.000	0.002	0.006	0.018	0.063	0.173	0.357	4361
BOWL	99.5%	6	0.000	0.000	0.000	0.001	0.003	0.008	0.028	0.083	0.195	4565
BOWL and MORL	95.0%	194	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1336
BOWL and MORL	98.0%	78	0.002	0.072	0.555	0.832	0.944	0.983	0.994	0.998	0.999	2859
BOWL and MORL	98.5%	58	0.000	0.008	0.099	0.308	0.613	0.841	0.943	0.980	0.992	3245
BOWL and MORL	99.0%	39	0.000	0.001	0.010	0.038	0.130	0.319	0.610	0.825	0.922	3684
BOWL and MORL	99.5%	19	0.000	0.000	0.001	0.004	0.014	0.040	0.129	0.313	0.543	4182

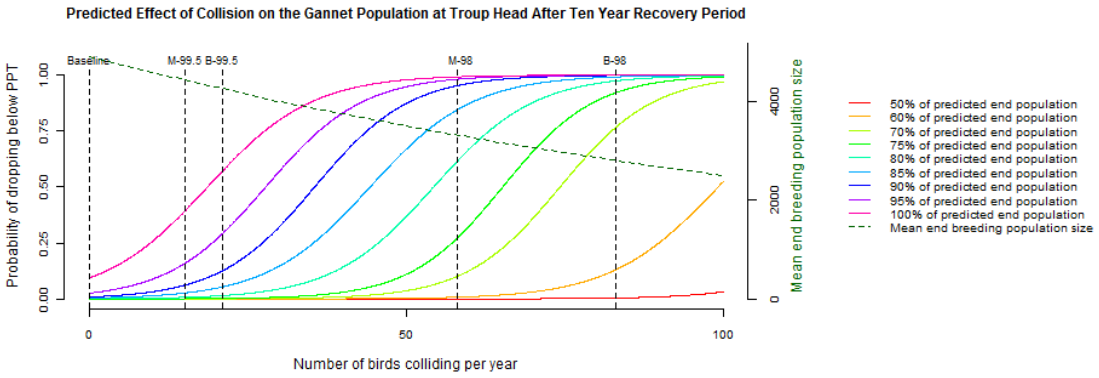


Figure E.30. Probability of the gannet population at Troup Head dropping below population percentage thresholds (after 10 year recovery period).

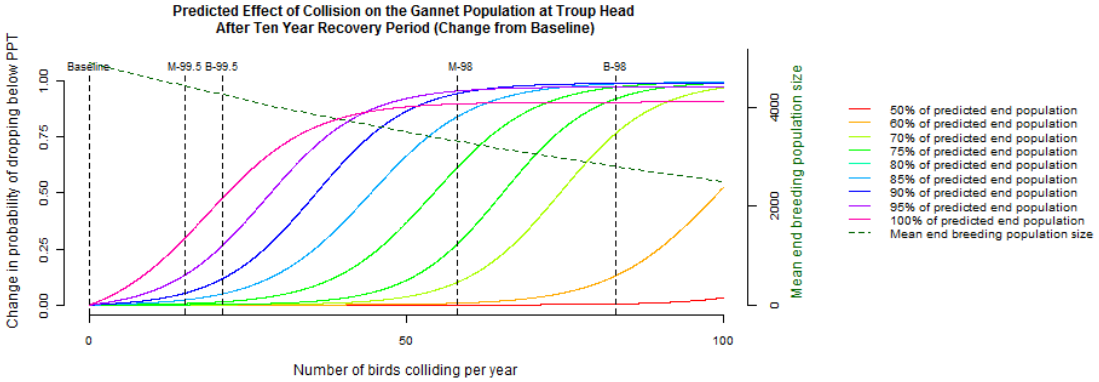


Figure E.31. Change in probability of the gannet population at Troup Head dropping below population percentage thresholds (after 10 year recovery period).

Appendix F – PVA Outputs: Kittiwake – East Caithness Cliffs

Collision and displacement

Table F.1. Modelled probabilities of dropping below baseline predicted population size for the kittiwake population at East Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.028	0.083	0.174	0.230	0.292	0.351	0.412	0.474	0.531	54435
Whole site	10%	214	95.0%	181	0.037	0.103	0.205	0.265	0.331	0.392	0.455	0.517	0.575	52151
Whole site	10%	214	98.0%	72	0.031	0.091	0.186	0.244	0.307	0.367	0.430	0.491	0.549	53510
Whole site	10%	214	98.5%	54	0.030	0.089	0.183	0.240	0.303	0.363	0.425	0.487	0.544	53740
Whole site	10%	214	99.0%	36	0.029	0.087	0.180	0.237	0.299	0.359	0.421	0.482	0.540	53971
Whole site	10%	214	99.5%	18	0.028	0.085	0.177	0.234	0.296	0.355	0.417	0.478	0.536	54202
Sum of MacColl, Telford & Stevenson	10%	214	95.0%	218	0.039	0.108	0.212	0.272	0.339	0.400	0.464	0.526	0.583	51695
Sum of MacColl, Telford & Stevenson	10%	214	98.0%	87	0.032	0.092	0.188	0.247	0.310	0.370	0.433	0.494	0.552	53322
Sum of MacColl, Telford & Stevenson	10%	214	98.5%	65	0.031	0.090	0.184	0.242	0.306	0.365	0.428	0.489	0.547	53598
Sum of MacColl, Telford & Stevenson	10%	214	99.0%	44	0.030	0.088	0.181	0.238	0.301	0.360	0.423	0.484	0.542	53876
Sum of MacColl, Telford & Stevenson	10%	214	99.5%	22	0.029	0.085	0.177	0.234	0.296	0.356	0.418	0.479	0.537	54155
MacColl	10%	214	95.0%	109	0.033	0.095	0.192	0.251	0.315	0.375	0.438	0.500	0.558	53040
MacColl	10%	214	98.0%	44	0.030	0.088	0.181	0.238	0.301	0.361	0.423	0.484	0.542	53873
MacColl	10%	214	98.5%	33	0.029	0.087	0.179	0.236	0.299	0.358	0.420	0.481	0.539	54013
MacColl	10%	214	99.0%	22	0.029	0.085	0.177	0.234	0.297	0.356	0.418	0.479	0.537	54153
MacColl	10%	214	99.5%	11	0.028	0.084	0.175	0.232	0.294	0.353	0.415	0.476	0.534	54294
Stevenson	10%	214	95.0%	63	0.031	0.090	0.184	0.242	0.305	0.365	0.427	0.489	0.547	53624
Stevenson	10%	214	98.0%	25	0.029	0.086	0.178	0.235	0.297	0.356	0.418	0.480	0.537	54109
Stevenson	10%	214	98.5%	19	0.029	0.085	0.177	0.234	0.296	0.355	0.417	0.478	0.536	54191
Stevenson	10%	214	99.0%	13	0.028	0.084	0.176	0.233	0.295	0.354	0.415	0.477	0.534	54272
Stevenson	10%	214	99.5%	6	0.028	0.084	0.175	0.231	0.293	0.352	0.414	0.475	0.533	54354
Telford	10%	214	95.0%	45	0.030	0.088	0.181	0.239	0.301	0.361	0.423	0.484	0.542	53857
Telford	10%	214	98.0%	18	0.028	0.085	0.177	0.234	0.296	0.355	0.417	0.478	0.536	54203
Telford	10%	214	98.5%	13	0.028	0.085	0.176	0.233	0.295	0.354	0.416	0.477	0.535	54261
Telford	10%	214	99.0%	9	0.028	0.084	0.175	0.232	0.294	0.353	0.415	0.476	0.533	54319
Telford	10%	214	99.5%	4	0.028	0.084	0.174	0.231	0.293	0.352	0.413	0.475	0.532	54377
MacColl and Stevenson	10%	214	95.0%	173	0.037	0.102	0.203	0.263	0.329	0.390	0.454	0.515	0.573	52250
MacColl and Stevenson	10%	214	98.0%	69	0.031	0.090	0.185	0.243	0.306	0.366	0.429	0.490	0.548	53550
MacColl and Stevenson	10%	214	98.5%	52	0.030	0.089	0.182	0.240	0.303	0.362	0.425	0.486	0.544	53770
MacColl and Stevenson	10%	214	99.0%	35	0.029	0.087	0.179	0.237	0.299	0.358	0.421	0.482	0.540	53991
MacColl and Stevenson	10%	214	99.5%	17	0.028	0.085	0.176	0.233	0.296	0.355	0.416	0.478	0.535	54213
Telford and MacColl	10%	214	95.0%	154	0.036	0.100	0.200	0.260	0.325	0.386	0.449	0.511	0.568	52477
Telford and MacColl	10%	214	98.0%	62	0.031	0.090	0.184	0.242	0.305	0.365	0.427	0.488	0.546	53643
Telford and MacColl	10%	214	98.5%	46	0.030	0.088	0.181	0.239	0.302	0.361	0.423	0.485	0.542	53840
Telford and MacColl	10%	214	99.0%	31	0.029	0.086	0.179	0.236	0.298	0.358	0.420	0.481	0.539	54038
Telford and MacColl	10%	214	99.5%	15	0.028	0.085	0.176	0.233	0.295	0.354	0.416	0.477	0.535	54236
Stevenson and Telford	10%	214	95.0%	108	0.033	0.095	0.192	0.251	0.315	0.375	0.438	0.500	0.557	53055
Stevenson and Telford	10%	214	98.0%	43	0.030	0.088	0.181	0.238	0.301	0.360	0.423	0.484	0.542	53879
Stevenson and Telford	10%	214	98.5%	32	0.029	0.087	0.179	0.236	0.299	0.358	0.420	0.481	0.539	54017
Stevenson and Telford	10%	214	99.0%	22	0.029	0.085	0.177	0.234	0.296	0.356	0.418	0.479	0.537	54156
Stevenson and Telford	10%	214	99.5%	11	0.028	0.084	0.175	0.232	0.294	0.353	0.415	0.476	0.534	54296
BOWL	10%	214	95.0%	32	0.029	0.086	0.179	0.236	0.299	0.358	0.420	0.481	0.539	54023
BOWL	10%	214	98.0%	13	0.028	0.085	0.176	0.233	0.295	0.354	0.415	0.477	0.534	54267
BOWL	10%	214	98.5%	9	0.028	0.084	0.175	0.232	0.294	0.353	0.415	0.476	0.533	54319
BOWL	10%	214	99.0%	6	0.028	0.084	0.175	0.231	0.293	0.352	0.414	0.475	0.533	54358
BOWL	10%	214	99.5%	3	0.028	0.084	0.174	0.231	0.293	0.352	0.413	0.474	0.532	54396
BOWL and MORL	10%	214	95.0%	213	0.039	0.107	0.211	0.271	0.338	0.399	0.463	0.525	0.582	51757
BOWL and MORL	10%	214	98.0%	85	0.032	0.092	0.188	0.246	0.310	0.370	0.433	0.494	0.552	53348
BOWL and MORL	10%	214	98.5%	64	0.031	0.090	0.184	0.242	0.305	0.365	0.428	0.489	0.547	53617
BOWL and MORL	10%	214	99.0%	43	0.030	0.088	0.181	0.238	0.301	0.360	0.422	0.484	0.542	53889
BOWL and MORL	10%	214	99.5%	21	0.029	0.085	0.177	0.234	0.296	0.356	0.417	0.479	0.536	54161

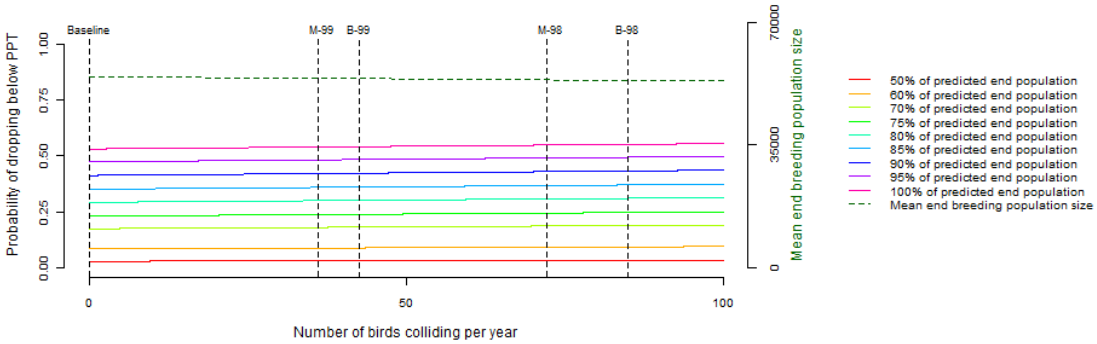


Figure F.1. Probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

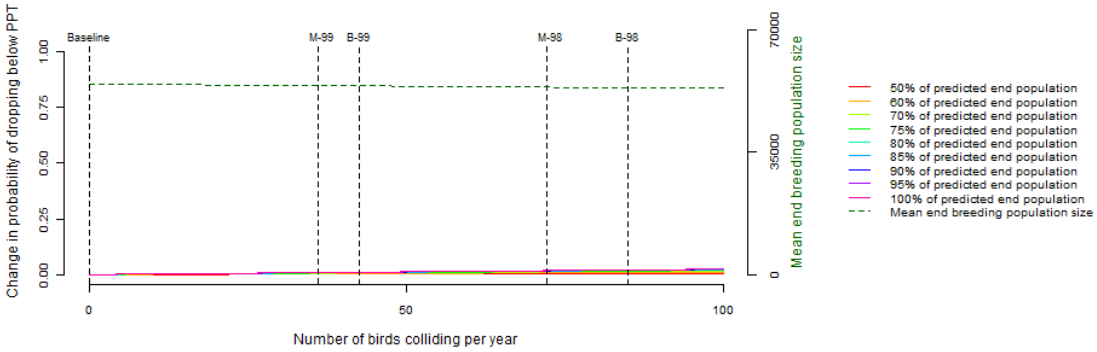


Figure F.2. Change in probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table F.2. Modelled probabilities of dropping below baseline predicted population size for the kittiwake population at East Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.120	0.240	0.367	0.427	0.482	0.540	0.592	0.639	0.687	46456
Whole site	10%	214	95.0%	181	0.140	0.264	0.399	0.461	0.521	0.576	0.629	0.675	0.721	44560
Whole site	10%	214	98.0%	72	0.128	0.249	0.380	0.440	0.498	0.554	0.607	0.654	0.700	45688
Whole site	10%	214	98.5%	54	0.126	0.247	0.377	0.437	0.494	0.550	0.603	0.650	0.697	45879
Whole site	10%	214	99.0%	36	0.124	0.244	0.374	0.434	0.490	0.547	0.599	0.647	0.694	46071
Whole site	10%	214	99.5%	18	0.122	0.242	0.371	0.430	0.486	0.543	0.595	0.643	0.690	46263
Sum of MacColl, Telford & Stevenson	10%	214	95.0%	218	0.145	0.270	0.406	0.467	0.529	0.583	0.636	0.682	0.727	44181
Sum of MacColl, Telford & Stevenson	10%	214	98.0%	87	0.129	0.251	0.383	0.443	0.501	0.557	0.610	0.657	0.703	45532
Sum of MacColl, Telford & Stevenson	10%	214	98.5%	65	0.127	0.248	0.379	0.439	0.496	0.553	0.605	0.653	0.699	45762
Sum of MacColl, Telford & Stevenson	10%	214	99.0%	44	0.125	0.245	0.375	0.435	0.491	0.548	0.601	0.648	0.695	45992
Sum of MacColl, Telford & Stevenson	10%	214	99.5%	22	0.122	0.242	0.371	0.431	0.486	0.544	0.596	0.644	0.691	46223
MacColl	10%	214	95.0%	109	0.132	0.254	0.387	0.447	0.506	0.561	0.614	0.661	0.707	45298
MacColl	10%	214	98.0%	44	0.125	0.245	0.375	0.435	0.491	0.548	0.601	0.648	0.695	45989
MacColl	10%	214	98.5%	33	0.124	0.244	0.373	0.433	0.489	0.546	0.599	0.646	0.693	46106
MacColl	10%	214	99.0%	22	0.122	0.242	0.371	0.431	0.487	0.544	0.596	0.644	0.691	46222
MacColl	10%	214	99.5%	11	0.121	0.241	0.369	0.429	0.484	0.542	0.594	0.642	0.689	46339
Stevenson	10%	214	95.0%	63	0.127	0.248	0.378	0.439	0.496	0.552	0.605	0.652	0.699	45783
Stevenson	10%	214	98.0%	25	0.123	0.243	0.372	0.432	0.487	0.545	0.597	0.645	0.692	46186
Stevenson	10%	214	98.5%	19	0.122	0.242	0.371	0.431	0.486	0.543	0.596	0.643	0.690	46253
Stevenson	10%	214	99.0%	13	0.121	0.241	0.370	0.429	0.484	0.542	0.594	0.642	0.689	46321
Stevenson	10%	214	99.5%	6	0.121	0.240	0.369	0.428	0.483	0.541	0.593	0.641	0.688	46388
Telford	10%	214	95.0%	45	0.125	0.246	0.375	0.435	0.492	0.549	0.601	0.648	0.695	45976
Telford	10%	214	98.0%	18	0.122	0.242	0.371	0.430	0.486	0.543	0.595	0.643	0.690	46264
Telford	10%	214	98.5%	13	0.121	0.241	0.370	0.430	0.485	0.542	0.595	0.642	0.689	46312
Telford	10%	214	99.0%	9	0.121	0.241	0.369	0.429	0.484	0.541	0.594	0.641	0.688	46360
Telford	10%	214	99.5%	4	0.121	0.240	0.368	0.428	0.483	0.540	0.593	0.640	0.688	46408
MacColl and Stevenson	10%	214	95.0%	173	0.139	0.263	0.398	0.459	0.520	0.574	0.627	0.673	0.719	44642
MacColl and Stevenson	10%	214	98.0%	69	0.127	0.249	0.379	0.440	0.497	0.553	0.606	0.653	0.700	45722
MacColl and Stevenson	10%	214	98.5%	52	0.126	0.247	0.376	0.437	0.493	0.550	0.602	0.650	0.697	45904
MacColl and Stevenson	10%	214	99.0%	35	0.124	0.244	0.373	0.433	0.489	0.546	0.599	0.646	0.693	46088
MacColl and Stevenson	10%	214	99.5%	17	0.122	0.242	0.370	0.430	0.485	0.543	0.595	0.643	0.690	46272
Telford and MacColl	10%	214	95.0%	154	0.137	0.261	0.394	0.456	0.516	0.570	0.623	0.670	0.716	44830
Telford and MacColl	10%	214	98.0%	62	0.127	0.248	0.378	0.438	0.495	0.552	0.604	0.652	0.698	45799
Telford and MacColl	10%	214	98.5%	46	0.125	0.246	0.375	0.436	0.492	0.549	0.601	0.649	0.696	45962
Telford and MacColl	10%	214	99.0%	31	0.123	0.244	0.373	0.433	0.488	0.546	0.598	0.646	0.693	46126
Telford and MacColl	10%	214	99.5%	15	0.122	0.242	0.370	0.430	0.485	0.543	0.595	0.643	0.690	46291
Stevenson and Telford	10%	214	95.0%	108	0.132	0.254	0.386	0.447	0.505	0.561	0.614	0.661	0.707	45310
Stevenson and Telford	10%	214	98.0%	43	0.125	0.245	0.375	0.435	0.491	0.548	0.601	0.648	0.695	45994
Stevenson and Telford	10%	214	98.5%	32	0.123	0.244	0.373	0.433	0.489	0.546	0.598	0.646	0.693	46109
Stevenson and Telford	10%	214	99.0%	22	0.122	0.242	0.371	0.431	0.486	0.544	0.596	0.644	0.691	46225
Stevenson and Telford	10%	214	99.5%	11	0.121	0.241	0.369	0.429	0.484	0.542	0.594	0.642	0.689	46340
BOWL	10%	214	95.0%	32	0.123	0.244	0.373	0.433	0.489	0.546	0.598	0.646	0.693	46114
BOWL	10%	214	98.0%	13	0.121	0.241	0.370	0.429	0.485	0.542	0.594	0.642	0.689	46317
BOWL	10%	214	98.5%	9	0.121	0.241	0.369	0.429	0.484	0.541	0.594	0.641	0.688	46360
BOWL	10%	214	99.0%	6	0.121	0.240	0.368	0.428	0.483	0.541	0.593	0.641	0.688	46392
BOWL	10%	214	99.5%	3	0.120	0.240	0.368	0.428	0.482	0.540	0.592	0.640	0.687	46424
BOWL and MORL	10%	214	95.0%	213	0.144	0.269	0.405	0.467	0.528	0.582	0.635	0.681	0.726	44232
BOWL and MORL	10%	214	98.0%	85	0.129	0.251	0.382	0.443	0.500	0.557	0.609	0.656	0.703	45553
BOWL and MORL	10%	214	98.5%	64	0.127	0.248	0.379	0.439	0.496	0.552	0.605	0.652	0.699	45777
BOWL and MORL	10%	214	99.0%	43	0.125	0.245	0.375	0.435	0.491	0.548	0.601	0.648	0.695	46003
BOWL and MORL	10%	214	99.5%	21	0.122	0.242	0.371	0.431	0.486	0.544	0.596	0.644	0.691	46229

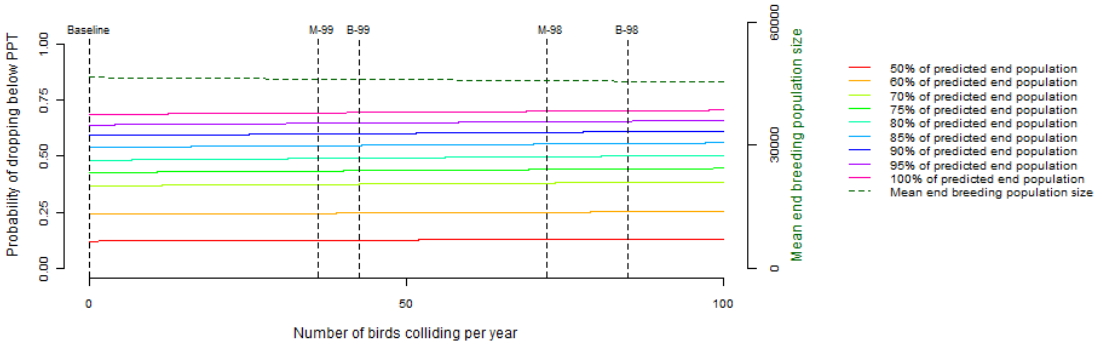


Figure F.3. Probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

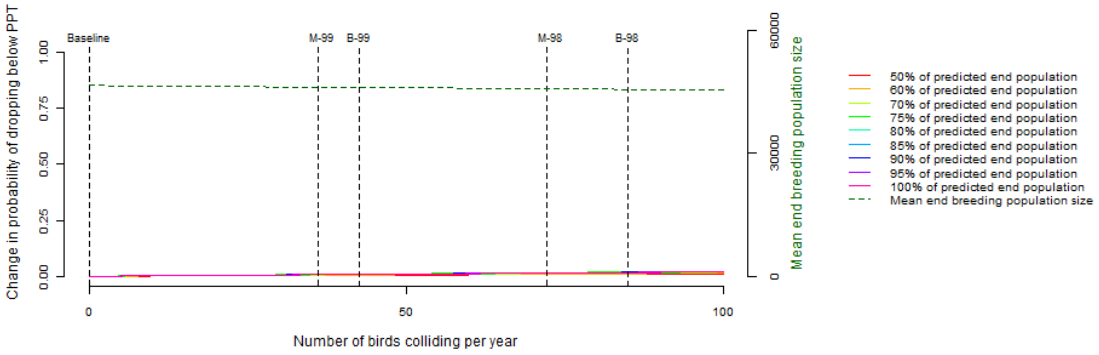


Figure F.4. Change in probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

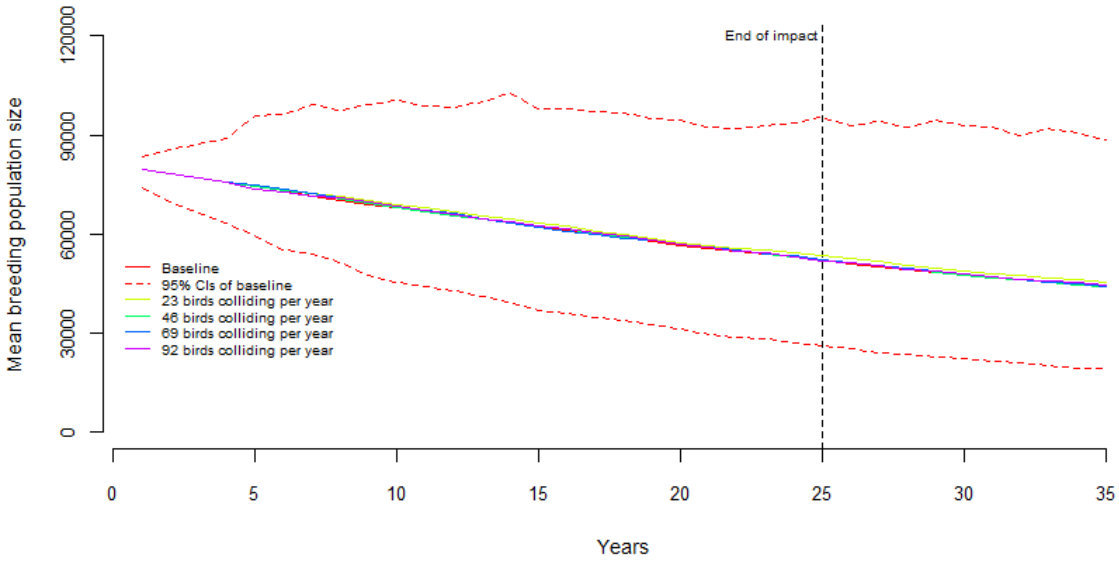


Figure F.5. Population projections for the kittiwake population at East Caithness Cliffs at different levels of collision with a high level of displacement.

Table F.3. Modelled probabilities of dropping below current population size for the kittiwake population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.391	0.626	0.806	0.868	0.915	0.947	0.966	0.981	0.990	52875
Whole site	50%	1213	95.0%	181	0.434	0.664	0.831	0.888	0.929	0.957	0.976	0.987	0.994	50857
Whole site	50%	1213	98.0%	72	0.408	0.642	0.816	0.876	0.921	0.951	0.970	0.983	0.992	52058
Whole site	50%	1213	98.5%	54	0.404	0.638	0.814	0.874	0.919	0.950	0.969	0.983	0.992	52261
Whole site	50%	1213	99.0%	36	0.400	0.634	0.811	0.872	0.918	0.949	0.968	0.982	0.991	52465
Whole site	50%	1213	99.5%	18	0.395	0.630	0.809	0.870	0.916	0.948	0.967	0.981	0.991	52669
Sum of MacColl, Telford & Stevenson	50%	1213	95.0%	218	0.443	0.672	0.835	0.892	0.932	0.958	0.977	0.988	0.995	50453
Sum of MacColl, Telford & Stevenson	50%	1213	98.0%	87	0.412	0.645	0.818	0.878	0.922	0.952	0.971	0.984	0.992	51892
Sum of MacColl, Telford & Stevenson	50%	1213	98.5%	65	0.406	0.640	0.815	0.876	0.920	0.951	0.970	0.983	0.992	52136
Sum of MacColl, Telford & Stevenson	50%	1213	99.0%	44	0.401	0.636	0.812	0.873	0.918	0.949	0.968	0.982	0.991	52381
Sum of MacColl, Telford & Stevenson	50%	1213	99.5%	22	0.396	0.631	0.809	0.871	0.916	0.948	0.967	0.982	0.991	52627
MacColl	50%	1213	95.0%	109	0.417	0.650	0.821	0.880	0.924	0.953	0.972	0.985	0.993	51643
MacColl	50%	1213	98.0%	44	0.401	0.636	0.812	0.873	0.918	0.949	0.968	0.982	0.991	52379
MacColl	50%	1213	98.5%	33	0.399	0.633	0.811	0.872	0.917	0.949	0.968	0.982	0.991	52502
MacColl	50%	1213	99.0%	22	0.396	0.631	0.809	0.871	0.916	0.948	0.967	0.982	0.991	52626
MacColl	50%	1213	99.5%	11	0.394	0.629	0.808	0.869	0.915	0.948	0.966	0.981	0.991	52750
Stevenson	50%	1213	95.0%	63	0.406	0.640	0.815	0.875	0.920	0.950	0.970	0.983	0.992	52159
Stevenson	50%	1213	98.0%	25	0.397	0.632	0.810	0.871	0.917	0.948	0.967	0.982	0.991	52587
Stevenson	50%	1213	98.5%	19	0.396	0.630	0.809	0.870	0.916	0.948	0.967	0.981	0.991	52659
Stevenson	50%	1213	99.0%	13	0.394	0.629	0.808	0.870	0.916	0.948	0.967	0.981	0.991	52731
Stevenson	50%	1213	99.5%	6	0.393	0.628	0.807	0.869	0.915	0.947	0.966	0.981	0.990	52803
Telford	50%	1213	95.0%	45	0.402	0.636	0.813	0.873	0.918	0.949	0.969	0.982	0.991	52365
Telford	50%	1213	98.0%	18	0.395	0.630	0.809	0.870	0.916	0.948	0.967	0.981	0.991	52670
Telford	50%	1213	98.5%	13	0.394	0.629	0.808	0.870	0.916	0.948	0.967	0.981	0.991	52721
Telford	50%	1213	99.0%	9	0.393	0.628	0.808	0.869	0.915	0.947	0.966	0.981	0.990	52772
Telford	50%	1213	99.5%	4	0.392	0.627	0.807	0.869	0.915	0.947	0.966	0.981	0.990	52824
MacColl and Stevenson	50%	1213	95.0%	173	0.432	0.663	0.830	0.887	0.929	0.956	0.975	0.986	0.994	50944
MacColl and Stevenson	50%	1213	98.0%	69	0.407	0.641	0.816	0.876	0.920	0.951	0.970	0.983	0.992	52094
MacColl and Stevenson	50%	1213	98.5%	52	0.403	0.637	0.814	0.874	0.919	0.950	0.969	0.983	0.992	52288
MacColl and Stevenson	50%	1213	99.0%	35	0.399	0.634	0.811	0.872	0.918	0.949	0.968	0.982	0.991	52483
MacColl and Stevenson	50%	1213	99.5%	17	0.395	0.630	0.809	0.870	0.916	0.948	0.967	0.981	0.991	52678
Telford and MacColl	50%	1213	95.0%	154	0.428	0.659	0.827	0.885	0.927	0.955	0.974	0.986	0.994	51145
Telford and MacColl	50%	1213	98.0%	62	0.406	0.640	0.815	0.875	0.920	0.950	0.970	0.983	0.992	52176
Telford and MacColl	50%	1213	98.5%	46	0.402	0.636	0.813	0.873	0.919	0.950	0.969	0.982	0.991	52350
Telford and MacColl	50%	1213	99.0%	31	0.398	0.633	0.811	0.872	0.917	0.949	0.968	0.982	0.991	52524
Telford and MacColl	50%	1213	99.5%	15	0.395	0.630	0.809	0.870	0.916	0.948	0.967	0.981	0.991	52699
Stevenson and Telford	50%	1213	95.0%	108	0.417	0.649	0.821	0.880	0.924	0.953	0.972	0.985	0.993	51656
Stevenson and Telford	50%	1213	98.0%	43	0.401	0.636	0.812	0.873	0.918	0.949	0.968	0.982	0.991	52384
Stevenson and Telford	50%	1213	98.5%	32	0.399	0.633	0.811	0.872	0.917	0.949	0.968	0.982	0.991	52506
Stevenson and Telford	50%	1213	99.0%	22	0.396	0.631	0.809	0.871	0.916	0.948	0.967	0.982	0.991	52629
Stevenson and Telford	50%	1213	99.5%	11	0.394	0.629	0.808	0.869	0.915	0.948	0.966	0.981	0.991	52752
BOWL	50%	1213	95.0%	32	0.399	0.633	0.811	0.872	0.917	0.949	0.968	0.982	0.991	52511
BOWL	50%	1213	98.0%	13	0.394	0.629	0.808	0.870	0.916	0.948	0.967	0.981	0.991	52727
BOWL	50%	1213	98.5%	9	0.393	0.628	0.808	0.869	0.915	0.947	0.966	0.981	0.990	52772
BOWL	50%	1213	99.0%	6	0.393	0.628	0.807	0.869	0.915	0.947	0.966	0.981	0.990	52806
BOWL	50%	1213	99.5%	3	0.392	0.627	0.807	0.869	0.915	0.947	0.966	0.981	0.990	52841
BOWL and MORL	50%	1213	95.0%	213	0.442	0.671	0.835	0.891	0.932	0.958	0.977	0.988	0.995	50508
BOWL and MORL	50%	1213	98.0%	85	0.411	0.645	0.818	0.878	0.922	0.952	0.971	0.984	0.992	51915
BOWL and MORL	50%	1213	98.5%	64	0.406	0.640	0.815	0.875	0.920	0.951	0.970	0.983	0.992	52153
BOWL and MORL	50%	1213	99.0%	43	0.401	0.635	0.812	0.873	0.918	0.949	0.968	0.982	0.991	52393
BOWL and MORL	50%	1213	99.5%	21	0.396	0.631	0.809	0.871	0.916	0.948	0.967	0.982	0.991	52633

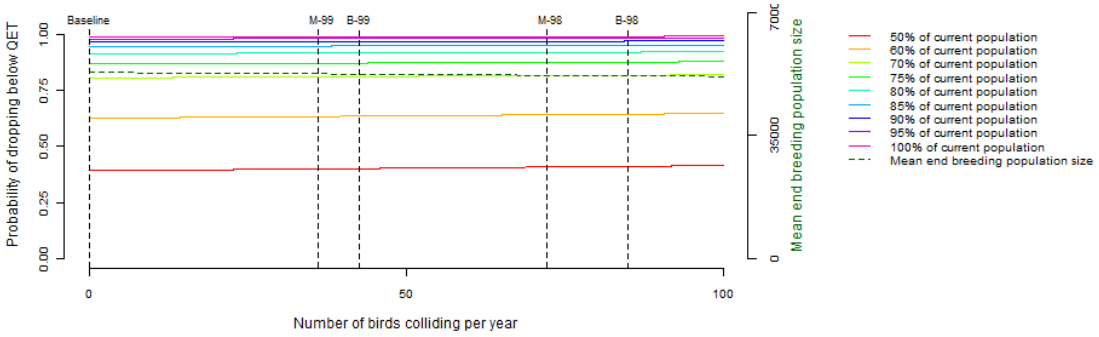


Figure F.6. Probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

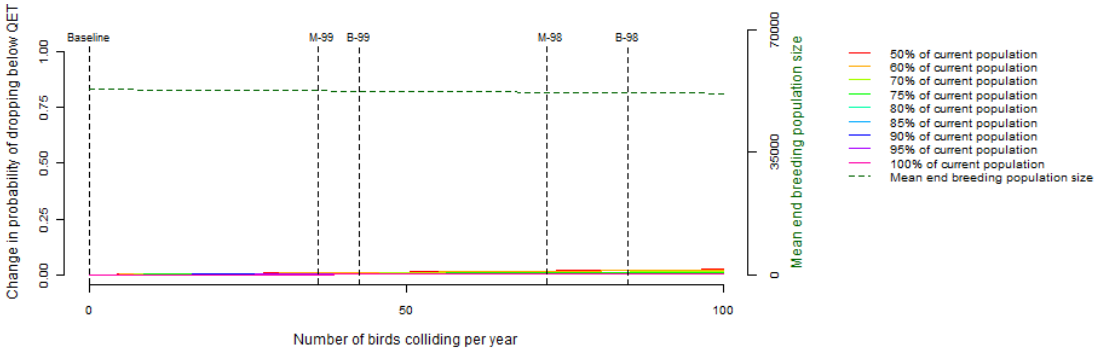


Figure F.7. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table F.4. Modelled probabilities of dropping below current population size for the kittiwake population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size.

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.610	0.788	0.899	0.933	0.957	0.972	0.982	0.991	0.997	44872
Whole site	50%	1213	95.0%	181	0.651	0.818	0.918	0.948	0.969	0.981	0.989	0.994	0.998	43174
Whole site	50%	1213	98.0%	72	0.627	0.800	0.907	0.939	0.962	0.976	0.985	0.992	0.997	44185
Whole site	50%	1213	98.5%	54	0.622	0.797	0.905	0.938	0.961	0.975	0.984	0.992	0.997	44355
Whole site	50%	1213	99.0%	36	0.618	0.794	0.903	0.936	0.959	0.974	0.984	0.991	0.997	44527
Whole site	50%	1213	99.5%	18	0.614	0.791	0.901	0.935	0.958	0.973	0.983	0.991	0.997	44699
Sum of MacColl, Telford & Stevenson	50%	1213	95.0%	218	0.659	0.824	0.921	0.951	0.971	0.982	0.990	0.994	0.998	42833
Sum of MacColl, Telford & Stevenson	50%	1213	98.0%	87	0.630	0.803	0.908	0.941	0.963	0.977	0.986	0.992	0.997	44045
Sum of MacColl, Telford & Stevenson	50%	1213	98.5%	65	0.625	0.799	0.906	0.939	0.961	0.976	0.985	0.992	0.997	44250
Sum of MacColl, Telford & Stevenson	50%	1213	99.0%	44	0.620	0.795	0.903	0.937	0.960	0.974	0.984	0.992	0.997	44456
Sum of MacColl, Telford & Stevenson	50%	1213	99.5%	22	0.615	0.792	0.901	0.935	0.958	0.973	0.983	0.991	0.997	44663
MacColl	50%	1213	95.0%	109	0.635	0.807	0.910	0.942	0.964	0.978	0.986	0.993	0.997	43835
MacColl	50%	1213	98.0%	44	0.620	0.795	0.903	0.937	0.960	0.974	0.984	0.992	0.997	44454
MacColl	50%	1213	98.5%	33	0.618	0.794	0.902	0.936	0.959	0.974	0.983	0.991	0.997	44558
MacColl	50%	1213	99.0%	22	0.615	0.792	0.901	0.935	0.958	0.973	0.983	0.991	0.997	44662
MacColl	50%	1213	99.5%	11	0.613	0.790	0.900	0.934	0.958	0.973	0.982	0.991	0.997	44767
Stevenson	50%	1213	95.0%	63	0.625	0.799	0.906	0.939	0.961	0.975	0.985	0.992	0.997	44270
Stevenson	50%	1213	98.0%	25	0.616	0.792	0.901	0.935	0.959	0.973	0.983	0.991	0.997	44630
Stevenson	50%	1213	98.5%	19	0.614	0.791	0.901	0.935	0.958	0.973	0.983	0.991	0.997	44690
Stevenson	50%	1213	99.0%	13	0.613	0.790	0.900	0.934	0.958	0.973	0.982	0.991	0.997	44751
Stevenson	50%	1213	99.5%	6	0.612	0.789	0.899	0.934	0.957	0.972	0.982	0.991	0.997	44811
Telford	50%	1213	95.0%	45	0.620	0.796	0.904	0.937	0.960	0.975	0.984	0.992	0.997	44442
Telford	50%	1213	98.0%	18	0.614	0.791	0.901	0.935	0.958	0.973	0.983	0.991	0.997	44699
Telford	50%	1213	98.5%	13	0.613	0.790	0.900	0.934	0.958	0.973	0.983	0.991	0.997	44742
Telford	50%	1213	99.0%	9	0.612	0.789	0.900	0.934	0.957	0.973	0.982	0.991	0.997	44785
Telford	50%	1213	99.5%	4	0.611	0.788	0.899	0.933	0.957	0.972	0.982	0.991	0.997	44828
MacColl and Stevenson	50%	1213	95.0%	173	0.649	0.817	0.917	0.947	0.968	0.980	0.988	0.994	0.998	43247
MacColl and Stevenson	50%	1213	98.0%	69	0.626	0.800	0.906	0.939	0.962	0.976	0.985	0.992	0.997	44215
MacColl and Stevenson	50%	1213	98.5%	52	0.622	0.797	0.904	0.938	0.961	0.975	0.984	0.992	0.997	44378
MacColl and Stevenson	50%	1213	99.0%	35	0.618	0.794	0.902	0.936	0.959	0.974	0.983	0.991	0.997	44542
MacColl and Stevenson	50%	1213	99.5%	17	0.614	0.791	0.901	0.935	0.958	0.973	0.983	0.991	0.997	44706
Telford and MacColl	50%	1213	95.0%	154	0.645	0.814	0.915	0.946	0.967	0.980	0.988	0.993	0.998	43416
Telford and MacColl	50%	1213	98.0%	62	0.624	0.799	0.905	0.938	0.961	0.975	0.985	0.992	0.997	44284
Telford and MacColl	50%	1213	98.5%	46	0.621	0.796	0.904	0.937	0.960	0.975	0.984	0.992	0.997	44430
Telford and MacColl	50%	1213	99.0%	31	0.617	0.793	0.902	0.936	0.959	0.974	0.983	0.991	0.997	44577
Telford and MacColl	50%	1213	99.5%	15	0.614	0.790	0.900	0.934	0.958	0.973	0.983	0.991	0.997	44724
Stevenson and Telford	50%	1213	95.0%	108	0.635	0.806	0.910	0.942	0.964	0.978	0.986	0.993	0.997	43846
Stevenson and Telford	50%	1213	98.0%	43	0.620	0.795	0.903	0.937	0.960	0.974	0.984	0.992	0.997	44459
Stevenson and Telford	50%	1213	98.5%	32	0.618	0.793	0.902	0.936	0.959	0.974	0.983	0.991	0.997	44561
Stevenson and Telford	50%	1213	99.0%	22	0.615	0.792	0.901	0.935	0.958	0.973	0.983	0.991	0.997	44665
Stevenson and Telford	50%	1213	99.5%	11	0.613	0.790	0.900	0.934	0.958	0.973	0.982	0.991	0.997	44768
BOWL	50%	1213	95.0%	32	0.617	0.793	0.902	0.936	0.959	0.974	0.983	0.991	0.997	44566
BOWL	50%	1213	98.0%	13	0.613	0.790	0.900	0.934	0.958	0.973	0.983	0.991	0.997	44747
BOWL	50%	1213	98.5%	9	0.612	0.789	0.900	0.934	0.957	0.973	0.982	0.991	0.997	44785
BOWL	50%	1213	99.0%	6	0.612	0.789	0.899	0.934	0.957	0.972	0.982	0.991	0.997	44814
BOWL	50%	1213	99.5%	3	0.611	0.788	0.899	0.933	0.957	0.972	0.982	0.991	0.997	44843
BOWL and MORL	50%	1213	95.0%	213	0.658	0.823	0.921	0.950	0.970	0.982	0.990	0.994	0.998	42879
BOWL and MORL	50%	1213	98.0%	85	0.629	0.803	0.908	0.940	0.963	0.977	0.985	0.992	0.997	44064
BOWL and MORL	50%	1213	98.5%	64	0.625	0.799	0.906	0.939	0.961	0.975	0.985	0.992	0.997	44264
BOWL and MORL	50%	1213	99.0%	43	0.620	0.795	0.903	0.937	0.960	0.974	0.984	0.992	0.997	44466
BOWL and MORL	50%	1213	99.5%	21	0.615	0.791	0.901	0.935	0.958	0.973	0.983	0.991	0.997	44668

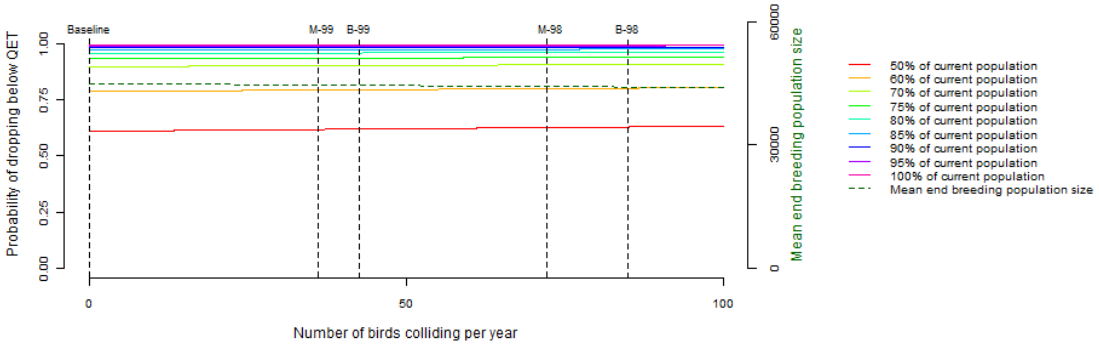


Figure F.8. Probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

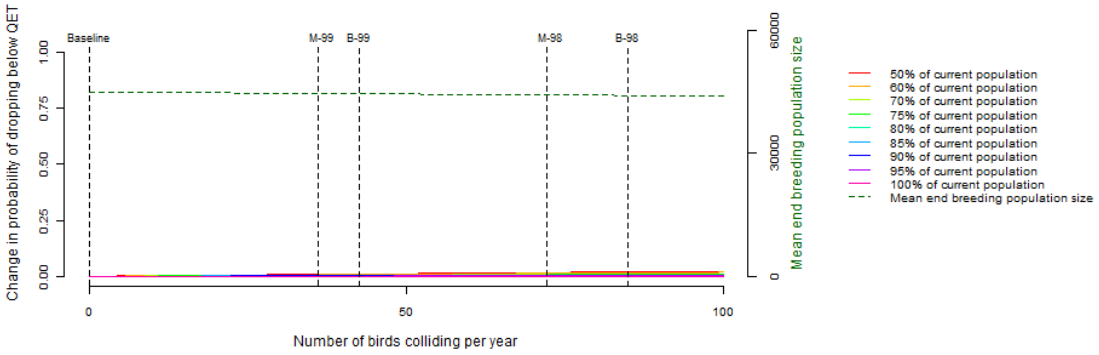


Figure F.9. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table F.5. Modelled probabilities of dropping below baseline predicted population size for the kittiwake population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (PPT= population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.035	0.101	0.201	0.260	0.322	0.386	0.447	0.509	0.571	52875
Whole site	50%	1213	95.0%	181	0.044	0.121	0.231	0.297	0.361	0.426	0.490	0.550	0.609	50857
Whole site	50%	1213	98.0%	72	0.039	0.109	0.213	0.274	0.337	0.402	0.464	0.525	0.586	52058
Whole site	50%	1213	98.5%	54	0.038	0.107	0.210	0.271	0.333	0.398	0.460	0.521	0.582	52261
Whole site	50%	1213	99.0%	36	0.037	0.105	0.207	0.267	0.330	0.394	0.456	0.517	0.579	52465
Whole site	50%	1213	99.5%	18	0.036	0.103	0.204	0.264	0.326	0.390	0.452	0.513	0.575	52669
Sum of MacColl, Telford & Stevenson	50%	1213	95.0%	218	0.046	0.126	0.238	0.304	0.369	0.435	0.499	0.559	0.617	50453
Sum of MacColl, Telford & Stevenson	50%	1213	98.0%	87	0.039	0.111	0.215	0.277	0.341	0.406	0.468	0.529	0.589	51892
Sum of MacColl, Telford & Stevenson	50%	1213	98.5%	65	0.038	0.108	0.211	0.273	0.336	0.401	0.463	0.524	0.585	52136
Sum of MacColl, Telford & Stevenson	50%	1213	99.0%	44	0.037	0.106	0.208	0.269	0.331	0.396	0.458	0.519	0.580	52381
Sum of MacColl, Telford & Stevenson	50%	1213	99.5%	22	0.036	0.104	0.204	0.264	0.327	0.391	0.453	0.514	0.575	52627
MacColl	50%	1213	95.0%	109	0.040	0.113	0.219	0.282	0.345	0.410	0.473	0.534	0.594	51643
MacColl	50%	1213	98.0%	44	0.037	0.106	0.208	0.269	0.331	0.396	0.458	0.519	0.580	52379
MacColl	50%	1213	98.5%	33	0.037	0.105	0.206	0.266	0.329	0.394	0.455	0.516	0.578	52502
MacColl	50%	1213	99.0%	22	0.036	0.104	0.204	0.264	0.327	0.391	0.453	0.514	0.576	52626
MacColl	50%	1213	99.5%	11	0.036	0.102	0.203	0.262	0.324	0.389	0.450	0.511	0.573	52750
Stevenson	50%	1213	95.0%	63	0.038	0.108	0.211	0.272	0.335	0.400	0.462	0.523	0.584	52159
Stevenson	50%	1213	98.0%	25	0.036	0.104	0.205	0.265	0.327	0.392	0.453	0.514	0.576	52587
Stevenson	50%	1213	98.5%	19	0.036	0.103	0.204	0.264	0.326	0.390	0.452	0.513	0.575	52659
Stevenson	50%	1213	99.0%	13	0.036	0.103	0.203	0.262	0.325	0.389	0.450	0.512	0.574	52731
Stevenson	50%	1213	99.5%	6	0.035	0.102	0.202	0.261	0.323	0.388	0.449	0.510	0.572	52803
Telford	50%	1213	95.0%	45	0.037	0.106	0.208	0.269	0.332	0.396	0.458	0.519	0.580	52365
Telford	50%	1213	98.0%	18	0.036	0.103	0.204	0.264	0.326	0.390	0.452	0.513	0.575	52670
Telford	50%	1213	98.5%	13	0.036	0.103	0.203	0.263	0.325	0.389	0.451	0.512	0.574	52721
Telford	50%	1213	99.0%	9	0.036	0.102	0.202	0.262	0.324	0.388	0.450	0.511	0.573	52772
Telford	50%	1213	99.5%	4	0.035	0.102	0.202	0.261	0.323	0.387	0.449	0.510	0.572	52824
MacColl and Stevenson	50%	1213	95.0%	173	0.044	0.120	0.230	0.295	0.359	0.425	0.488	0.549	0.608	50944
MacColl and Stevenson	50%	1213	98.0%	69	0.038	0.109	0.212	0.274	0.337	0.402	0.464	0.525	0.586	52094
MacColl and Stevenson	50%	1213	98.5%	52	0.038	0.107	0.209	0.270	0.333	0.398	0.460	0.521	0.582	52288
MacColl and Stevenson	50%	1213	99.0%	35	0.037	0.105	0.206	0.267	0.329	0.394	0.456	0.517	0.578	52483
MacColl and Stevenson	50%	1213	99.5%	17	0.036	0.103	0.204	0.263	0.326	0.390	0.452	0.513	0.575	52678
Telford and MacColl	50%	1213	95.0%	154	0.043	0.118	0.227	0.291	0.355	0.421	0.484	0.544	0.604	51145
Telford and MacColl	50%	1213	98.0%	62	0.038	0.108	0.211	0.272	0.335	0.400	0.462	0.523	0.584	52176
Telford and MacColl	50%	1213	98.5%	46	0.037	0.106	0.208	0.269	0.332	0.396	0.458	0.519	0.581	52350
Telford and MacColl	50%	1213	99.0%	31	0.037	0.104	0.206	0.266	0.329	0.393	0.455	0.516	0.577	52524
Telford and MacColl	50%	1213	99.5%	15	0.036	0.103	0.203	0.263	0.325	0.390	0.451	0.512	0.574	52699
Stevenson and Telford	50%	1213	95.0%	108	0.040	0.113	0.219	0.282	0.345	0.410	0.473	0.534	0.594	51656
Stevenson and Telford	50%	1213	98.0%	43	0.037	0.106	0.208	0.269	0.331	0.396	0.458	0.519	0.580	52384
Stevenson and Telford	50%	1213	98.5%	32	0.037	0.105	0.206	0.266	0.329	0.393	0.455	0.516	0.578	52506
Stevenson and Telford	50%	1213	99.0%	22	0.036	0.104	0.204	0.264	0.327	0.391	0.453	0.514	0.575	52629
Stevenson and Telford	50%	1213	99.5%	11	0.036	0.102	0.203	0.262	0.324	0.389	0.450	0.511	0.573	52752
BOWL	50%	1213	95.0%	32	0.037	0.105	0.206	0.266	0.329	0.393	0.455	0.516	0.578	52511
BOWL	50%	1213	98.0%	13	0.036	0.103	0.203	0.263	0.325	0.389	0.451	0.512	0.574	52727
BOWL	50%	1213	98.5%	9	0.036	0.102	0.202	0.262	0.324	0.388	0.450	0.511	0.573	52772
BOWL	50%	1213	99.0%	6	0.035	0.102	0.202	0.261	0.323	0.388	0.449	0.510	0.572	52806
BOWL	50%	1213	99.5%	3	0.035	0.102	0.201	0.261	0.323	0.387	0.448	0.509	0.571	52841
BOWL and MORL	50%	1213	95.0%	213	0.046	0.125	0.237	0.303	0.368	0.434	0.498	0.558	0.616	50508
BOWL and MORL	50%	1213	98.0%	85	0.039	0.110	0.215	0.277	0.340	0.405	0.467	0.528	0.589	51915
BOWL and MORL	50%	1213	98.5%	64	0.038	0.108	0.211	0.273	0.336	0.400	0.462	0.523	0.585	52153
BOWL and MORL	50%	1213	99.0%	43	0.037	0.106	0.208	0.268	0.331	0.396	0.457	0.518	0.580	52393
BOWL and MORL	50%	1213	99.5%	21	0.036	0.103	0.204	0.264	0.327	0.391	0.452	0.514	0.575	52633

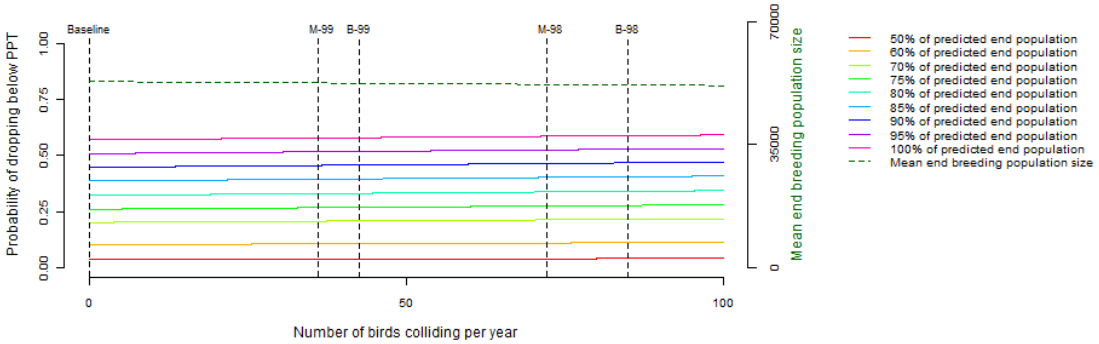


Figure F.10. Probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

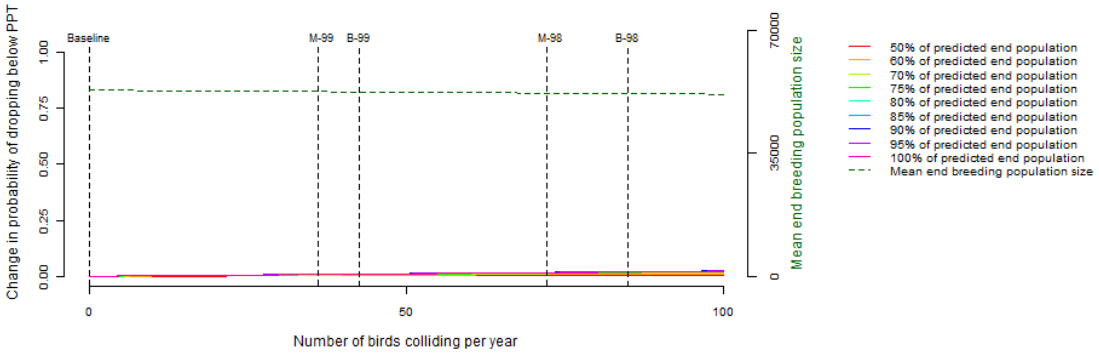


Figure F.11. Change in probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table F.6. Modelled probabilities of dropping below baseline predicted population size for the kittiwake population at East Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.139	0.262	0.387	0.447	0.505	0.566	0.619	0.668	0.712	44872
Whole site	50%	1213	95.0%	181	0.156	0.286	0.422	0.486	0.547	0.606	0.657	0.704	0.747	43174
Whole site	50%	1213	98.0%	72	0.146	0.271	0.401	0.463	0.522	0.582	0.634	0.683	0.726	44185
Whole site	50%	1213	98.5%	54	0.144	0.269	0.397	0.459	0.518	0.578	0.631	0.679	0.723	44355
Whole site	50%	1213	99.0%	36	0.142	0.266	0.394	0.455	0.514	0.574	0.627	0.675	0.719	44527
Whole site	50%	1213	99.5%	18	0.141	0.264	0.390	0.451	0.509	0.570	0.623	0.672	0.715	44699
Sum of MacColl, Telford & Stevenson	50%	1213	95.0%	218	0.160	0.292	0.429	0.495	0.556	0.614	0.664	0.711	0.754	42833
Sum of MacColl, Telford & Stevenson	50%	1213	98.0%	87	0.147	0.273	0.404	0.466	0.526	0.585	0.637	0.686	0.729	44045
Sum of MacColl, Telford & Stevenson	50%	1213	98.5%	65	0.145	0.270	0.399	0.461	0.520	0.581	0.633	0.681	0.725	44250
Sum of MacColl, Telford & Stevenson	50%	1213	99.0%	44	0.143	0.267	0.395	0.457	0.515	0.576	0.628	0.677	0.721	44456
Sum of MacColl, Telford & Stevenson	50%	1213	99.5%	22	0.141	0.264	0.391	0.452	0.510	0.571	0.624	0.672	0.716	44663
MacColl	50%	1213	95.0%	109	0.149	0.276	0.408	0.471	0.531	0.590	0.642	0.690	0.734	43835
MacColl	50%	1213	98.0%	44	0.143	0.267	0.395	0.457	0.515	0.576	0.628	0.677	0.721	44454
MacColl	50%	1213	98.5%	33	0.142	0.266	0.393	0.454	0.513	0.574	0.626	0.675	0.718	44558
MacColl	50%	1213	99.0%	22	0.141	0.264	0.391	0.452	0.510	0.571	0.624	0.672	0.716	44662
MacColl	50%	1213	99.5%	11	0.140	0.263	0.389	0.449	0.508	0.569	0.622	0.670	0.714	44767
Stevenson	50%	1213	95.0%	63	0.145	0.270	0.399	0.461	0.520	0.580	0.632	0.681	0.724	44270
Stevenson	50%	1213	98.0%	25	0.141	0.265	0.392	0.453	0.511	0.572	0.625	0.673	0.717	44630
Stevenson	50%	1213	98.5%	19	0.141	0.264	0.391	0.451	0.510	0.571	0.623	0.672	0.716	44690
Stevenson	50%	1213	99.0%	13	0.140	0.263	0.389	0.450	0.508	0.569	0.622	0.671	0.714	44751
Stevenson	50%	1213	99.5%	6	0.140	0.262	0.388	0.448	0.507	0.568	0.621	0.669	0.713	44811
Telford	50%	1213	95.0%	45	0.143	0.268	0.396	0.457	0.516	0.576	0.629	0.677	0.721	44442
Telford	50%	1213	98.0%	18	0.141	0.264	0.390	0.451	0.509	0.570	0.623	0.672	0.715	44699
Telford	50%	1213	98.5%	13	0.140	0.263	0.390	0.450	0.508	0.569	0.622	0.671	0.714	44742
Telford	50%	1213	99.0%	9	0.140	0.263	0.389	0.449	0.507	0.568	0.621	0.670	0.714	44785
Telford	50%	1213	99.5%	4	0.140	0.262	0.388	0.448	0.506	0.567	0.620	0.669	0.713	44828
MacColl and Stevenson	50%	1213	95.0%	173	0.155	0.285	0.420	0.485	0.545	0.604	0.655	0.702	0.746	43247
MacColl and Stevenson	50%	1213	98.0%	69	0.145	0.271	0.400	0.462	0.521	0.581	0.634	0.682	0.726	44215
MacColl and Stevenson	50%	1213	98.5%	52	0.144	0.268	0.397	0.458	0.517	0.578	0.630	0.678	0.722	44378
MacColl and Stevenson	50%	1213	99.0%	35	0.142	0.266	0.394	0.455	0.513	0.574	0.627	0.675	0.719	44542
MacColl and Stevenson	50%	1213	99.5%	17	0.141	0.264	0.390	0.451	0.509	0.570	0.623	0.671	0.715	44706
Telford and MacColl	50%	1213	95.0%	154	0.153	0.283	0.416	0.481	0.541	0.600	0.651	0.699	0.742	43416
Telford and MacColl	50%	1213	98.0%	62	0.145	0.270	0.399	0.461	0.520	0.580	0.632	0.680	0.724	44284
Telford and MacColl	50%	1213	98.5%	46	0.143	0.268	0.396	0.457	0.516	0.577	0.629	0.677	0.721	44430
Telford and MacColl	50%	1213	99.0%	31	0.142	0.266	0.393	0.454	0.512	0.573	0.626	0.674	0.718	44577
Telford and MacColl	50%	1213	99.5%	15	0.141	0.264	0.390	0.450	0.509	0.570	0.622	0.671	0.715	44724
Stevenson and Telford	50%	1213	95.0%	108	0.149	0.276	0.408	0.471	0.530	0.590	0.642	0.690	0.733	43846
Stevenson and Telford	50%	1213	98.0%	43	0.143	0.267	0.395	0.456	0.515	0.576	0.628	0.677	0.721	44459
Stevenson and Telford	50%	1213	98.5%	32	0.142	0.266	0.393	0.454	0.513	0.573	0.626	0.675	0.718	44561
Stevenson and Telford	50%	1213	99.0%	22	0.141	0.264	0.391	0.452	0.510	0.571	0.624	0.672	0.716	44665
Stevenson and Telford	50%	1213	99.5%	11	0.140	0.263	0.389	0.449	0.508	0.569	0.622	0.670	0.714	44768
BOWL	50%	1213	95.0%	32	0.142	0.266	0.393	0.454	0.513	0.573	0.626	0.674	0.718	44566
BOWL	50%	1213	98.0%	13	0.140	0.263	0.389	0.450	0.508	0.569	0.622	0.671	0.714	44747
BOWL	50%	1213	98.5%	9	0.140	0.263	0.389	0.449	0.507	0.568	0.621	0.670	0.714	44785
BOWL	50%	1213	99.0%	6	0.140	0.262	0.388	0.448	0.507	0.568	0.621	0.669	0.713	44814
BOWL	50%	1213	99.5%	3	0.139	0.262	0.388	0.448	0.506	0.567	0.620	0.669	0.712	44843
BOWL and MORL	50%	1213	95.0%	213	0.159	0.291	0.428	0.493	0.555	0.612	0.663	0.710	0.753	42879
BOWL and MORL	50%	1213	98.0%	85	0.147	0.273	0.403	0.466	0.525	0.585	0.637	0.685	0.729	44064
BOWL and MORL	50%	1213	98.5%	64	0.145	0.270	0.399	0.461	0.520	0.580	0.633	0.681	0.725	44264
BOWL and MORL	50%	1213	99.0%	43	0.143	0.267	0.395	0.456	0.515	0.576	0.628	0.677	0.720	44466
BOWL and MORL	50%	1213	99.5%	21	0.141	0.264	0.391	0.452	0.510	0.571	0.624	0.672	0.716	44668

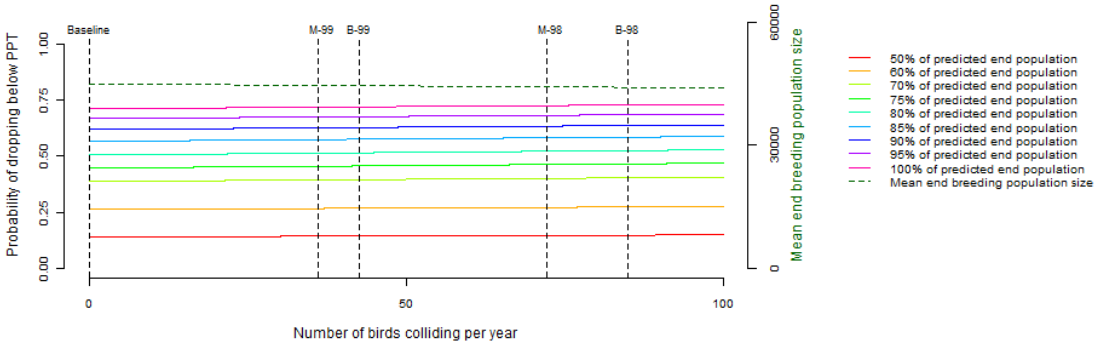


Figure F.12. Probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

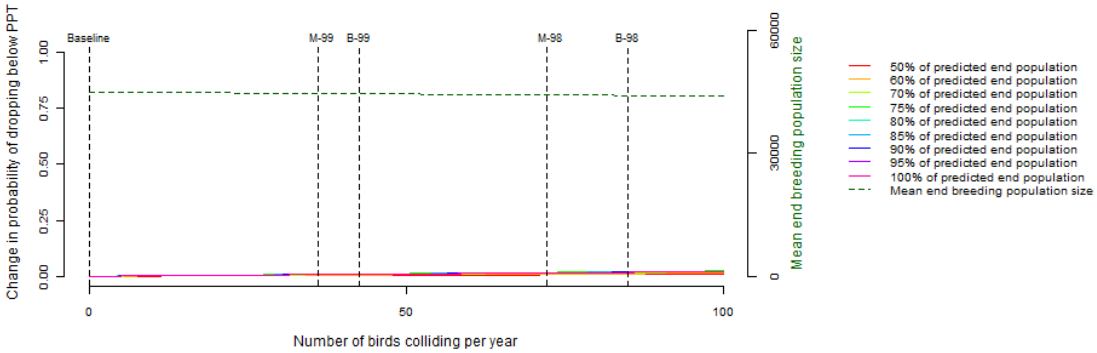


Figure F.13. Change in probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Displacement

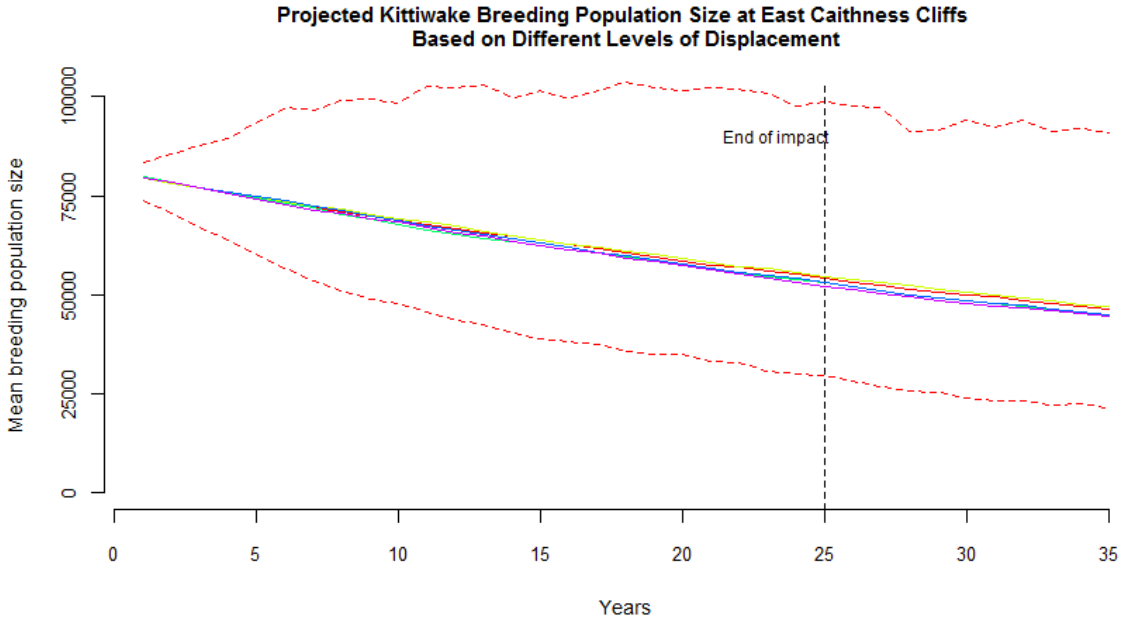


Figure F.14. Population projections for the kittiwake population at East Caithness Cliffs at different levels of displacement.

Table F.7. Modelled probabilities of dropping below current population size for kittiwake population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development) (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.350	0.582	0.774	0.845	0.901	0.940	0.967	0.981	0.991	54712
Whole site	50%	1072	0.379	0.615	0.797	0.861	0.912	0.953	0.975	0.988	0.994	53213
Whole site	10%	214	0.355	0.588	0.778	0.848	0.903	0.943	0.969	0.983	0.992	54409
Sum of MacColl, Telford & Stevenson	50%	1072	0.379	0.615	0.797	0.861	0.912	0.953	0.975	0.988	0.994	53213
Sum of MacColl, Telford & Stevenson	10%	214	0.355	0.588	0.778	0.848	0.903	0.943	0.969	0.983	0.992	54409
MacColl	50%	539	0.364	0.599	0.786	0.853	0.906	0.947	0.971	0.985	0.993	53953
MacColl	10%	108	0.353	0.585	0.776	0.847	0.902	0.942	0.968	0.982	0.992	54559
Telford	50%	222	0.356	0.589	0.779	0.849	0.903	0.943	0.969	0.983	0.992	54398
Telford	10%	44	0.351	0.583	0.775	0.846	0.901	0.941	0.968	0.982	0.992	54649
Stevenson	50%	312	0.358	0.591	0.781	0.850	0.904	0.944	0.970	0.984	0.992	54272
Stevenson	10%	62	0.351	0.584	0.775	0.846	0.901	0.941	0.968	0.982	0.992	54624
MacColl and Stevenson	50%	851	0.373	0.608	0.793	0.858	0.909	0.951	0.974	0.987	0.994	53519
MacColl and Stevenson	10%	170	0.354	0.587	0.777	0.848	0.902	0.942	0.969	0.983	0.992	54471
Stevenson and Telford	50%	533	0.364	0.598	0.786	0.853	0.906	0.947	0.971	0.985	0.993	53961
Stevenson and Telford	10%	107	0.353	0.585	0.776	0.847	0.902	0.942	0.968	0.982	0.992	54561
Telford and MacColl	50%	761	0.370	0.605	0.791	0.857	0.909	0.950	0.973	0.986	0.993	53644
Telford and MacColl	10%	152	0.354	0.586	0.777	0.847	0.902	0.942	0.969	0.983	0.992	54497
BOWL	50%	140	0.353	0.586	0.777	0.847	0.902	0.942	0.968	0.983	0.992	54513
BOWL	10%	28	0.350	0.583	0.774	0.845	0.901	0.941	0.968	0.982	0.991	54672
BOWL and MORL	50%	1213	0.383	0.619	0.800	0.863	0.913	0.955	0.976	0.989	0.994	53020
BOWL and MORL	10%	243	0.356	0.589	0.779	0.849	0.903	0.943	0.969	0.983	0.992	54369

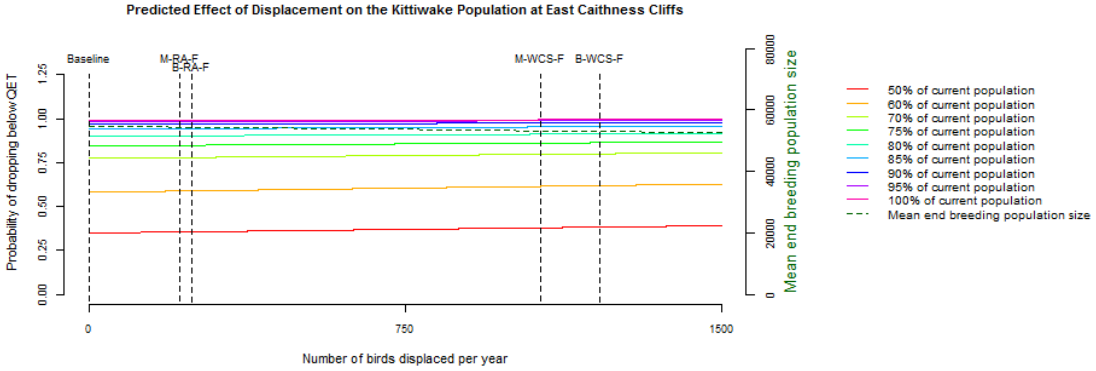


Figure F.15. Probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

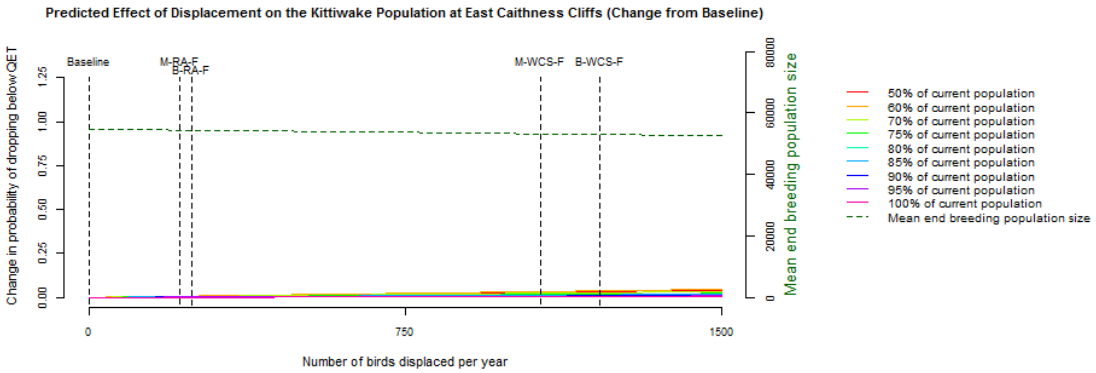


Figure F.16. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table F.8. Modelled probabilities of dropping below current population size for the kittiwake population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.571	0.760	0.878	0.916	0.946	0.970	0.984	0.991	0.996	46928
Whole site	50%	1072	0.604	0.781	0.894	0.930	0.958	0.977	0.990	0.995	0.998	45400
Whole site	10%	214	0.578	0.764	0.881	0.919	0.949	0.971	0.985	0.992	0.996	46618
Sum of MacColl, Telford & Stevenson	50%	1072	0.604	0.781	0.894	0.930	0.958	0.977	0.990	0.995	0.998	45400
Sum of MacColl, Telford & Stevenson	10%	214	0.578	0.764	0.881	0.919	0.949	0.971	0.985	0.992	0.996	46618
MacColl	50%	539	0.588	0.771	0.886	0.923	0.952	0.973	0.987	0.993	0.997	46154
MacColl	10%	108	0.575	0.762	0.879	0.917	0.947	0.970	0.984	0.991	0.996	46772
Telford	50%	222	0.578	0.764	0.881	0.919	0.949	0.971	0.985	0.992	0.996	46608
Telford	10%	44	0.573	0.761	0.878	0.916	0.946	0.970	0.984	0.991	0.996	46864
Stevenson	50%	312	0.581	0.766	0.883	0.920	0.950	0.972	0.986	0.992	0.997	46479
Stevenson	10%	62	0.573	0.761	0.879	0.917	0.947	0.970	0.984	0.991	0.996	46838
MacColl and Stevenson	50%	851	0.597	0.777	0.891	0.928	0.956	0.975	0.989	0.994	0.997	45712
MacColl and Stevenson	10%	170	0.577	0.763	0.880	0.918	0.948	0.971	0.985	0.992	0.996	46682
Stevenson and Telford	50%	533	0.588	0.770	0.886	0.923	0.952	0.973	0.987	0.993	0.997	46162
Stevenson and Telford	10%	107	0.575	0.762	0.879	0.917	0.947	0.970	0.984	0.991	0.996	46774
Telford and MacColl	50%	761	0.594	0.775	0.889	0.926	0.955	0.975	0.988	0.994	0.997	45839
Telford and MacColl	10%	152	0.576	0.763	0.880	0.918	0.948	0.971	0.985	0.992	0.996	46708
BOWL	50%	140	0.576	0.763	0.880	0.918	0.948	0.971	0.985	0.991	0.996	46725
BOWL	10%	28	0.572	0.760	0.878	0.916	0.946	0.970	0.984	0.991	0.996	46887
BOWL and MORL	50%	1213	0.608	0.783	0.896	0.932	0.960	0.978	0.990	0.995	0.998	45204
BOWL and MORL	10%	243	0.579	0.765	0.881	0.919	0.949	0.971	0.985	0.992	0.996	46578

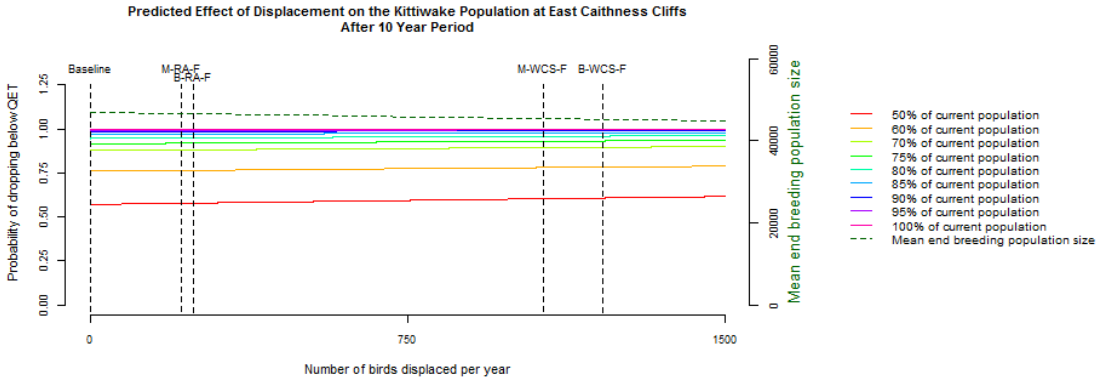


Figure F.17. Probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

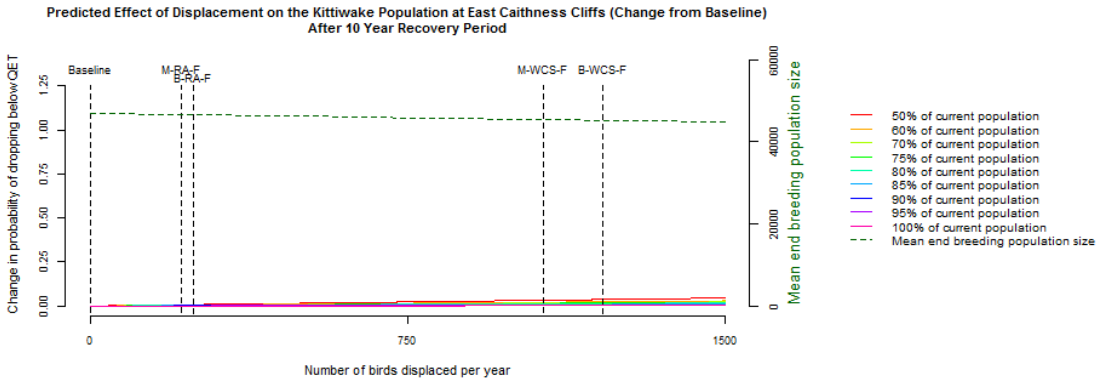


Figure F.18. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table F.9. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the kittiwake population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.024	0.075	0.160	0.215	0.276	0.338	0.401	0.463	0.528	54712
Whole site	50%	1072	0.033	0.097	0.193	0.249	0.312	0.373	0.436	0.496	0.553	53213
Whole site	10%	214	0.025	0.079	0.166	0.222	0.283	0.345	0.408	0.470	0.533	54409
Sum of MacColl, Telford & Stevenson	50%	1072	0.033	0.097	0.193	0.249	0.312	0.373	0.436	0.496	0.553	53213
Sum of MacColl, Telford & Stevenson	10%	214	0.025	0.079	0.166	0.222	0.283	0.345	0.408	0.470	0.533	54409
MacColl	50%	539	0.028	0.085	0.176	0.232	0.294	0.356	0.419	0.480	0.540	53953
MacColl	10%	108	0.024	0.077	0.163	0.218	0.279	0.342	0.405	0.467	0.530	54559
Telford	50%	222	0.025	0.079	0.166	0.222	0.283	0.345	0.408	0.470	0.533	54398
Telford	10%	44	0.024	0.076	0.161	0.216	0.277	0.340	0.403	0.465	0.529	54649
Stevenson	50%	312	0.026	0.081	0.169	0.225	0.286	0.348	0.411	0.473	0.535	54272
Stevenson	10%	62	0.024	0.076	0.162	0.217	0.278	0.340	0.403	0.465	0.529	54624
MacColl and Stevenson	50%	851	0.031	0.092	0.185	0.242	0.304	0.366	0.429	0.489	0.547	53519
MacColl and Stevenson	10%	170	0.025	0.078	0.165	0.220	0.281	0.344	0.407	0.469	0.532	54471
Stevenson and Telford	50%	533	0.028	0.085	0.176	0.231	0.294	0.355	0.418	0.480	0.540	53961
Stevenson and Telford	10%	107	0.024	0.077	0.163	0.218	0.279	0.342	0.405	0.467	0.530	54561
Telford and MacColl	50%	761	0.030	0.090	0.183	0.239	0.301	0.363	0.426	0.487	0.545	53644
Telford and MacColl	10%	152	0.025	0.078	0.164	0.220	0.281	0.343	0.406	0.468	0.531	54497
BOWL	50%	140	0.025	0.077	0.164	0.219	0.280	0.343	0.406	0.468	0.531	54513
BOWL	10%	28	0.024	0.075	0.161	0.216	0.277	0.339	0.402	0.464	0.528	54672
BOWL and MORL	50%	1213	0.034	0.100	0.197	0.254	0.317	0.378	0.440	0.500	0.556	53020
BOWL and MORL	10%	243	0.026	0.079	0.167	0.222	0.284	0.346	0.409	0.471	0.533	54369

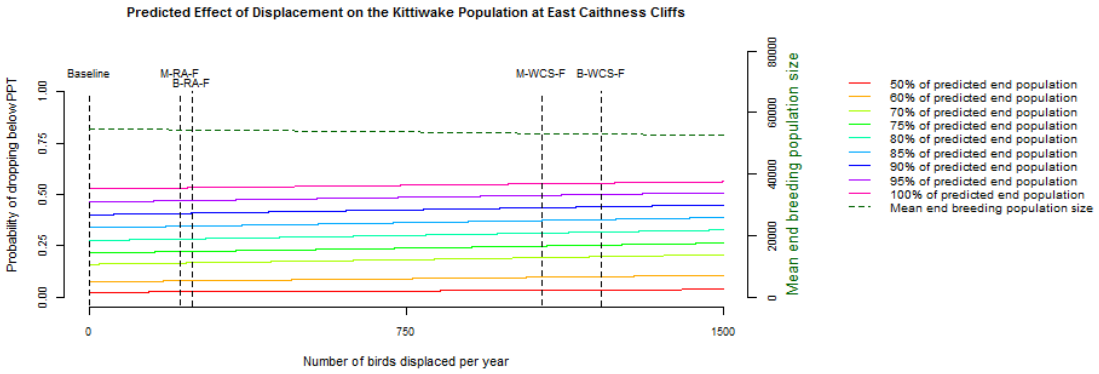


Figure F.19. Probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

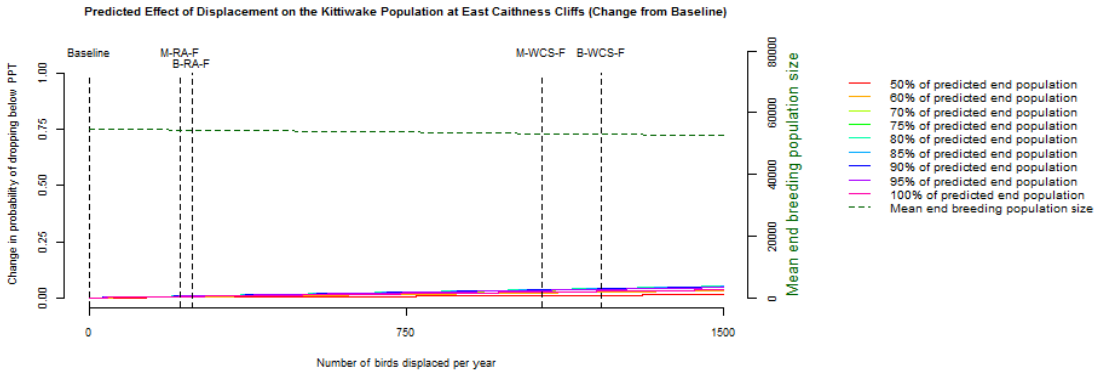


Figure F.20. Change in probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table F.10. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the kittiwake population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.111	0.219	0.351	0.412	0.472	0.533	0.587	0.636	0.682	46928
Whole site	50%	1072	0.131	0.241	0.371	0.437	0.501	0.559	0.610	0.660	0.704	45400
Whole site	10%	214	0.114	0.223	0.355	0.417	0.478	0.538	0.592	0.640	0.687	46618
Sum of MacColl, Telford & Stevenson	50%	1072	0.131	0.241	0.371	0.437	0.501	0.559	0.610	0.660	0.704	45400
Sum of MacColl, Telford & Stevenson	10%	214	0.114	0.223	0.355	0.417	0.478	0.538	0.592	0.640	0.687	46618
MacColl	50%	539	0.120	0.230	0.361	0.425	0.487	0.546	0.599	0.648	0.693	46154
MacColl	10%	108	0.113	0.221	0.353	0.414	0.475	0.536	0.590	0.638	0.685	46772
Telford	50%	222	0.115	0.224	0.355	0.417	0.478	0.539	0.592	0.641	0.687	46608
Telford	10%	44	0.111	0.220	0.352	0.413	0.473	0.534	0.588	0.637	0.683	46864
Stevenson	50%	312	0.116	0.225	0.357	0.419	0.480	0.541	0.594	0.643	0.689	46479
Stevenson	10%	62	0.112	0.220	0.352	0.413	0.474	0.535	0.589	0.637	0.684	46838
MacColl and Stevenson	50%	851	0.126	0.236	0.367	0.432	0.495	0.553	0.606	0.655	0.700	45712
MacColl and Stevenson	10%	170	0.114	0.223	0.354	0.416	0.477	0.537	0.591	0.639	0.686	46682
Stevenson and Telford	50%	533	0.120	0.230	0.361	0.424	0.486	0.546	0.599	0.648	0.693	46162
Stevenson and Telford	10%	107	0.113	0.221	0.353	0.414	0.475	0.536	0.590	0.638	0.685	46774
Telford and MacColl	50%	761	0.125	0.234	0.365	0.430	0.493	0.551	0.604	0.653	0.698	45839
Telford and MacColl	10%	152	0.113	0.222	0.354	0.415	0.476	0.537	0.591	0.639	0.686	46708
BOWL	50%	140	0.113	0.222	0.354	0.415	0.476	0.537	0.590	0.639	0.685	46725
BOWL	10%	28	0.111	0.220	0.352	0.412	0.473	0.534	0.588	0.636	0.683	46887
BOWL and MORL	50%	1213	0.133	0.244	0.374	0.441	0.505	0.562	0.613	0.663	0.707	45204
BOWL and MORL	10%	243	0.115	0.224	0.356	0.418	0.479	0.539	0.593	0.641	0.687	46578

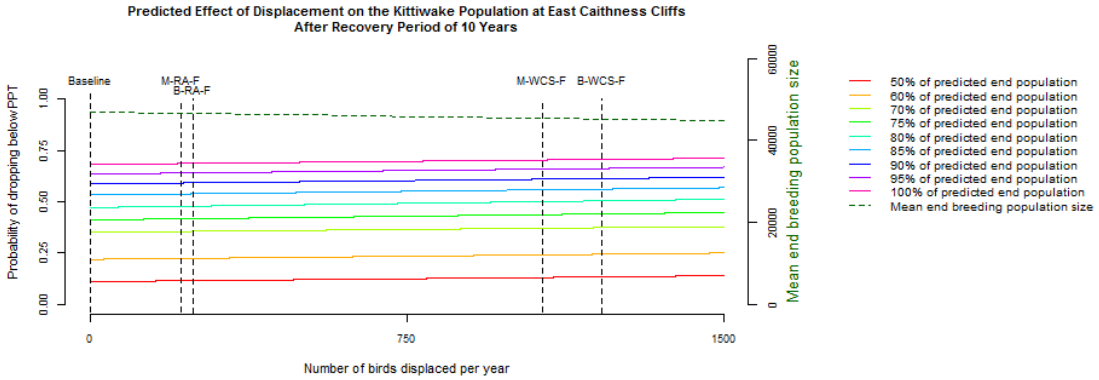


Figure F.21. Probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

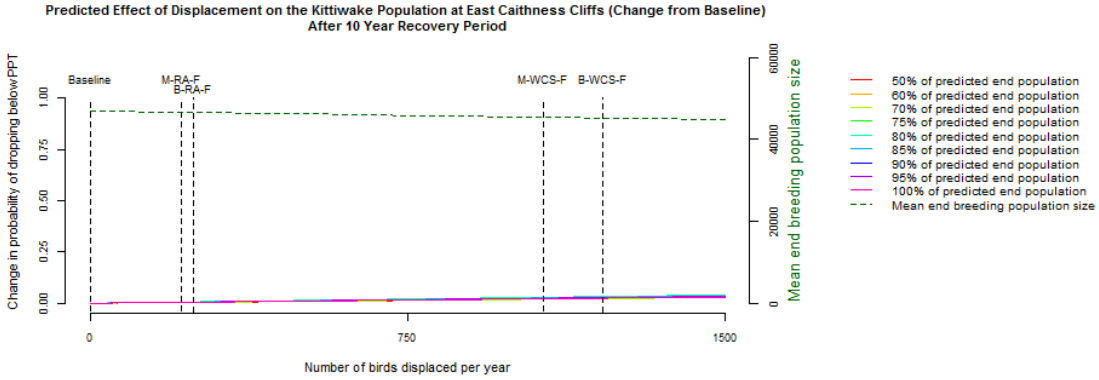


Figure F.22. Change in probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Collision

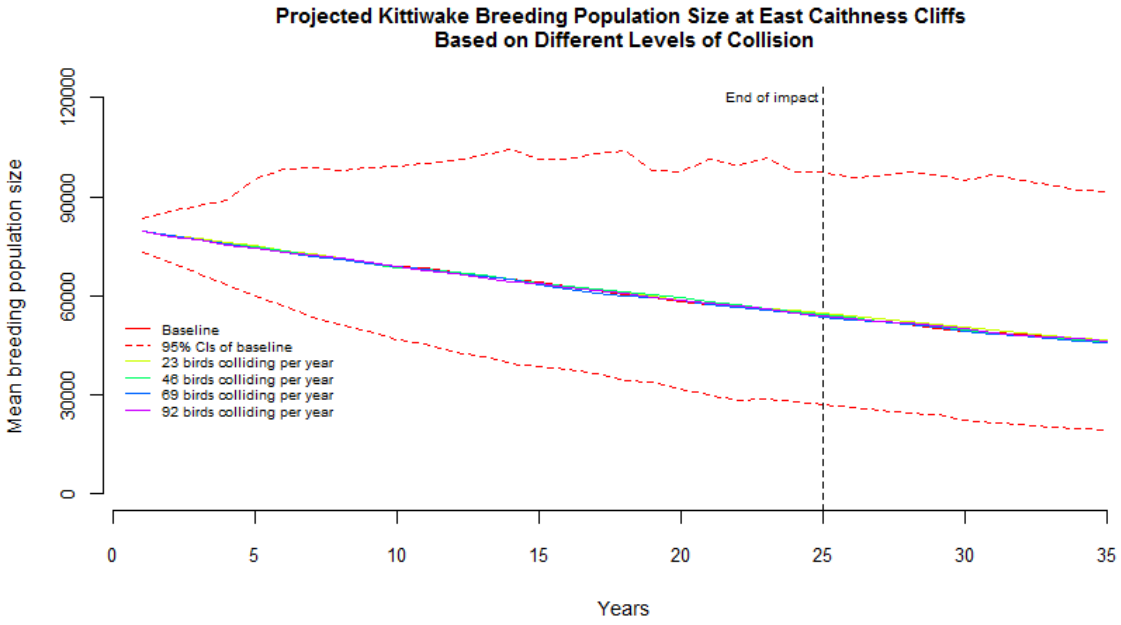


Figure F.23. Population projections for the kittiwake population at East Caithness Cliffs at different levels of collision.

Table F.11. Modelled probabilities of dropping below current population size for the kittiwake population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.348	0.579	0.781	0.845	0.899	0.936	0.963	0.982	0.989	54585
Whole site	95.0%	181	0.388	0.622	0.808	0.870	0.914	0.948	0.972	0.986	0.993	52528
Whole site	98.0%	72	0.364	0.596	0.792	0.855	0.905	0.941	0.967	0.984	0.991	53753
Whole site	98.5%	54	0.360	0.592	0.789	0.853	0.904	0.940	0.966	0.983	0.991	53959
Whole site	99.0%	36	0.356	0.588	0.787	0.850	0.902	0.939	0.965	0.983	0.990	54167
Whole site	99.5%	18	0.352	0.584	0.784	0.848	0.901	0.938	0.964	0.982	0.990	54375
Sum of MacColl, Telford & Stevenson	95.0%	218	0.397	0.630	0.814	0.874	0.917	0.950	0.973	0.987	0.994	52116
Sum of MacColl, Telford & Stevenson	98.0%	87	0.367	0.600	0.795	0.857	0.907	0.942	0.968	0.984	0.991	53583
Sum of MacColl, Telford & Stevenson	98.5%	65	0.362	0.595	0.791	0.854	0.905	0.941	0.967	0.983	0.991	53832
Sum of MacColl, Telford & Stevenson	99.0%	44	0.357	0.590	0.788	0.851	0.903	0.939	0.966	0.983	0.990	54082
Sum of MacColl, Telford & Stevenson	99.5%	22	0.352	0.585	0.784	0.848	0.901	0.938	0.964	0.982	0.990	54333
MacColl	95.0%	109	0.372	0.605	0.798	0.860	0.908	0.944	0.969	0.984	0.992	53329
MacColl	98.0%	44	0.357	0.590	0.788	0.851	0.903	0.939	0.966	0.983	0.990	54079
MacColl	98.5%	33	0.355	0.587	0.786	0.850	0.902	0.939	0.965	0.983	0.990	54205
MacColl	99.0%	22	0.352	0.585	0.784	0.848	0.901	0.938	0.964	0.982	0.990	54331
MacColl	99.5%	11	0.350	0.582	0.783	0.847	0.900	0.937	0.964	0.982	0.990	54458
Stevenson	95.0%	63	0.362	0.594	0.791	0.854	0.905	0.941	0.967	0.983	0.991	53856
Stevenson	98.0%	25	0.353	0.585	0.785	0.849	0.901	0.938	0.965	0.982	0.990	54292
Stevenson	98.5%	19	0.352	0.584	0.784	0.848	0.901	0.938	0.964	0.982	0.990	54365
Stevenson	99.0%	13	0.350	0.582	0.783	0.847	0.900	0.937	0.964	0.982	0.990	54438
Stevenson	99.5%	6	0.349	0.581	0.782	0.846	0.900	0.937	0.964	0.982	0.990	54511
Telford	95.0%	45	0.358	0.590	0.788	0.851	0.903	0.939	0.966	0.983	0.990	54065
Telford	98.0%	18	0.351	0.584	0.784	0.848	0.901	0.938	0.964	0.982	0.990	54376
Telford	98.5%	13	0.350	0.583	0.783	0.847	0.900	0.937	0.964	0.982	0.990	54428
Telford	99.0%	9	0.349	0.582	0.782	0.846	0.900	0.937	0.964	0.982	0.990	54480
Telford	99.5%	4	0.349	0.581	0.782	0.846	0.900	0.937	0.964	0.982	0.990	54532
MacColl and Stevenson	95.0%	173	0.387	0.620	0.807	0.869	0.913	0.947	0.972	0.986	0.993	52617
MacColl and Stevenson	98.0%	69	0.363	0.596	0.792	0.855	0.905	0.941	0.967	0.983	0.991	53789
MacColl and Stevenson	98.5%	52	0.359	0.592	0.789	0.852	0.904	0.940	0.966	0.983	0.991	53987
MacColl and Stevenson	99.0%	35	0.355	0.588	0.786	0.850	0.902	0.939	0.965	0.983	0.990	54185
MacColl and Stevenson	99.5%	17	0.351	0.584	0.784	0.847	0.901	0.938	0.964	0.982	0.990	54385
Telford and MacColl	95.0%	154	0.382	0.616	0.805	0.866	0.912	0.946	0.971	0.986	0.993	52822
Telford and MacColl	98.0%	62	0.361	0.594	0.791	0.854	0.905	0.941	0.967	0.983	0.991	53872
Telford and MacColl	98.5%	46	0.358	0.590	0.788	0.852	0.903	0.940	0.966	0.983	0.991	54050
Telford and MacColl	99.0%	31	0.354	0.587	0.786	0.849	0.902	0.938	0.965	0.982	0.990	54227
Telford and MacColl	99.5%	15	0.351	0.583	0.783	0.847	0.901	0.937	0.964	0.982	0.990	54406
Stevenson and Telford	95.0%	108	0.372	0.605	0.798	0.860	0.908	0.944	0.969	0.984	0.992	53343
Stevenson and Telford	98.0%	43	0.357	0.590	0.788	0.851	0.903	0.939	0.966	0.983	0.990	54085
Stevenson and Telford	98.5%	32	0.355	0.587	0.786	0.850	0.902	0.939	0.965	0.982	0.990	54209
Stevenson and Telford	99.0%	22	0.352	0.585	0.784	0.848	0.901	0.938	0.964	0.982	0.990	54334
Stevenson and Telford	99.5%	11	0.350	0.582	0.783	0.847	0.900	0.937	0.964	0.982	0.990	54459
BOWL	95.0%	32	0.355	0.587	0.786	0.850	0.902	0.939	0.965	0.982	0.990	54214
BOWL	98.0%	13	0.350	0.583	0.783	0.847	0.900	0.937	0.964	0.982	0.990	54434
BOWL	98.5%	9	0.349	0.582	0.782	0.846	0.900	0.937	0.964	0.982	0.990	54480
BOWL	99.0%	6	0.349	0.581	0.782	0.846	0.900	0.937	0.964	0.982	0.990	54515
BOWL	99.5%	3	0.348	0.580	0.781	0.845	0.899	0.937	0.963	0.982	0.989	54550
BOWL and MORL	95.0%	213	0.396	0.629	0.813	0.874	0.917	0.950	0.973	0.987	0.994	52172
BOWL and MORL	98.0%	85	0.367	0.599	0.794	0.857	0.906	0.942	0.968	0.984	0.991	53606
BOWL and MORL	98.5%	64	0.362	0.595	0.791	0.854	0.905	0.941	0.967	0.983	0.991	53849
BOWL and MORL	99.0%	43	0.357	0.590	0.788	0.851	0.903	0.939	0.966	0.983	0.990	54093
BOWL and MORL	99.5%	21	0.352	0.584	0.784	0.848	0.901	0.938	0.964	0.982	0.990	54338

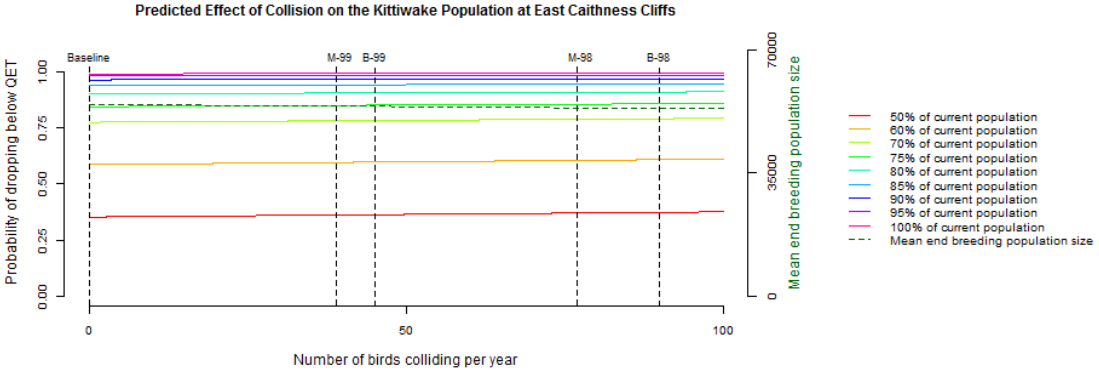


Figure F.24. Probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

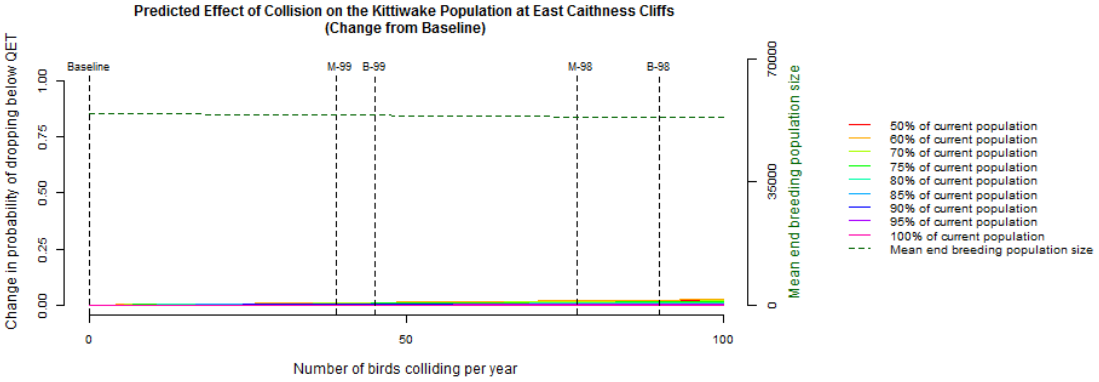


Figure F.25. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table F.12. Modelled probabilities of dropping below current population size for the kittiwake population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.574	0.762	0.882	0.922	0.950	0.969	0.983	0.991	0.995	46571
Whole site	95.0%	181	0.615	0.793	0.902	0.936	0.959	0.977	0.988	0.994	0.997	44884
Whole site	98.0%	72	0.591	0.774	0.890	0.928	0.954	0.972	0.985	0.992	0.996	45889
Whole site	98.5%	54	0.586	0.771	0.888	0.926	0.953	0.971	0.985	0.992	0.996	46058
Whole site	99.0%	36	0.582	0.768	0.886	0.925	0.952	0.970	0.984	0.992	0.996	46228
Whole site	99.5%	18	0.578	0.765	0.884	0.923	0.951	0.970	0.984	0.991	0.995	46399
Sum of MacColl, Telford & Stevenson	95.0%	218	0.624	0.799	0.906	0.938	0.961	0.978	0.989	0.995	0.997	44546
Sum of MacColl, Telford & Stevenson	98.0%	87	0.594	0.777	0.892	0.929	0.955	0.973	0.986	0.993	0.996	45750
Sum of MacColl, Telford & Stevenson	98.5%	65	0.589	0.773	0.890	0.927	0.953	0.972	0.985	0.992	0.996	45954
Sum of MacColl, Telford & Stevenson	99.0%	44	0.584	0.769	0.887	0.925	0.952	0.971	0.984	0.992	0.996	46159
Sum of MacColl, Telford & Stevenson	99.5%	22	0.579	0.766	0.885	0.923	0.951	0.970	0.984	0.991	0.996	46364
MacColl	95.0%	109	0.599	0.781	0.895	0.930	0.956	0.974	0.986	0.993	0.996	45542
MacColl	98.0%	44	0.584	0.769	0.887	0.925	0.952	0.971	0.984	0.992	0.996	46156
MacColl	98.5%	33	0.581	0.768	0.886	0.924	0.952	0.970	0.984	0.992	0.996	46260
MacColl	99.0%	22	0.579	0.766	0.885	0.923	0.951	0.970	0.984	0.991	0.996	46363
MacColl	99.5%	11	0.576	0.764	0.883	0.923	0.950	0.969	0.983	0.991	0.995	46467
Stevenson	95.0%	63	0.589	0.773	0.889	0.927	0.953	0.972	0.985	0.992	0.996	45973
Stevenson	98.0%	25	0.580	0.766	0.885	0.924	0.951	0.970	0.984	0.991	0.996	46331
Stevenson	98.5%	19	0.578	0.765	0.884	0.923	0.951	0.970	0.984	0.991	0.995	46391
Stevenson	99.0%	13	0.577	0.764	0.884	0.923	0.950	0.969	0.984	0.991	0.995	46451
Stevenson	99.5%	6	0.575	0.763	0.883	0.922	0.950	0.969	0.983	0.991	0.995	46511
Telford	95.0%	45	0.584	0.770	0.887	0.925	0.952	0.971	0.985	0.992	0.996	46145
Telford	98.0%	18	0.578	0.765	0.884	0.923	0.951	0.970	0.984	0.991	0.995	46400
Telford	98.5%	13	0.577	0.764	0.884	0.923	0.951	0.969	0.984	0.991	0.995	46443
Telford	99.0%	9	0.576	0.763	0.883	0.922	0.950	0.969	0.983	0.991	0.995	46485
Telford	99.5%	4	0.575	0.762	0.883	0.922	0.950	0.969	0.983	0.991	0.995	46528
MacColl and Stevenson	95.0%	173	0.614	0.791	0.901	0.935	0.959	0.976	0.988	0.994	0.997	44957
MacColl and Stevenson	98.0%	69	0.590	0.774	0.890	0.927	0.954	0.972	0.985	0.992	0.996	45919
MacColl and Stevenson	98.5%	52	0.586	0.771	0.888	0.926	0.953	0.971	0.985	0.992	0.996	46081
MacColl and Stevenson	99.0%	35	0.582	0.768	0.886	0.924	0.952	0.970	0.984	0.992	0.996	46244
MacColl and Stevenson	99.5%	17	0.578	0.765	0.884	0.923	0.951	0.970	0.984	0.991	0.995	46407
Telford and MacColl	95.0%	154	0.609	0.788	0.899	0.934	0.958	0.976	0.987	0.994	0.997	45125
Telford and MacColl	98.0%	62	0.588	0.773	0.889	0.927	0.953	0.972	0.985	0.992	0.996	45987
Telford and MacColl	98.5%	46	0.585	0.770	0.887	0.925	0.952	0.971	0.985	0.992	0.996	46132
Telford and MacColl	99.0%	31	0.581	0.767	0.886	0.924	0.952	0.970	0.984	0.991	0.996	46278
Telford and MacColl	99.5%	15	0.577	0.764	0.884	0.923	0.951	0.969	0.984	0.991	0.995	46424
Stevenson and Telford	95.0%	108	0.599	0.781	0.895	0.930	0.956	0.974	0.986	0.993	0.996	45553
Stevenson and Telford	98.0%	43	0.584	0.769	0.887	0.925	0.952	0.971	0.984	0.992	0.996	46161
Stevenson and Telford	98.5%	32	0.581	0.767	0.886	0.924	0.952	0.970	0.984	0.992	0.996	46263
Stevenson and Telford	99.0%	22	0.579	0.766	0.885	0.923	0.951	0.970	0.984	0.991	0.996	46365
Stevenson and Telford	99.5%	11	0.576	0.764	0.883	0.923	0.950	0.969	0.983	0.991	0.995	46468
BOWL	95.0%	32	0.581	0.767	0.886	0.924	0.952	0.970	0.984	0.992	0.996	46267
BOWL	98.0%	13	0.577	0.764	0.884	0.923	0.950	0.969	0.984	0.991	0.995	46447
BOWL	98.5%	9	0.576	0.763	0.883	0.922	0.950	0.969	0.983	0.991	0.995	46485
BOWL	99.0%	6	0.575	0.763	0.883	0.922	0.950	0.969	0.983	0.991	0.995	46514
BOWL	99.5%	3	0.575	0.762	0.882	0.922	0.950	0.969	0.983	0.991	0.995	46542
BOWL and MORL	95.0%	213	0.623	0.798	0.905	0.938	0.961	0.978	0.989	0.995	0.997	44592
BOWL and MORL	98.0%	85	0.594	0.777	0.892	0.929	0.955	0.973	0.986	0.993	0.996	45769
BOWL and MORL	98.5%	64	0.589	0.773	0.890	0.927	0.953	0.972	0.985	0.992	0.996	45968
BOWL and MORL	99.0%	43	0.584	0.769	0.887	0.925	0.952	0.971	0.984	0.992	0.996	46168
BOWL and MORL	99.5%	21	0.579	0.765	0.885	0.923	0.951	0.970	0.984	0.991	0.996	46369

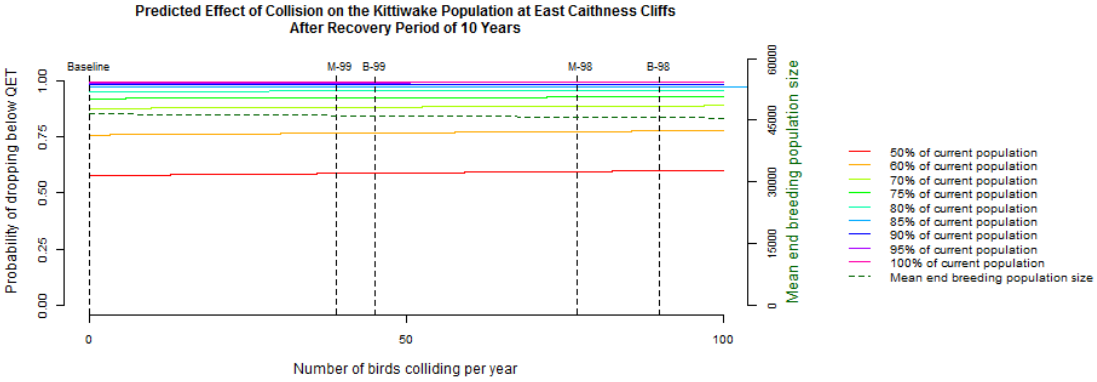


Figure F.26. Probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

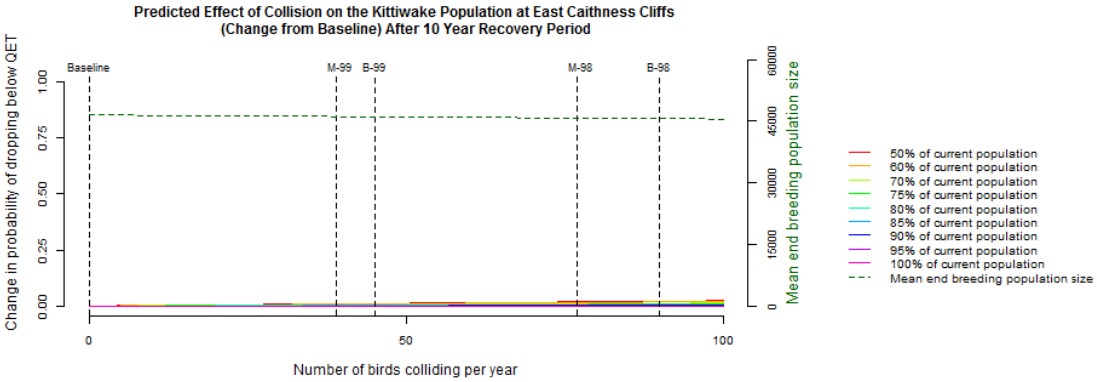


Figure F.27. Change in probability of the kittiwake population at East Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table F.13. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the kittiwake population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.026	0.081	0.175	0.223	0.277	0.337	0.398	0.455	0.513	54585
Whole site	95.0%	181	0.034	0.099	0.198	0.253	0.314	0.378	0.441	0.502	0.560	52528
Whole site	98.0%	72	0.029	0.088	0.184	0.235	0.292	0.353	0.415	0.474	0.532	53753
Whole site	98.5%	54	0.028	0.086	0.182	0.232	0.288	0.349	0.411	0.469	0.527	53959
Whole site	99.0%	36	0.027	0.085	0.179	0.229	0.284	0.345	0.407	0.464	0.523	54167
Whole site	99.5%	18	0.026	0.083	0.177	0.226	0.281	0.341	0.402	0.460	0.518	54375
Sum of MacColl, Telford & Stevenson	95.0%	218	0.036	0.103	0.203	0.260	0.322	0.387	0.450	0.512	0.569	52116
Sum of MacColl, Telford & Stevenson	98.0%	87	0.029	0.089	0.186	0.237	0.295	0.356	0.419	0.478	0.536	53583
Sum of MacColl, Telford & Stevenson	98.5%	65	0.028	0.087	0.183	0.234	0.290	0.351	0.414	0.472	0.530	53832
Sum of MacColl, Telford & Stevenson	99.0%	44	0.027	0.085	0.180	0.230	0.286	0.346	0.408	0.466	0.524	54082
Sum of MacColl, Telford & Stevenson	99.5%	22	0.026	0.083	0.178	0.227	0.281	0.341	0.403	0.461	0.519	54333
MacColl	95.0%	109	0.030	0.091	0.189	0.241	0.299	0.361	0.424	0.484	0.541	53329
MacColl	98.0%	44	0.027	0.085	0.180	0.230	0.286	0.346	0.409	0.466	0.525	54079
MacColl	98.5%	33	0.027	0.084	0.179	0.228	0.284	0.344	0.406	0.464	0.522	54205
MacColl	99.0%	22	0.026	0.083	0.178	0.227	0.281	0.342	0.403	0.461	0.519	54331
MacColl	99.5%	11	0.026	0.082	0.176	0.225	0.279	0.339	0.401	0.458	0.516	54458
Stevenson	95.0%	63	0.028	0.087	0.183	0.233	0.290	0.351	0.413	0.472	0.530	53856
Stevenson	98.0%	25	0.027	0.084	0.178	0.227	0.282	0.342	0.404	0.462	0.520	54292
Stevenson	98.5%	19	0.026	0.083	0.177	0.226	0.281	0.341	0.403	0.460	0.518	54365
Stevenson	99.0%	13	0.026	0.083	0.177	0.225	0.280	0.339	0.401	0.458	0.517	54438
Stevenson	99.5%	6	0.026	0.082	0.176	0.224	0.278	0.338	0.400	0.457	0.515	54511
Telford	95.0%	45	0.027	0.085	0.181	0.230	0.286	0.347	0.409	0.467	0.525	54065
Telford	98.0%	18	0.026	0.083	0.177	0.226	0.281	0.341	0.402	0.460	0.518	54376
Telford	98.5%	13	0.026	0.083	0.177	0.225	0.280	0.340	0.401	0.459	0.517	54428
Telford	99.0%	9	0.026	0.082	0.176	0.225	0.279	0.339	0.400	0.457	0.516	54480
Telford	99.5%	4	0.026	0.082	0.176	0.224	0.278	0.338	0.399	0.456	0.514	54532
MacColl and Stevenson	95.0%	173	0.033	0.098	0.197	0.252	0.313	0.376	0.440	0.500	0.558	52617
MacColl and Stevenson	98.0%	69	0.028	0.088	0.184	0.234	0.291	0.352	0.415	0.473	0.531	53789
MacColl and Stevenson	98.5%	52	0.028	0.086	0.181	0.231	0.287	0.348	0.410	0.469	0.527	53987
MacColl and Stevenson	99.0%	35	0.027	0.085	0.179	0.229	0.284	0.344	0.406	0.464	0.522	54185
MacColl and Stevenson	99.5%	17	0.026	0.083	0.177	0.226	0.280	0.340	0.402	0.460	0.518	54385
Telford and MacColl	95.0%	154	0.033	0.096	0.195	0.249	0.309	0.372	0.435	0.495	0.553	52822
Telford and MacColl	98.0%	62	0.028	0.087	0.183	0.233	0.289	0.350	0.413	0.471	0.529	53872
Telford and MacColl	98.5%	46	0.027	0.086	0.181	0.231	0.286	0.347	0.409	0.467	0.525	54050
Telford and MacColl	99.0%	31	0.027	0.084	0.179	0.228	0.283	0.344	0.405	0.463	0.521	54227
Telford and MacColl	99.5%	15	0.026	0.083	0.177	0.226	0.280	0.340	0.402	0.459	0.517	54406
Stevenson and Telford	95.0%	108	0.030	0.091	0.189	0.241	0.299	0.361	0.424	0.483	0.541	53343
Stevenson and Telford	98.0%	43	0.027	0.085	0.180	0.230	0.286	0.346	0.408	0.466	0.524	54085
Stevenson and Telford	98.5%	32	0.027	0.084	0.179	0.228	0.283	0.344	0.406	0.464	0.522	54209
Stevenson and Telford	99.0%	22	0.026	0.083	0.178	0.227	0.281	0.341	0.403	0.461	0.519	54334
Stevenson and Telford	99.5%	11	0.026	0.082	0.176	0.225	0.279	0.339	0.401	0.458	0.516	54459
BOWL	95.0%	32	0.027	0.084	0.179	0.228	0.283	0.344	0.406	0.463	0.522	54214
BOWL	98.0%	13	0.026	0.083	0.177	0.225	0.280	0.340	0.401	0.458	0.517	54434
BOWL	98.5%	9	0.026	0.082	0.176	0.225	0.279	0.339	0.400	0.457	0.516	54480
BOWL	99.0%	6	0.026	0.082	0.176	0.224	0.278	0.338	0.400	0.457	0.515	54515
BOWL	99.5%	3	0.026	0.082	0.175	0.224	0.278	0.337	0.399	0.456	0.514	54550
BOWL and MORL	95.0%	213	0.036	0.102	0.203	0.259	0.321	0.385	0.449	0.511	0.568	52172
BOWL and MORL	98.0%	85	0.029	0.089	0.186	0.237	0.294	0.356	0.418	0.477	0.535	53606
BOWL and MORL	98.5%	64	0.028	0.087	0.183	0.233	0.290	0.351	0.413	0.472	0.530	53849
BOWL and MORL	99.0%	43	0.027	0.085	0.180	0.230	0.286	0.346	0.408	0.466	0.524	54093
BOWL and MORL	99.5%	21	0.026	0.083	0.178	0.226	0.281	0.341	0.403	0.461	0.519	54338

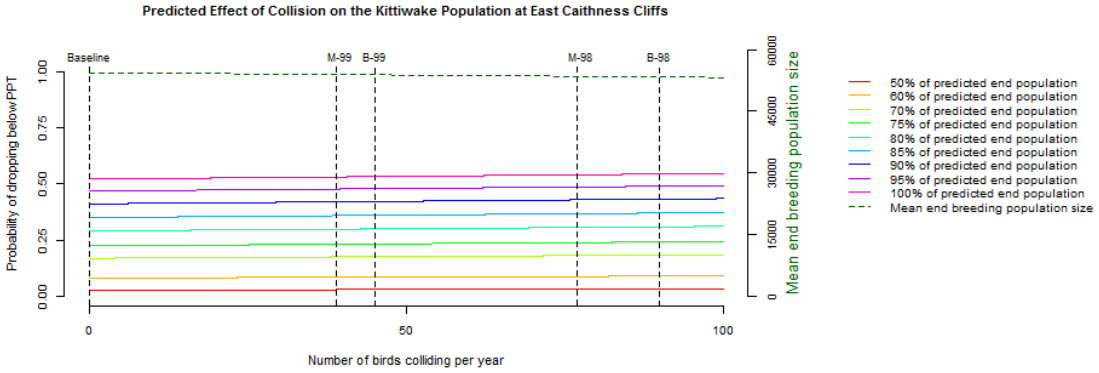


Figure F.28. Probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

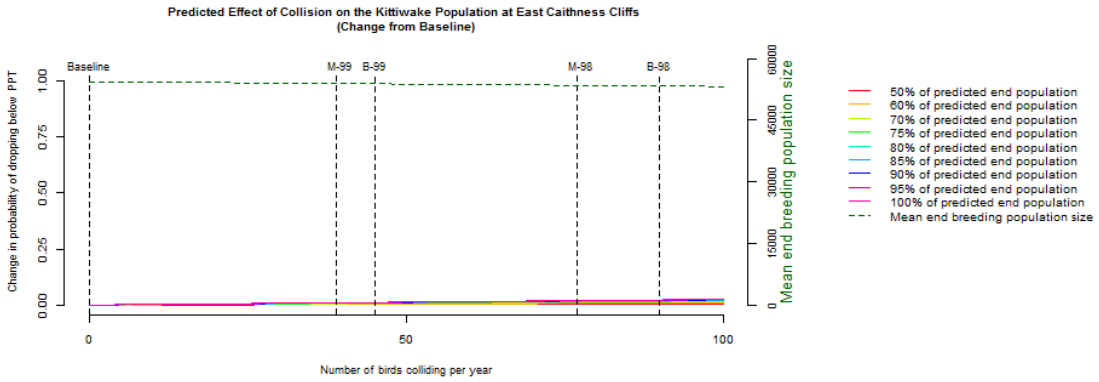


Figure F.29. Change in probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table F.14. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the kittiwake population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.117	0.228	0.357	0.415	0.474	0.536	0.594	0.638	0.684	46571
Whole site	95.0%	181	0.134	0.254	0.387	0.448	0.511	0.572	0.628	0.674	0.718	44884
Whole site	98.0%	72	0.123	0.238	0.369	0.428	0.489	0.550	0.607	0.652	0.698	45889
Whole site	98.5%	54	0.121	0.236	0.366	0.425	0.485	0.546	0.604	0.649	0.694	46058
Whole site	99.0%	36	0.120	0.233	0.363	0.421	0.482	0.543	0.601	0.645	0.691	46228
Whole site	99.5%	18	0.118	0.231	0.360	0.418	0.478	0.539	0.597	0.641	0.688	46399
Sum of MacColl, Telford & Stevenson	95.0%	218	0.137	0.259	0.393	0.455	0.518	0.579	0.634	0.681	0.724	44546
Sum of MacColl, Telford & Stevenson	98.0%	87	0.125	0.240	0.371	0.431	0.492	0.553	0.610	0.655	0.701	45750
Sum of MacColl, Telford & Stevenson	98.5%	65	0.123	0.237	0.368	0.427	0.488	0.549	0.606	0.651	0.697	45954
Sum of MacColl, Telford & Stevenson	99.0%	44	0.120	0.234	0.364	0.423	0.483	0.544	0.602	0.646	0.692	46159
Sum of MacColl, Telford & Stevenson	99.5%	22	0.119	0.231	0.361	0.419	0.479	0.540	0.598	0.642	0.688	46364
MacColl	95.0%	109	0.127	0.243	0.375	0.435	0.497	0.558	0.614	0.660	0.705	45542
MacColl	98.0%	44	0.121	0.234	0.364	0.423	0.483	0.544	0.602	0.646	0.693	46156
MacColl	98.5%	33	0.120	0.233	0.362	0.421	0.481	0.542	0.600	0.644	0.690	46260
MacColl	99.0%	22	0.119	0.231	0.361	0.419	0.479	0.540	0.598	0.642	0.688	46363
MacColl	99.5%	11	0.118	0.230	0.359	0.417	0.477	0.538	0.596	0.640	0.686	46467
Stevenson	95.0%	63	0.122	0.237	0.367	0.426	0.487	0.548	0.606	0.650	0.696	45973
Stevenson	98.0%	25	0.119	0.232	0.361	0.419	0.480	0.541	0.599	0.643	0.689	46331
Stevenson	98.5%	19	0.118	0.231	0.360	0.418	0.478	0.539	0.597	0.641	0.688	46391
Stevenson	99.0%	13	0.118	0.230	0.359	0.417	0.477	0.538	0.596	0.640	0.687	46451
Stevenson	99.5%	6	0.117	0.229	0.358	0.416	0.476	0.537	0.595	0.639	0.685	46511
Telford	95.0%	45	0.121	0.234	0.364	0.423	0.484	0.545	0.602	0.647	0.693	46145
Telford	98.0%	18	0.118	0.231	0.360	0.418	0.478	0.539	0.597	0.641	0.688	46400
Telford	98.5%	13	0.118	0.230	0.359	0.417	0.477	0.538	0.596	0.640	0.687	46443
Telford	99.0%	9	0.117	0.229	0.358	0.416	0.476	0.537	0.596	0.639	0.686	46485
Telford	99.5%	4	0.117	0.229	0.358	0.416	0.475	0.536	0.595	0.638	0.685	46528
MacColl and Stevenson	95.0%	173	0.133	0.252	0.385	0.447	0.509	0.570	0.626	0.672	0.716	44957
MacColl and Stevenson	98.0%	69	0.123	0.238	0.368	0.427	0.488	0.549	0.607	0.652	0.697	45919
MacColl and Stevenson	98.5%	52	0.121	0.235	0.365	0.424	0.485	0.546	0.604	0.648	0.694	46081
MacColl and Stevenson	99.0%	35	0.120	0.233	0.363	0.421	0.481	0.543	0.600	0.645	0.691	46244
MacColl and Stevenson	99.5%	17	0.118	0.231	0.360	0.418	0.478	0.539	0.597	0.641	0.688	46407
Telford and MacColl	95.0%	154	0.131	0.250	0.382	0.443	0.506	0.567	0.623	0.668	0.713	45125
Telford and MacColl	98.0%	62	0.122	0.237	0.367	0.426	0.487	0.548	0.606	0.650	0.696	45987
Telford and MacColl	98.5%	46	0.121	0.235	0.365	0.423	0.484	0.545	0.603	0.647	0.693	46132
Telford and MacColl	99.0%	31	0.119	0.232	0.362	0.420	0.481	0.542	0.600	0.644	0.690	46278
Telford and MacColl	99.5%	15	0.118	0.230	0.360	0.418	0.478	0.539	0.597	0.641	0.687	46424
Stevenson and Telford	95.0%	108	0.127	0.243	0.375	0.435	0.496	0.557	0.614	0.659	0.704	45553
Stevenson and Telford	98.0%	43	0.120	0.234	0.364	0.423	0.483	0.544	0.602	0.646	0.692	46161
Stevenson and Telford	98.5%	32	0.119	0.233	0.362	0.421	0.481	0.542	0.600	0.644	0.690	46263
Stevenson and Telford	99.0%	22	0.118	0.231	0.361	0.419	0.479	0.540	0.598	0.642	0.688	46365
Stevenson and Telford	99.5%	11	0.118	0.230	0.359	0.417	0.477	0.538	0.596	0.640	0.686	46468
BOWL	95.0%	32	0.119	0.233	0.362	0.421	0.481	0.542	0.600	0.644	0.690	46267
BOWL	98.0%	13	0.118	0.230	0.359	0.417	0.477	0.538	0.596	0.640	0.687	46447
BOWL	98.5%	9	0.117	0.229	0.358	0.416	0.476	0.537	0.596	0.639	0.686	46485
BOWL	99.0%	6	0.117	0.229	0.358	0.416	0.476	0.537	0.595	0.639	0.685	46514
BOWL	99.5%	3	0.117	0.229	0.358	0.415	0.475	0.536	0.594	0.638	0.685	46542
BOWL and MORL	95.0%	213	0.137	0.258	0.392	0.454	0.517	0.578	0.633	0.680	0.723	44592
BOWL and MORL	98.0%	85	0.124	0.240	0.371	0.430	0.492	0.553	0.610	0.655	0.700	45769
BOWL and MORL	98.5%	64	0.122	0.237	0.367	0.426	0.487	0.548	0.606	0.650	0.696	45968
BOWL and MORL	99.0%	43	0.120	0.234	0.364	0.423	0.483	0.544	0.602	0.646	0.692	46168
BOWL and MORL	99.5%	21	0.118	0.231	0.360	0.419	0.479	0.540	0.598	0.642	0.688	46369

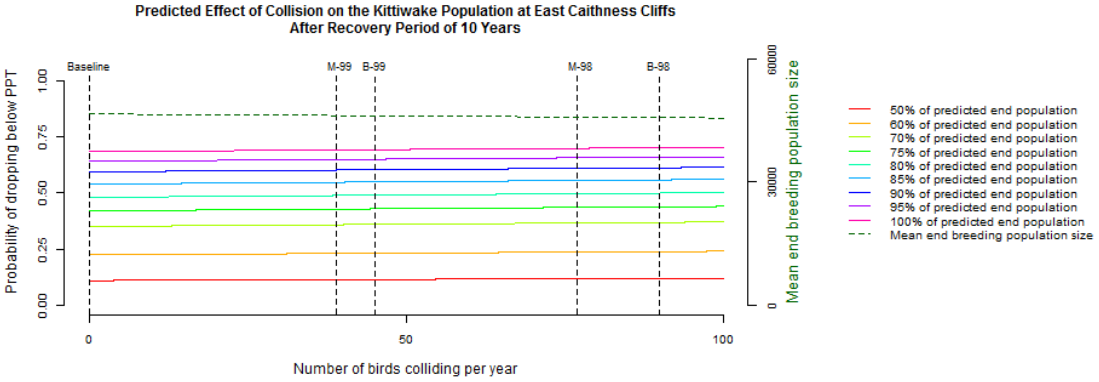


Figure F.30. Probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

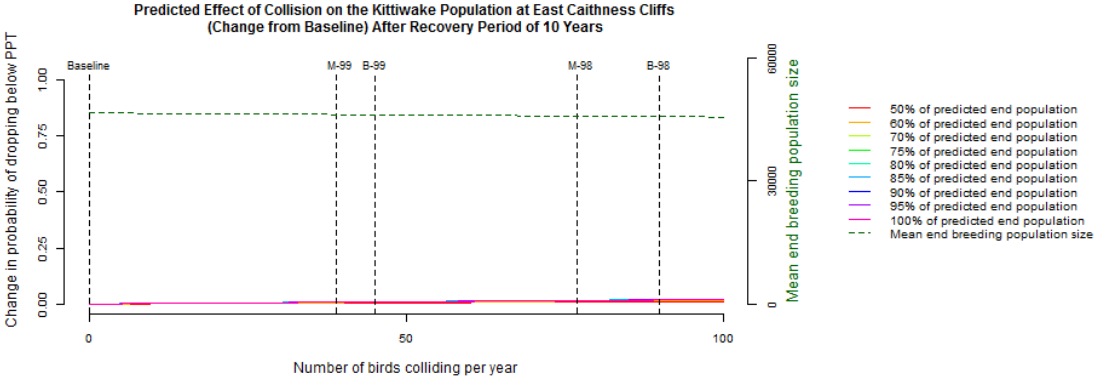


Figure F.31. Change in probability of the kittiwake population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix G – PVA Outputs: Kittiwake – North Caithness Cliffs

Collision and displacement

Table G.1. Modelled probabilities of dropping below baseline predicted population size for the kittiwake population at North Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.022	0.068	0.150	0.199	0.255	0.310	0.365	0.423	0.480	13684
Whole site	10%	86	95.0%	72	0.033	0.094	0.195	0.253	0.317	0.378	0.439	0.498	0.557	12803
Whole site	10%	86	98.0%	29	0.026	0.077	0.167	0.220	0.279	0.336	0.394	0.453	0.511	13325
Whole site	10%	86	98.5%	22	0.025	0.075	0.163	0.214	0.273	0.330	0.387	0.445	0.503	13414
Whole site	10%	86	99.0%	14	0.024	0.073	0.159	0.209	0.267	0.323	0.380	0.438	0.496	13503
Whole site	10%	86	99.5%	7	0.023	0.070	0.155	0.204	0.261	0.316	0.373	0.430	0.488	13593
Sum of MacColl, Telford & Stevenson	10%	86	95.0%	87	0.036	0.100	0.205	0.265	0.331	0.393	0.454	0.514	0.572	12630
Sum of MacColl, Telford & Stevenson	10%	86	98.0%	35	0.027	0.080	0.171	0.224	0.284	0.342	0.400	0.459	0.517	13252
Sum of MacColl, Telford & Stevenson	10%	86	98.5%	26	0.026	0.077	0.166	0.218	0.277	0.334	0.391	0.450	0.508	13359
Sum of MacColl, Telford & Stevenson	10%	86	99.0%	17	0.025	0.074	0.160	0.211	0.270	0.326	0.383	0.441	0.499	13466
Sum of MacColl, Telford & Stevenson	10%	86	99.5%	9	0.023	0.071	0.155	0.205	0.262	0.318	0.374	0.432	0.489	13575
MacColl	10%	86	95.0%	44	0.028	0.083	0.176	0.231	0.292	0.350	0.409	0.468	0.527	13144
MacColl	10%	86	98.0%	18	0.025	0.074	0.160	0.211	0.270	0.326	0.383	0.441	0.499	13465
MacColl	10%	86	98.5%	13	0.024	0.072	0.158	0.208	0.266	0.322	0.378	0.436	0.494	13520
MacColl	10%	86	99.0%	9	0.023	0.071	0.155	0.205	0.262	0.318	0.374	0.432	0.490	13574
MacColl	10%	86	99.5%	4	0.023	0.069	0.153	0.202	0.259	0.314	0.370	0.427	0.485	13629
Stevenson	10%	86	95.0%	25	0.026	0.076	0.165	0.217	0.276	0.333	0.391	0.449	0.507	13369
Stevenson	10%	86	98.0%	10	0.024	0.071	0.156	0.206	0.264	0.319	0.375	0.433	0.491	13557
Stevenson	10%	86	98.5%	8	0.023	0.070	0.155	0.204	0.262	0.317	0.373	0.430	0.488	13589
Stevenson	10%	86	99.0%	5	0.023	0.070	0.153	0.203	0.260	0.314	0.370	0.428	0.486	13621
Stevenson	10%	86	99.5%	3	0.023	0.069	0.152	0.201	0.257	0.312	0.368	0.425	0.483	13652
Telford	10%	86	95.0%	18	0.025	0.074	0.161	0.212	0.270	0.326	0.383	0.441	0.499	13459
Telford	10%	86	98.0%	7	0.023	0.070	0.155	0.204	0.261	0.316	0.372	0.430	0.488	13594
Telford	10%	86	98.5%	5	0.023	0.070	0.153	0.203	0.260	0.315	0.371	0.428	0.486	13616
Telford	10%	86	99.0%	4	0.023	0.069	0.152	0.202	0.258	0.313	0.369	0.426	0.484	13639
Telford	10%	86	99.5%	2	0.023	0.069	0.151	0.200	0.257	0.311	0.367	0.424	0.482	13661
MacColl and Stevenson	10%	86	95.0%	69	0.032	0.093	0.193	0.250	0.314	0.375	0.435	0.495	0.553	12841
MacColl and Stevenson	10%	86	98.0%	28	0.026	0.077	0.166	0.219	0.278	0.335	0.393	0.451	0.510	13340
MacColl and Stevenson	10%	86	98.5%	21	0.025	0.075	0.162	0.214	0.272	0.329	0.386	0.444	0.502	13426
MacColl and Stevenson	10%	86	99.0%	14	0.024	0.072	0.158	0.209	0.267	0.322	0.379	0.437	0.495	13511
MacColl and Stevenson	10%	86	99.5%	7	0.023	0.070	0.154	0.204	0.261	0.316	0.372	0.430	0.488	13597
Telford and MacColl	10%	86	95.0%	62	0.031	0.090	0.188	0.244	0.308	0.368	0.428	0.487	0.546	12928
Telford and MacColl	10%	86	98.0%	25	0.026	0.076	0.165	0.217	0.276	0.332	0.390	0.448	0.506	13376
Telford and MacColl	10%	86	98.5%	19	0.025	0.074	0.161	0.212	0.270	0.327	0.384	0.442	0.500	13453
Telford and MacColl	10%	86	99.0%	12	0.024	0.072	0.157	0.208	0.265	0.321	0.378	0.435	0.493	13529
Telford and MacColl	10%	86	99.5%	6	0.023	0.070	0.154	0.203	0.260	0.315	0.371	0.429	0.487	13607
Stevenson and Telford	10%	86	95.0%	43	0.028	0.083	0.176	0.230	0.291	0.350	0.409	0.468	0.526	13149
Stevenson and Telford	10%	86	98.0%	17	0.025	0.074	0.160	0.211	0.269	0.326	0.383	0.441	0.499	13468
Stevenson and Telford	10%	86	98.5%	13	0.024	0.072	0.158	0.208	0.266	0.322	0.378	0.436	0.494	13521
Stevenson and Telford	10%	86	99.0%	9	0.023	0.071	0.155	0.205	0.262	0.318	0.374	0.432	0.489	13575
Stevenson and Telford	10%	86	99.5%	4	0.023	0.069	0.153	0.202	0.259	0.314	0.370	0.427	0.485	13630
BOWL	10%	86	95.0%	79	0.034	0.097	0.200	0.258	0.323	0.385	0.446	0.505	0.564	12724
BOWL	10%	86	98.0%	32	0.027	0.079	0.169	0.222	0.282	0.339	0.397	0.456	0.514	13287
BOWL	10%	86	98.5%	24	0.025	0.076	0.164	0.216	0.275	0.332	0.389	0.448	0.506	13385
BOWL	10%	86	99.0%	16	0.024	0.073	0.160	0.210	0.268	0.324	0.381	0.439	0.497	13484
BOWL	10%	86	99.5%	8	0.023	0.071	0.155	0.205	0.262	0.317	0.373	0.431	0.489	13584
BOWL and MORL	10%	86	95.0%	151	0.050	0.132	0.255	0.321	0.392	0.459	0.522	0.581	0.637	11905
BOWL and MORL	10%	86	98.0%	60	0.031	0.089	0.187	0.243	0.306	0.367	0.426	0.486	0.544	12943
BOWL and MORL	10%	86	98.5%	45	0.029	0.083	0.177	0.232	0.293	0.352	0.411	0.470	0.528	13124
BOWL and MORL	10%	86	99.0%	30	0.026	0.078	0.168	0.221	0.280	0.338	0.396	0.454	0.512	13308
BOWL and MORL	10%	86	99.5%	15	0.024	0.073	0.159	0.210	0.268	0.324	0.380	0.438	0.496	13495

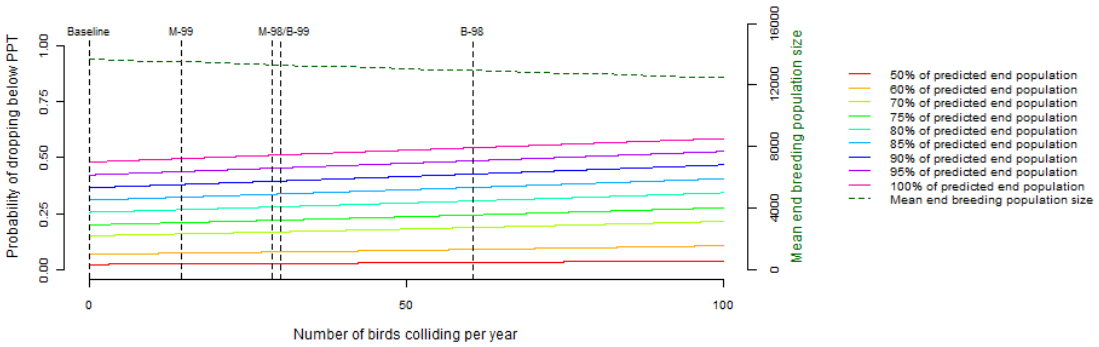


Figure G.1. Probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

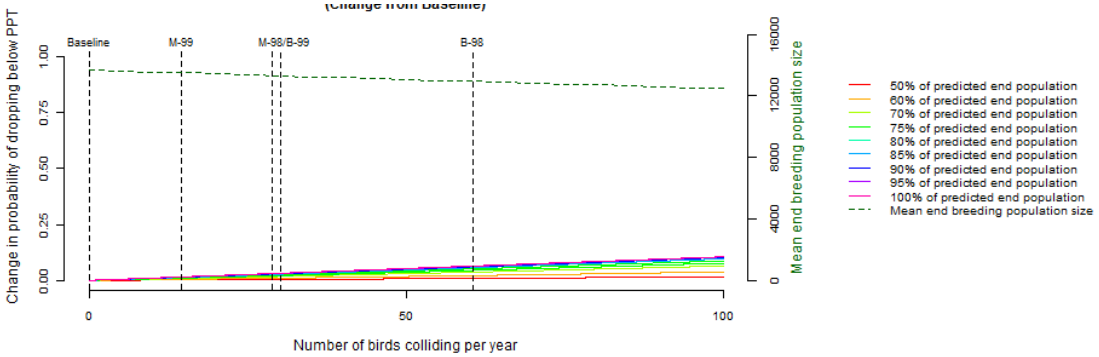


Figure G.2. Change in probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table G.2. Modelled probabilities of dropping below baseline predicted population size for the kittiwake population at North Caithness Cliffs with increasing collision rates incorporating low level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.099	0.204	0.329	0.388	0.446	0.500	0.552	0.596	0.642	11727
Whole site	10%	86	95.0%	72	0.129	0.250	0.386	0.448	0.509	0.564	0.617	0.662	0.706	10968
Whole site	10%	86	98.0%	29	0.110	0.222	0.351	0.411	0.471	0.526	0.578	0.623	0.669	11417
Whole site	10%	86	98.5%	22	0.108	0.217	0.346	0.405	0.465	0.520	0.572	0.616	0.662	11494
Whole site	10%	86	99.0%	14	0.105	0.213	0.340	0.399	0.458	0.513	0.565	0.610	0.656	11571
Whole site	10%	86	99.5%	7	0.102	0.209	0.335	0.393	0.452	0.507	0.559	0.603	0.649	11648
Sum of MacColl, Telford & Stevenson	10%	86	95.0%	87	0.136	0.260	0.398	0.460	0.522	0.577	0.629	0.675	0.718	10818
Sum of MacColl, Telford & Stevenson	10%	86	98.0%	35	0.113	0.226	0.356	0.416	0.476	0.531	0.584	0.628	0.674	11354
Sum of MacColl, Telford & Stevenson	10%	86	98.5%	26	0.109	0.220	0.349	0.409	0.468	0.524	0.576	0.620	0.666	11446
Sum of MacColl, Telford & Stevenson	10%	86	99.0%	17	0.106	0.215	0.342	0.402	0.461	0.516	0.568	0.612	0.658	11539
Sum of MacColl, Telford & Stevenson	10%	86	99.5%	9	0.103	0.210	0.336	0.395	0.453	0.508	0.560	0.604	0.650	11632
MacColl	10%	86	95.0%	44	0.116	0.231	0.363	0.424	0.484	0.539	0.592	0.637	0.682	11261
MacColl	10%	86	98.0%	18	0.106	0.215	0.342	0.402	0.461	0.516	0.568	0.612	0.658	11538
MacColl	10%	86	98.5%	13	0.104	0.212	0.339	0.398	0.457	0.512	0.564	0.608	0.654	11585
MacColl	10%	86	99.0%	9	0.103	0.210	0.336	0.395	0.453	0.508	0.560	0.604	0.650	11632
MacColl	10%	86	99.5%	4	0.101	0.207	0.332	0.391	0.449	0.504	0.556	0.600	0.646	11679
Stevenson	10%	86	95.0%	25	0.109	0.220	0.349	0.408	0.468	0.523	0.575	0.620	0.665	11455
Stevenson	10%	86	98.0%	10	0.103	0.210	0.337	0.396	0.454	0.509	0.561	0.605	0.652	11617
Stevenson	10%	86	98.5%	8	0.102	0.209	0.335	0.394	0.452	0.507	0.559	0.603	0.649	11644
Stevenson	10%	86	99.0%	5	0.101	0.207	0.333	0.392	0.450	0.505	0.557	0.601	0.647	11672
Stevenson	10%	86	99.5%	3	0.100	0.206	0.331	0.390	0.448	0.503	0.554	0.598	0.645	11699
Telford	10%	86	95.0%	18	0.106	0.215	0.343	0.402	0.461	0.516	0.568	0.613	0.659	11533
Telford	10%	86	98.0%	7	0.102	0.209	0.335	0.393	0.452	0.507	0.559	0.603	0.649	11649
Telford	10%	86	98.5%	5	0.101	0.208	0.333	0.392	0.450	0.505	0.557	0.601	0.647	11668
Telford	10%	86	99.0%	4	0.101	0.207	0.332	0.390	0.449	0.504	0.555	0.599	0.646	11688
Telford	10%	86	99.5%	2	0.100	0.206	0.330	0.389	0.447	0.502	0.554	0.598	0.644	11707
MacColl and Stevenson	10%	86	95.0%	69	0.127	0.248	0.383	0.445	0.506	0.562	0.614	0.659	0.703	11000
MacColl and Stevenson	10%	86	98.0%	28	0.110	0.221	0.350	0.410	0.470	0.525	0.577	0.622	0.667	11430
MacColl and Stevenson	10%	86	98.5%	21	0.107	0.217	0.345	0.405	0.464	0.519	0.571	0.615	0.661	11504
MacColl and Stevenson	10%	86	99.0%	14	0.105	0.213	0.340	0.399	0.458	0.513	0.565	0.609	0.655	11578
MacColl and Stevenson	10%	86	99.5%	7	0.102	0.209	0.334	0.393	0.452	0.506	0.558	0.602	0.649	11652
Telford and MacColl	10%	86	95.0%	62	0.124	0.243	0.377	0.439	0.500	0.555	0.607	0.653	0.697	11075
Telford and MacColl	10%	86	98.0%	25	0.109	0.219	0.348	0.408	0.467	0.522	0.574	0.619	0.665	11461
Telford and MacColl	10%	86	98.5%	19	0.106	0.216	0.343	0.403	0.462	0.517	0.569	0.613	0.659	11527
Telford and MacColl	10%	86	99.0%	12	0.104	0.212	0.339	0.398	0.456	0.511	0.563	0.608	0.654	11593
Telford and MacColl	10%	86	99.5%	6	0.102	0.208	0.334	0.393	0.451	0.506	0.558	0.602	0.648	11660
Stevenson and Telford	10%	86	95.0%	43	0.116	0.231	0.363	0.423	0.484	0.539	0.591	0.636	0.681	11266
Stevenson and Telford	10%	86	98.0%	17	0.106	0.215	0.342	0.402	0.461	0.516	0.568	0.612	0.658	11540
Stevenson and Telford	10%	86	98.5%	13	0.104	0.212	0.339	0.398	0.457	0.512	0.564	0.608	0.654	11586
Stevenson and Telford	10%	86	99.0%	9	0.103	0.210	0.336	0.395	0.453	0.508	0.560	0.604	0.650	11633
Stevenson and Telford	10%	86	99.5%	4	0.101	0.207	0.332	0.391	0.449	0.504	0.556	0.600	0.646	11680
BOWL	10%	86	95.0%	79	0.132	0.254	0.391	0.454	0.515	0.570	0.623	0.668	0.711	10899
BOWL	10%	86	98.0%	32	0.112	0.224	0.354	0.414	0.474	0.529	0.581	0.626	0.671	11384
BOWL	10%	86	98.5%	24	0.108	0.219	0.348	0.407	0.467	0.522	0.574	0.618	0.664	11469
BOWL	10%	86	99.0%	16	0.105	0.214	0.341	0.401	0.460	0.515	0.567	0.611	0.657	11554
BOWL	10%	86	99.5%	8	0.102	0.209	0.335	0.394	0.453	0.507	0.559	0.603	0.650	11640
BOWL and MORL	10%	86	95.0%	151	0.169	0.307	0.452	0.515	0.578	0.632	0.683	0.727	0.767	10194
BOWL and MORL	10%	86	98.0%	60	0.123	0.242	0.376	0.438	0.499	0.554	0.606	0.652	0.696	11088
BOWL and MORL	10%	86	98.5%	45	0.117	0.232	0.364	0.425	0.485	0.541	0.593	0.638	0.683	11244
BOWL and MORL	10%	86	99.0%	30	0.111	0.223	0.352	0.412	0.472	0.527	0.579	0.624	0.670	11403
BOWL and MORL	10%	86	99.5%	15	0.105	0.213	0.341	0.400	0.459	0.514	0.566	0.610	0.656	11563

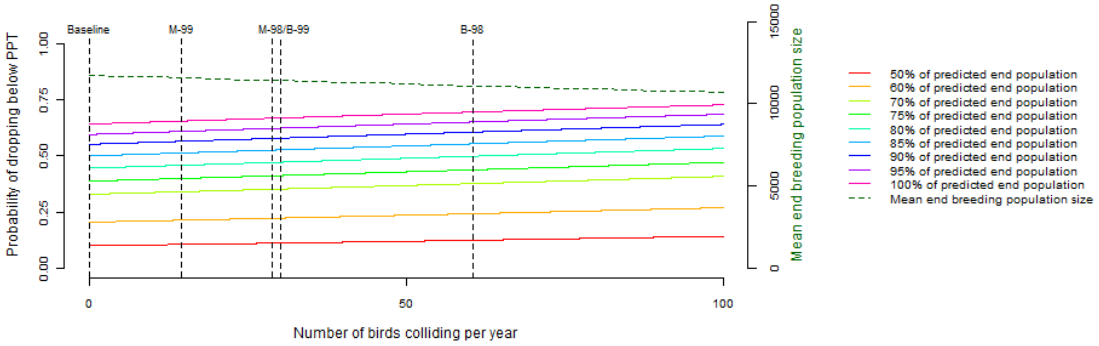


Figure G.3. Probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

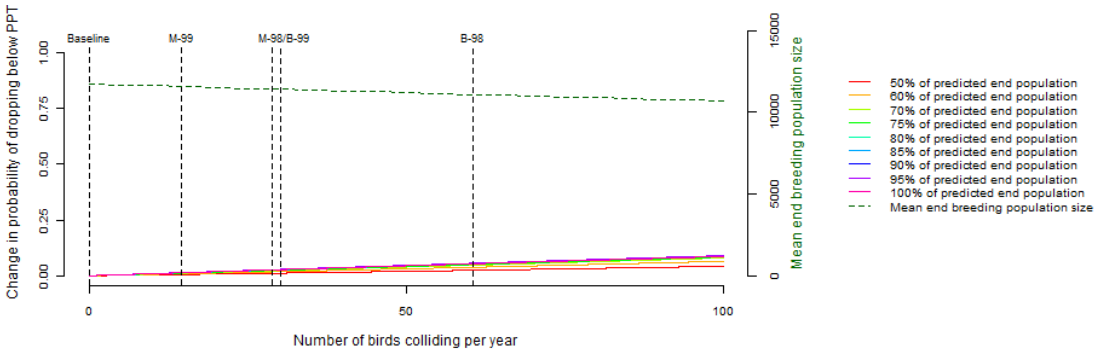


Figure G.4. Change in probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

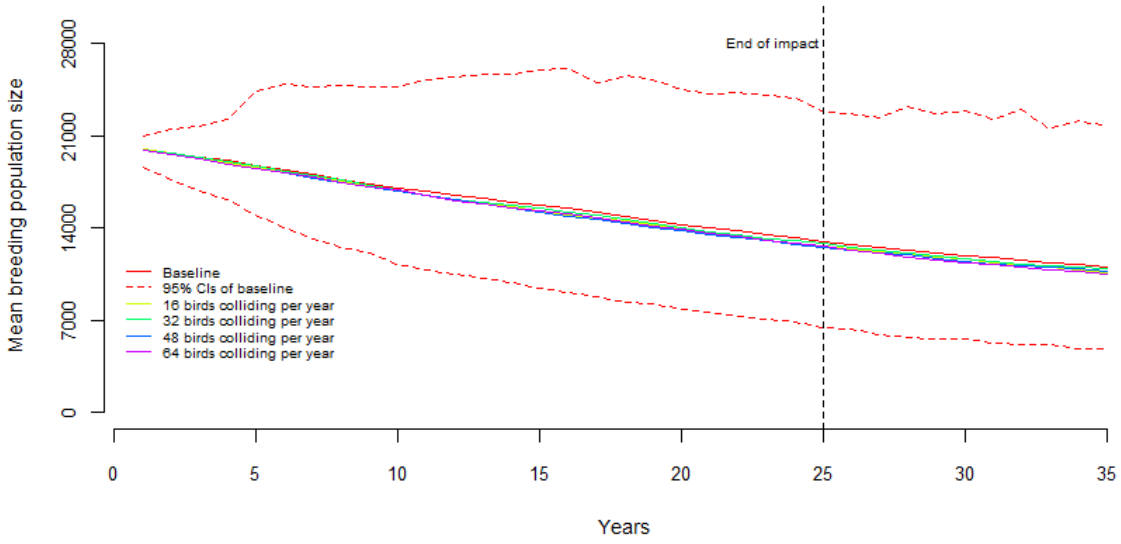


Figure G.5. Population projections for the kittiwake population at North Caithness Cliffs at different levels of collision with a high level of displacement.

Table G.3. Modelled probabilities of dropping below current population size for the kittiwake population at North Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.398	0.630	0.819	0.879	0.926	0.954	0.972	0.988	0.995	13142
Whole site	50%	485	95.0%	72	0.471	0.701	0.863	0.913	0.948	0.969	0.982	0.992	0.997	12299
Whole site	50%	485	98.0%	29	0.427	0.659	0.838	0.894	0.936	0.961	0.977	0.990	0.996	12798
Whole site	50%	485	98.5%	22	0.420	0.652	0.833	0.890	0.933	0.959	0.976	0.989	0.995	12883
Whole site	50%	485	99.0%	14	0.412	0.645	0.829	0.886	0.931	0.957	0.975	0.989	0.995	12969
Whole site	50%	485	99.5%	7	0.405	0.638	0.824	0.883	0.928	0.956	0.973	0.988	0.995	13055
Sum of MacColl, Telford & Stevenson	50%	485	95.0%	87	0.486	0.715	0.871	0.918	0.952	0.972	0.984	0.993	0.997	12133
Sum of MacColl, Telford & Stevenson	50%	485	98.0%	35	0.433	0.665	0.841	0.896	0.938	0.962	0.978	0.990	0.996	12729
Sum of MacColl, Telford & Stevenson	50%	485	98.5%	26	0.424	0.657	0.836	0.892	0.935	0.960	0.976	0.990	0.995	12831
Sum of MacColl, Telford & Stevenson	50%	485	99.0%	17	0.415	0.648	0.831	0.888	0.932	0.958	0.975	0.989	0.995	12934
Sum of MacColl, Telford & Stevenson	50%	485	99.5%	9	0.407	0.639	0.825	0.883	0.929	0.956	0.974	0.988	0.995	13038
MacColl	50%	485	95.0%	44	0.442	0.674	0.847	0.901	0.940	0.964	0.979	0.991	0.996	12625
MacColl	50%	485	98.0%	18	0.415	0.648	0.831	0.888	0.932	0.958	0.975	0.989	0.995	12933
MacColl	50%	485	98.5%	13	0.411	0.644	0.828	0.886	0.930	0.957	0.974	0.989	0.995	12985
MacColl	50%	485	99.0%	9	0.407	0.639	0.825	0.884	0.929	0.956	0.974	0.988	0.995	13037
MacColl	50%	485	99.5%	4	0.402	0.635	0.822	0.881	0.927	0.955	0.973	0.988	0.995	13090
Stevenson	50%	485	95.0%	25	0.423	0.656	0.836	0.892	0.934	0.960	0.976	0.990	0.995	12841
Stevenson	50%	485	98.0%	10	0.408	0.640	0.826	0.884	0.929	0.956	0.974	0.989	0.995	13021
Stevenson	50%	485	98.5%	8	0.406	0.638	0.824	0.883	0.928	0.956	0.973	0.988	0.995	13051
Stevenson	50%	485	99.0%	5	0.403	0.635	0.822	0.882	0.928	0.955	0.973	0.988	0.995	13081
Stevenson	50%	485	99.5%	3	0.401	0.633	0.821	0.880	0.927	0.955	0.972	0.988	0.995	13112
Telford	50%	485	95.0%	18	0.416	0.649	0.831	0.888	0.932	0.958	0.975	0.989	0.995	12927
Telford	50%	485	98.0%	7	0.405	0.637	0.824	0.883	0.928	0.956	0.973	0.988	0.995	13056
Telford	50%	485	98.5%	5	0.403	0.636	0.823	0.882	0.928	0.955	0.973	0.988	0.995	13077
Telford	50%	485	99.0%	4	0.402	0.634	0.822	0.881	0.927	0.955	0.973	0.988	0.995	13099
Telford	50%	485	99.5%	2	0.400	0.632	0.820	0.880	0.926	0.954	0.972	0.988	0.995	13121
MacColl and Stevenson	50%	485	95.0%	69	0.468	0.698	0.861	0.911	0.947	0.969	0.982	0.992	0.996	12335
MacColl and Stevenson	50%	485	98.0%	28	0.426	0.658	0.837	0.893	0.935	0.960	0.977	0.990	0.995	12813
MacColl and Stevenson	50%	485	98.5%	21	0.419	0.651	0.833	0.890	0.933	0.959	0.976	0.989	0.995	12895
MacColl and Stevenson	50%	485	99.0%	14	0.412	0.644	0.828	0.886	0.931	0.957	0.974	0.989	0.995	12977
MacColl and Stevenson	50%	485	99.5%	7	0.405	0.637	0.824	0.883	0.928	0.956	0.973	0.988	0.995	13059
Telford and MacColl	50%	485	95.0%	62	0.460	0.691	0.857	0.908	0.945	0.967	0.981	0.992	0.996	12418
Telford and MacColl	50%	485	98.0%	25	0.423	0.655	0.835	0.892	0.934	0.960	0.976	0.990	0.995	12848
Telford and MacColl	50%	485	98.5%	19	0.417	0.649	0.831	0.888	0.932	0.958	0.975	0.989	0.995	12921
Telford and MacColl	50%	485	99.0%	12	0.410	0.643	0.827	0.885	0.930	0.957	0.974	0.989	0.995	12994
Telford and MacColl	50%	485	99.5%	6	0.404	0.636	0.823	0.882	0.928	0.955	0.973	0.988	0.995	13068
Stevenson and Telford	50%	485	95.0%	43	0.442	0.674	0.847	0.900	0.940	0.964	0.979	0.991	0.996	12630
Stevenson and Telford	50%	485	98.0%	17	0.415	0.648	0.831	0.888	0.932	0.958	0.975	0.989	0.995	12935
Stevenson and Telford	50%	485	98.5%	13	0.411	0.643	0.828	0.886	0.930	0.957	0.974	0.989	0.995	12987
Stevenson and Telford	50%	485	99.0%	9	0.407	0.639	0.825	0.883	0.929	0.956	0.974	0.988	0.995	13038
Stevenson and Telford	50%	485	99.5%	4	0.402	0.635	0.822	0.881	0.927	0.955	0.973	0.988	0.995	13090
BOWL	50%	485	95.0%	79	0.478	0.708	0.867	0.915	0.950	0.970	0.983	0.993	0.997	12223
BOWL	50%	485	98.0%	32	0.430	0.663	0.840	0.895	0.937	0.961	0.977	0.990	0.996	12762
BOWL	50%	485	98.5%	24	0.422	0.655	0.835	0.891	0.934	0.960	0.976	0.990	0.995	12856
BOWL	50%	485	99.0%	16	0.414	0.646	0.830	0.887	0.931	0.958	0.975	0.989	0.995	12951
BOWL	50%	485	99.5%	8	0.406	0.638	0.824	0.883	0.929	0.956	0.973	0.988	0.995	13046
BOWL and MORL	50%	485	95.0%	151	0.552	0.769	0.900	0.940	0.965	0.980	0.990	0.995	0.998	11439
BOWL and MORL	50%	485	98.0%	60	0.459	0.690	0.857	0.908	0.945	0.967	0.981	0.992	0.996	12432
BOWL and MORL	50%	485	98.5%	45	0.444	0.676	0.848	0.901	0.941	0.964	0.979	0.991	0.996	12606
BOWL and MORL	50%	485	99.0%	30	0.428	0.661	0.839	0.894	0.936	0.961	0.977	0.990	0.996	12782
BOWL and MORL	50%	485	99.5%	15	0.413	0.646	0.829	0.887	0.931	0.958	0.975	0.989	0.995	12961

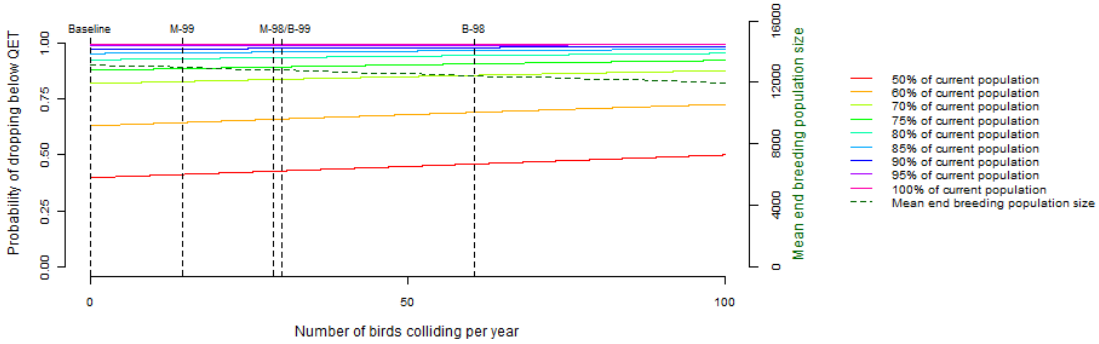


Figure G.6. Probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

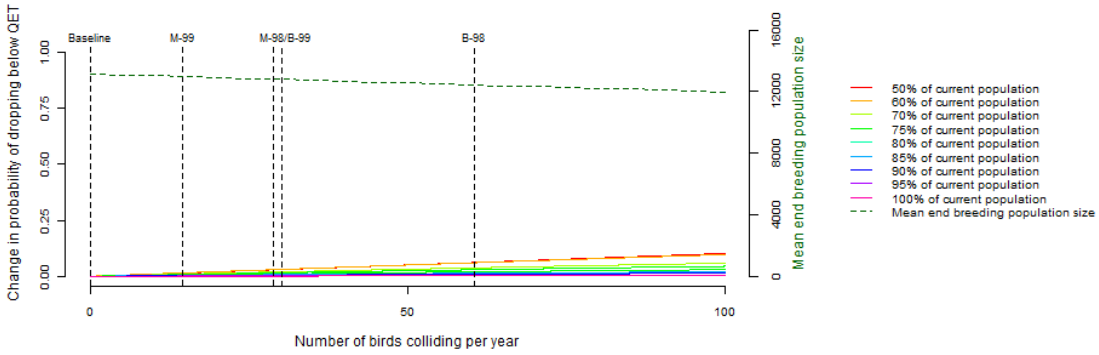


Figure G.7. Change in probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table G.4. Modelled probabilities of dropping below current population size for the kittiwake population at North Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.615	0.802	0.914	0.946	0.968	0.981	0.990	0.996	0.999	11117
Whole site	50%	485	95.0%	72	0.686	0.848	0.937	0.962	0.977	0.987	0.993	0.997	0.999	10424
Whole site	50%	485	98.0%	29	0.644	0.821	0.924	0.953	0.972	0.983	0.991	0.996	0.999	10834
Whole site	50%	485	98.5%	22	0.637	0.817	0.921	0.951	0.971	0.983	0.991	0.996	0.999	10904
Whole site	50%	485	99.0%	14	0.630	0.812	0.919	0.950	0.970	0.982	0.990	0.996	0.999	10975
Whole site	50%	485	99.5%	7	0.623	0.807	0.916	0.948	0.969	0.981	0.990	0.996	0.999	11045
Sum of MacColl, Telford & Stevenson	50%	485	95.0%	87	0.699	0.857	0.941	0.965	0.979	0.988	0.993	0.997	0.999	10287
Sum of MacColl, Telford & Stevenson	50%	485	98.0%	35	0.650	0.825	0.925	0.954	0.973	0.984	0.991	0.997	0.999	10777
Sum of MacColl, Telford & Stevenson	50%	485	98.5%	26	0.642	0.820	0.923	0.952	0.971	0.983	0.991	0.996	0.999	10861
Sum of MacColl, Telford & Stevenson	50%	485	99.0%	17	0.633	0.814	0.920	0.950	0.970	0.982	0.991	0.996	0.999	10946
Sum of MacColl, Telford & Stevenson	50%	485	99.5%	9	0.624	0.808	0.917	0.948	0.969	0.982	0.990	0.996	0.999	11031
MacColl	50%	485	95.0%	44	0.659	0.831	0.928	0.956	0.974	0.985	0.992	0.997	0.999	10692
MacColl	50%	485	98.0%	18	0.633	0.814	0.920	0.950	0.970	0.982	0.991	0.996	0.999	10945
MacColl	50%	485	98.5%	13	0.629	0.811	0.918	0.949	0.970	0.982	0.990	0.996	0.999	10987
MacColl	50%	485	99.0%	9	0.624	0.808	0.917	0.948	0.969	0.982	0.990	0.996	0.999	11030
MacColl	50%	485	99.5%	4	0.620	0.805	0.915	0.947	0.968	0.981	0.990	0.996	0.999	11073
Stevenson	50%	485	95.0%	25	0.641	0.819	0.922	0.952	0.971	0.983	0.991	0.996	0.999	10869
Stevenson	50%	485	98.0%	10	0.626	0.809	0.917	0.948	0.969	0.982	0.990	0.996	0.999	11017
Stevenson	50%	485	98.5%	8	0.623	0.807	0.916	0.948	0.969	0.981	0.990	0.996	0.999	11042
Stevenson	50%	485	99.0%	5	0.621	0.805	0.915	0.947	0.968	0.981	0.990	0.996	0.999	11067
Stevenson	50%	485	99.5%	3	0.618	0.803	0.914	0.947	0.968	0.981	0.990	0.996	0.999	11092
Telford	50%	485	95.0%	18	0.633	0.814	0.920	0.950	0.970	0.982	0.991	0.996	0.999	10940
Telford	50%	485	98.0%	7	0.623	0.807	0.916	0.948	0.969	0.981	0.990	0.996	0.999	11046
Telford	50%	485	98.5%	5	0.621	0.805	0.915	0.947	0.968	0.981	0.990	0.996	0.999	11063
Telford	50%	485	99.0%	4	0.619	0.804	0.915	0.947	0.968	0.981	0.990	0.996	0.999	11081
Telford	50%	485	99.5%	2	0.617	0.803	0.914	0.946	0.968	0.981	0.990	0.996	0.999	11099
MacColl and Stevenson	50%	485	95.0%	69	0.683	0.846	0.936	0.961	0.977	0.986	0.993	0.997	0.999	10454
MacColl and Stevenson	50%	485	98.0%	28	0.643	0.821	0.923	0.953	0.972	0.983	0.991	0.996	0.999	10847
MacColl and Stevenson	50%	485	98.5%	21	0.636	0.816	0.921	0.951	0.971	0.983	0.991	0.996	0.999	10913
MacColl and Stevenson	50%	485	99.0%	14	0.629	0.811	0.918	0.949	0.970	0.982	0.990	0.996	0.999	10981
MacColl and Stevenson	50%	485	99.5%	7	0.622	0.806	0.916	0.948	0.969	0.981	0.990	0.996	0.999	11049
Telford and MacColl	50%	485	95.0%	62	0.676	0.842	0.934	0.960	0.976	0.986	0.993	0.997	0.999	10522
Telford and MacColl	50%	485	98.0%	25	0.640	0.819	0.922	0.952	0.971	0.983	0.991	0.996	0.999	10875
Telford and MacColl	50%	485	98.5%	19	0.634	0.814	0.920	0.951	0.970	0.982	0.991	0.996	0.999	10935
Telford and MacColl	50%	485	99.0%	12	0.628	0.810	0.918	0.949	0.969	0.982	0.990	0.996	0.999	10995
Telford and MacColl	50%	485	99.5%	6	0.622	0.806	0.916	0.948	0.969	0.981	0.990	0.996	0.999	11056
Stevenson and Telford	50%	485	95.0%	43	0.658	0.831	0.928	0.956	0.974	0.985	0.992	0.997	0.999	10696
Stevenson and Telford	50%	485	98.0%	17	0.633	0.814	0.920	0.950	0.970	0.982	0.991	0.996	0.999	10947
Stevenson and Telford	50%	485	98.5%	13	0.628	0.811	0.918	0.949	0.970	0.982	0.990	0.996	0.999	10989
Stevenson and Telford	50%	485	99.0%	9	0.624	0.808	0.917	0.948	0.969	0.982	0.990	0.996	0.999	11031
Stevenson and Telford	50%	485	99.5%	4	0.620	0.805	0.915	0.947	0.968	0.981	0.990	0.996	0.999	11074
BOWL	50%	485	95.0%	79	0.692	0.852	0.938	0.963	0.978	0.987	0.993	0.997	0.999	10361
BOWL	50%	485	98.0%	32	0.647	0.823	0.925	0.954	0.972	0.984	0.991	0.997	0.999	10804
BOWL	50%	485	98.5%	24	0.639	0.818	0.922	0.952	0.971	0.983	0.991	0.996	0.999	10882
BOWL	50%	485	99.0%	16	0.631	0.813	0.919	0.950	0.970	0.982	0.990	0.996	0.999	10959
BOWL	50%	485	99.5%	8	0.623	0.807	0.916	0.948	0.969	0.982	0.990	0.996	0.999	11038
BOWL and MORL	50%	485	95.0%	151	0.754	0.888	0.955	0.974	0.984	0.991	0.995	0.998	0.999	9716
BOWL and MORL	50%	485	98.0%	60	0.675	0.841	0.933	0.960	0.976	0.986	0.992	0.997	0.999	10534
BOWL and MORL	50%	485	98.5%	45	0.660	0.832	0.929	0.957	0.974	0.985	0.992	0.997	0.999	10676
BOWL and MORL	50%	485	99.0%	30	0.646	0.822	0.924	0.953	0.972	0.984	0.991	0.997	0.999	10821
BOWL and MORL	50%	485	99.5%	15	0.631	0.812	0.919	0.950	0.970	0.982	0.990	0.996	0.999	10968

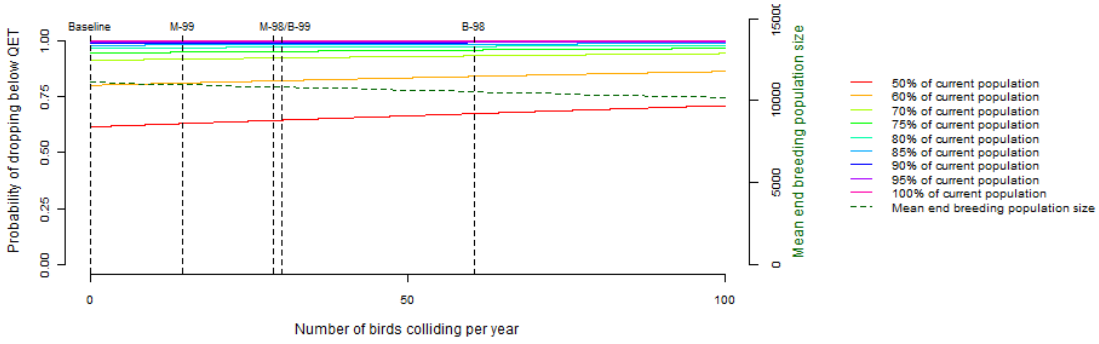


Figure G.8. Probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

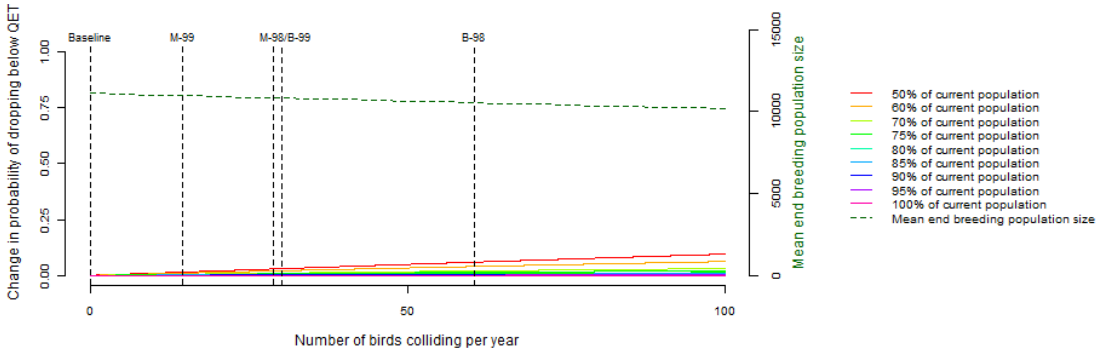


Figure G.9. Change in probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table G.5. Modelled probabilities of dropping below baseline predicted population size for the kittiwake population at North Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.030	0.084	0.175	0.231	0.293	0.358	0.421	0.482	0.536	13142
Whole site	50%	485	95.0%	72	0.043	0.115	0.227	0.290	0.360	0.429	0.494	0.555	0.611	12299
Whole site	50%	485	98.0%	29	0.035	0.095	0.195	0.253	0.319	0.386	0.450	0.511	0.566	12798
Whole site	50%	485	98.5%	22	0.033	0.092	0.190	0.248	0.312	0.379	0.443	0.504	0.559	12883
Whole site	50%	485	99.0%	14	0.032	0.089	0.185	0.242	0.306	0.372	0.435	0.496	0.551	12969
Whole site	50%	485	99.5%	7	0.031	0.087	0.180	0.236	0.299	0.365	0.428	0.489	0.544	13055
Sum of MacColl, Telford & Stevenson	50%	485	95.0%	87	0.047	0.122	0.238	0.303	0.374	0.443	0.509	0.570	0.626	12133
Sum of MacColl, Telford & Stevenson	50%	485	98.0%	35	0.036	0.098	0.199	0.258	0.324	0.392	0.456	0.517	0.573	12729
Sum of MacColl, Telford & Stevenson	50%	485	98.5%	26	0.034	0.094	0.193	0.251	0.316	0.383	0.447	0.508	0.563	12831
Sum of MacColl, Telford & Stevenson	50%	485	99.0%	17	0.033	0.091	0.187	0.244	0.308	0.375	0.438	0.499	0.554	12934
Sum of MacColl, Telford & Stevenson	50%	485	99.5%	9	0.031	0.087	0.181	0.237	0.301	0.366	0.430	0.490	0.545	13038
MacColl	50%	485	95.0%	44	0.037	0.102	0.205	0.266	0.332	0.400	0.465	0.526	0.582	12625
MacColl	50%	485	98.0%	18	0.033	0.091	0.187	0.244	0.308	0.375	0.438	0.499	0.554	12933
MacColl	50%	485	98.5%	13	0.032	0.089	0.184	0.241	0.305	0.371	0.434	0.495	0.550	12985
MacColl	50%	485	99.0%	9	0.031	0.087	0.181	0.237	0.301	0.366	0.430	0.491	0.545	13037
MacColl	50%	485	99.5%	4	0.030	0.086	0.178	0.234	0.297	0.362	0.425	0.486	0.541	13090
Stevenson	50%	485	95.0%	25	0.034	0.094	0.192	0.250	0.315	0.382	0.446	0.507	0.563	12841
Stevenson	50%	485	98.0%	10	0.031	0.088	0.182	0.238	0.302	0.368	0.431	0.492	0.547	13021
Stevenson	50%	485	98.5%	8	0.031	0.087	0.180	0.236	0.300	0.365	0.429	0.489	0.544	13051
Stevenson	50%	485	99.0%	5	0.031	0.086	0.179	0.234	0.297	0.363	0.426	0.487	0.541	13081
Stevenson	50%	485	99.5%	3	0.030	0.085	0.177	0.233	0.295	0.361	0.424	0.484	0.539	13112
Telford	50%	485	95.0%	18	0.033	0.091	0.187	0.245	0.309	0.375	0.439	0.500	0.555	12927
Telford	50%	485	98.0%	7	0.031	0.087	0.180	0.236	0.299	0.365	0.428	0.489	0.544	13056
Telford	50%	485	98.5%	5	0.031	0.086	0.179	0.235	0.298	0.363	0.426	0.487	0.542	13077
Telford	50%	485	99.0%	4	0.030	0.085	0.178	0.233	0.296	0.362	0.425	0.485	0.540	13099
Telford	50%	485	99.5%	2	0.030	0.085	0.176	0.232	0.295	0.360	0.423	0.483	0.538	13121
MacColl and Stevenson	50%	485	95.0%	69	0.043	0.113	0.224	0.287	0.357	0.425	0.490	0.552	0.608	12335
MacColl and Stevenson	50%	485	98.0%	28	0.034	0.095	0.194	0.252	0.318	0.385	0.449	0.510	0.565	12813
MacColl and Stevenson	50%	485	98.5%	21	0.033	0.092	0.189	0.247	0.311	0.378	0.442	0.503	0.558	12895
MacColl and Stevenson	50%	485	99.0%	14	0.032	0.089	0.184	0.241	0.305	0.371	0.435	0.496	0.551	12977
MacColl and Stevenson	50%	485	99.5%	7	0.031	0.087	0.180	0.236	0.299	0.365	0.428	0.489	0.543	13059
Telford and MacColl	50%	485	95.0%	62	0.041	0.110	0.219	0.281	0.350	0.418	0.483	0.545	0.601	12418
Telford and MacColl	50%	485	98.0%	25	0.034	0.094	0.192	0.250	0.315	0.382	0.446	0.507	0.562	12848
Telford and MacColl	50%	485	98.5%	19	0.033	0.091	0.188	0.245	0.309	0.376	0.439	0.501	0.555	12921
Telford and MacColl	50%	485	99.0%	12	0.032	0.089	0.183	0.240	0.304	0.370	0.433	0.494	0.549	12994
Telford and MacColl	50%	485	99.5%	6	0.031	0.086	0.179	0.235	0.298	0.364	0.427	0.488	0.542	13068
Stevenson and Telford	50%	485	95.0%	43	0.037	0.101	0.205	0.265	0.332	0.400	0.464	0.526	0.581	12630
Stevenson and Telford	50%	485	98.0%	17	0.033	0.091	0.187	0.244	0.308	0.375	0.438	0.499	0.554	12935
Stevenson and Telford	50%	485	98.5%	13	0.032	0.089	0.184	0.241	0.304	0.371	0.434	0.495	0.550	12987
Stevenson and Telford	50%	485	99.0%	9	0.031	0.087	0.181	0.237	0.301	0.366	0.430	0.490	0.545	13038
Stevenson and Telford	50%	485	99.5%	4	0.030	0.086	0.178	0.234	0.297	0.362	0.425	0.486	0.540	13090
BOWL	50%	485	95.0%	79	0.045	0.118	0.232	0.296	0.366	0.435	0.501	0.562	0.618	12223
BOWL	50%	485	98.0%	32	0.035	0.097	0.197	0.256	0.322	0.389	0.453	0.514	0.570	12762
BOWL	50%	485	98.5%	24	0.034	0.093	0.191	0.249	0.314	0.381	0.445	0.506	0.561	12856
BOWL	50%	485	99.0%	16	0.032	0.090	0.186	0.243	0.307	0.373	0.437	0.498	0.553	12951
BOWL	50%	485	99.5%	8	0.031	0.087	0.181	0.237	0.300	0.366	0.429	0.490	0.544	13046
BOWL and MORL	50%	485	95.0%	151	0.065	0.159	0.294	0.365	0.439	0.509	0.573	0.633	0.688	11439
BOWL and MORL	50%	485	98.0%	60	0.041	0.109	0.218	0.280	0.348	0.417	0.482	0.543	0.599	12432
BOWL and MORL	50%	485	98.5%	45	0.038	0.102	0.206	0.267	0.334	0.402	0.466	0.528	0.584	12606
BOWL and MORL	50%	485	99.0%	30	0.035	0.096	0.196	0.254	0.320	0.387	0.451	0.512	0.568	12782
BOWL and MORL	50%	485	99.5%	15	0.032	0.090	0.185	0.242	0.306	0.373	0.436	0.497	0.552	12961

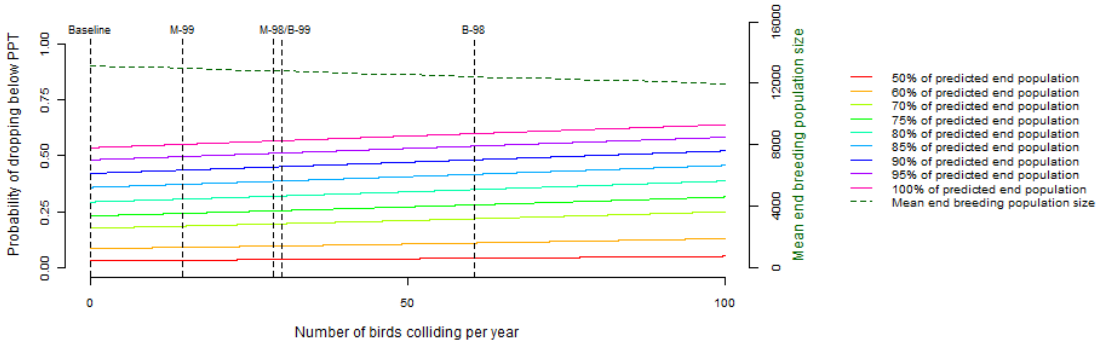


Figure G.10. Probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

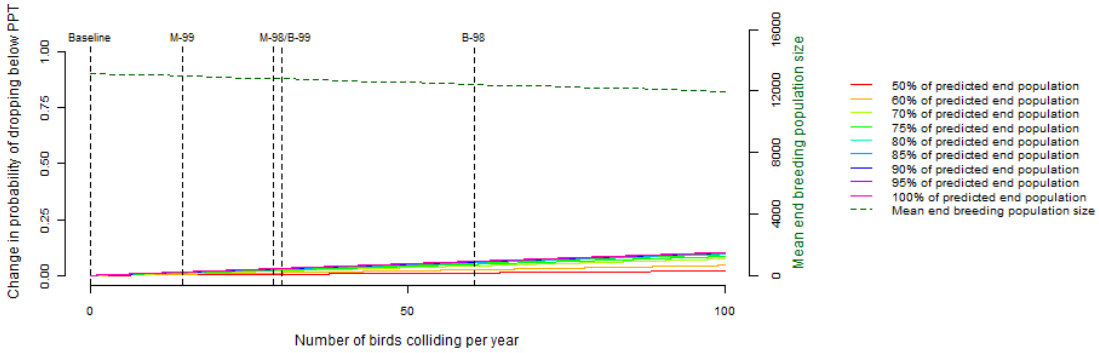


Figure G.11. Change in probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table G.6. Modelled probabilities of dropping below baseline predicted population size for the kittiwake population at North Caithness Cliffs with increasing collision rates incorporating high level displacement (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement	Displaced individuals	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
					50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	zero	0	NA	0	0.120	0.229	0.358	0.418	0.483	0.542	0.598	0.648	0.700	11117
Whole site	50%	485	95.0%	72	0.153	0.279	0.419	0.484	0.550	0.607	0.661	0.708	0.753	10424
Whole site	50%	485	98.0%	29	0.132	0.248	0.382	0.444	0.510	0.568	0.624	0.673	0.722	10834
Whole site	50%	485	98.5%	22	0.129	0.243	0.376	0.438	0.503	0.562	0.617	0.667	0.717	10904
Whole site	50%	485	99.0%	14	0.126	0.238	0.370	0.431	0.496	0.555	0.611	0.661	0.711	10975
Whole site	50%	485	99.5%	7	0.123	0.234	0.364	0.425	0.490	0.549	0.605	0.655	0.705	11045
Sum of MacColl, Telford & Stevenson	50%	485	95.0%	87	0.161	0.291	0.432	0.497	0.563	0.620	0.673	0.719	0.764	10287
Sum of MacColl, Telford & Stevenson	50%	485	98.0%	35	0.135	0.252	0.387	0.450	0.515	0.574	0.629	0.678	0.726	10777
Sum of MacColl, Telford & Stevenson	50%	485	98.5%	26	0.131	0.246	0.380	0.442	0.507	0.566	0.621	0.671	0.720	10861
Sum of MacColl, Telford & Stevenson	50%	485	99.0%	17	0.127	0.240	0.372	0.434	0.499	0.558	0.614	0.663	0.713	10946
Sum of MacColl, Telford & Stevenson	50%	485	99.5%	9	0.124	0.235	0.365	0.426	0.491	0.550	0.606	0.656	0.707	11031
MacColl	50%	485	95.0%	44	0.139	0.259	0.395	0.458	0.523	0.582	0.637	0.685	0.733	10692
MacColl	50%	485	98.0%	18	0.127	0.240	0.373	0.434	0.499	0.558	0.614	0.663	0.713	10945
MacColl	50%	485	98.5%	13	0.126	0.238	0.369	0.430	0.495	0.554	0.610	0.660	0.710	10987
MacColl	50%	485	99.0%	9	0.124	0.235	0.365	0.426	0.491	0.550	0.606	0.656	0.707	11030
MacColl	50%	485	99.5%	4	0.122	0.232	0.362	0.422	0.487	0.546	0.602	0.652	0.703	11073
Stevenson	50%	485	95.0%	25	0.131	0.246	0.379	0.441	0.506	0.565	0.621	0.670	0.719	10869
Stevenson	50%	485	98.0%	10	0.124	0.236	0.366	0.427	0.493	0.551	0.607	0.657	0.708	11017
Stevenson	50%	485	98.5%	8	0.123	0.234	0.364	0.425	0.490	0.549	0.605	0.655	0.706	11042
Stevenson	50%	485	99.0%	5	0.122	0.232	0.362	0.423	0.488	0.547	0.603	0.653	0.704	11067
Stevenson	50%	485	99.5%	3	0.121	0.230	0.360	0.421	0.486	0.544	0.600	0.651	0.702	11092
Telford	50%	485	95.0%	18	0.128	0.241	0.373	0.435	0.500	0.558	0.614	0.664	0.714	10940
Telford	50%	485	98.0%	7	0.123	0.234	0.364	0.425	0.490	0.549	0.605	0.655	0.705	11046
Telford	50%	485	98.5%	5	0.122	0.232	0.362	0.423	0.488	0.547	0.603	0.653	0.704	11063
Telford	50%	485	99.0%	4	0.122	0.231	0.361	0.422	0.487	0.545	0.601	0.651	0.703	11081
Telford	50%	485	99.5%	2	0.121	0.230	0.360	0.420	0.485	0.544	0.600	0.650	0.701	11099
MacColl and Stevenson	50%	485	95.0%	69	0.151	0.277	0.416	0.481	0.547	0.604	0.658	0.705	0.751	10454
MacColl and Stevenson	50%	485	98.0%	28	0.132	0.247	0.381	0.443	0.509	0.567	0.623	0.672	0.721	10847
MacColl and Stevenson	50%	485	98.5%	21	0.129	0.243	0.375	0.437	0.502	0.561	0.617	0.666	0.716	10913
MacColl and Stevenson	50%	485	99.0%	14	0.126	0.238	0.369	0.431	0.496	0.555	0.610	0.660	0.711	10981
MacColl and Stevenson	50%	485	99.5%	7	0.123	0.233	0.364	0.425	0.490	0.548	0.604	0.654	0.705	11049
Telford and MacColl	50%	485	95.0%	62	0.148	0.272	0.410	0.474	0.540	0.598	0.652	0.700	0.746	10522
Telford and MacColl	50%	485	98.0%	25	0.131	0.245	0.379	0.441	0.506	0.564	0.620	0.669	0.719	10875
Telford and MacColl	50%	485	98.5%	19	0.128	0.241	0.373	0.435	0.500	0.559	0.615	0.664	0.714	10935
Telford and MacColl	50%	485	99.0%	12	0.125	0.237	0.368	0.429	0.495	0.553	0.609	0.659	0.709	10995
Telford and MacColl	50%	485	99.5%	6	0.123	0.233	0.363	0.424	0.489	0.548	0.604	0.654	0.705	11056
Stevenson and Telford	50%	485	95.0%	43	0.139	0.258	0.394	0.457	0.523	0.581	0.636	0.685	0.733	10696
Stevenson and Telford	50%	485	98.0%	17	0.127	0.240	0.372	0.434	0.499	0.558	0.614	0.663	0.713	10947
Stevenson and Telford	50%	485	98.5%	13	0.126	0.237	0.369	0.430	0.495	0.554	0.610	0.659	0.710	10989
Stevenson and Telford	50%	485	99.0%	9	0.124	0.235	0.365	0.426	0.491	0.550	0.606	0.656	0.707	11031
Stevenson and Telford	50%	485	99.5%	4	0.122	0.232	0.362	0.422	0.487	0.546	0.602	0.652	0.703	11074
BOWL	50%	485	95.0%	79	0.156	0.285	0.425	0.490	0.556	0.613	0.666	0.713	0.758	10361
BOWL	50%	485	98.0%	32	0.134	0.250	0.385	0.447	0.513	0.571	0.626	0.675	0.724	10804
BOWL	50%	485	98.5%	24	0.130	0.245	0.378	0.440	0.505	0.564	0.619	0.669	0.718	10882
BOWL	50%	485	99.0%	16	0.127	0.239	0.371	0.433	0.498	0.557	0.612	0.662	0.712	10959
BOWL	50%	485	99.5%	8	0.123	0.234	0.365	0.426	0.491	0.549	0.605	0.655	0.706	11038
BOWL and MORL	50%	485	95.0%	151	0.197	0.342	0.489	0.556	0.620	0.673	0.723	0.766	0.804	9716
BOWL and MORL	50%	485	98.0%	60	0.147	0.271	0.409	0.473	0.539	0.596	0.651	0.699	0.745	10534
BOWL and MORL	50%	485	98.5%	45	0.140	0.260	0.396	0.459	0.525	0.583	0.638	0.686	0.734	10676
BOWL and MORL	50%	485	99.0%	30	0.133	0.249	0.383	0.446	0.511	0.569	0.625	0.674	0.723	10821
BOWL and MORL	50%	485	99.5%	15	0.126	0.239	0.371	0.432	0.497	0.556	0.612	0.661	0.712	10968

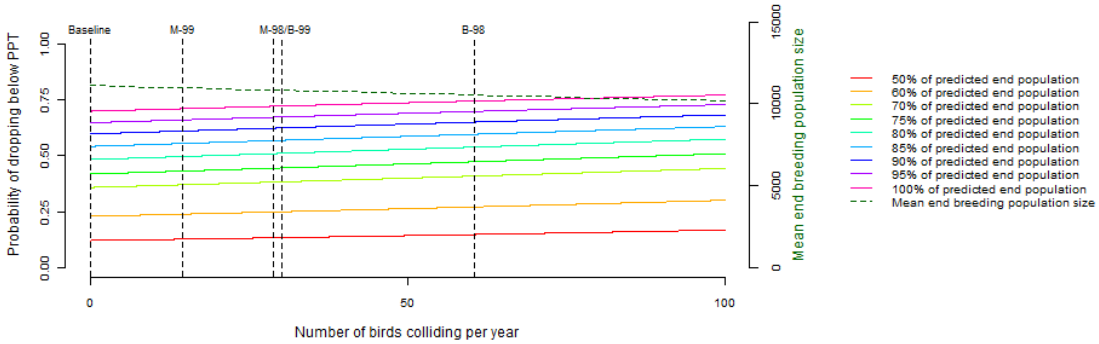


Figure G.12. Probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

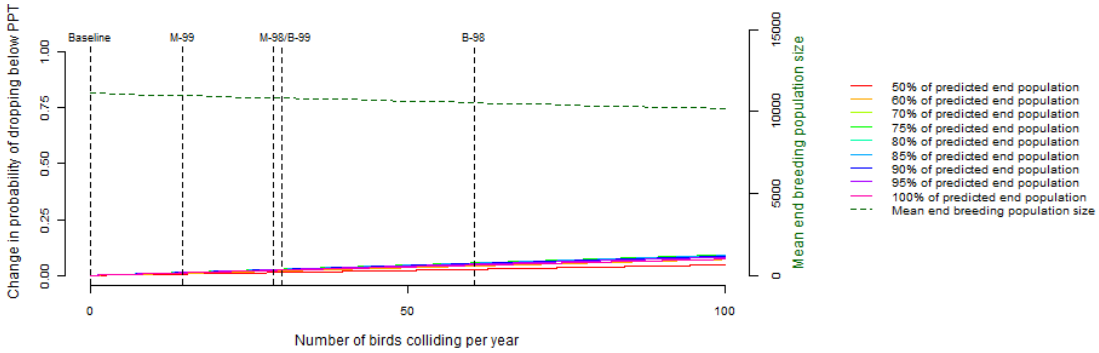


Figure G.13. Change in probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Displacement

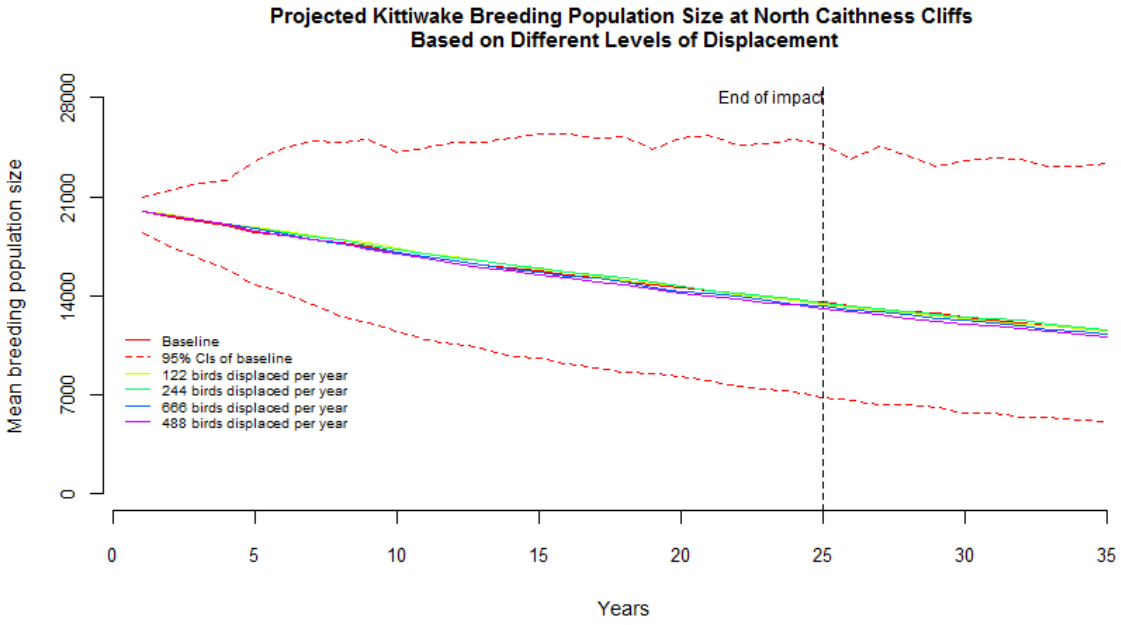


Figure G.14. Population projections for the kittiwake population at North Caithness Cliffs at different levels of displacement.

Table G.7. Modelled probabilities of dropping below current population size for the kittiwake population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development) (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.367	0.588	0.780	0.847	0.897	0.936	0.964	0.983	0.992	13666
Whole site	50%	429	0.392	0.629	0.805	0.869	0.916	0.950	0.973	0.987	0.995	13257
Whole site	10%	86	0.372	0.596	0.785	0.852	0.901	0.939	0.966	0.984	0.993	13583
Sum of MacColl, Telford & Stevenson	50%	429	0.392	0.629	0.805	0.869	0.916	0.950	0.973	0.987	0.995	13257
Sum of MacColl, Telford & Stevenson	10%	86	0.372	0.596	0.785	0.852	0.901	0.939	0.966	0.984	0.993	13583
MacColl	50%	216	0.380	0.609	0.793	0.858	0.907	0.943	0.969	0.986	0.994	13459
MacColl	10%	43	0.369	0.592	0.782	0.849	0.899	0.938	0.965	0.984	0.993	13624
Telford	50%	89	0.372	0.596	0.785	0.852	0.901	0.939	0.966	0.984	0.993	13580
Telford	10%	18	0.368	0.589	0.781	0.848	0.898	0.937	0.964	0.984	0.992	13648
Stevenson	50%	125	0.374	0.600	0.787	0.854	0.903	0.940	0.967	0.985	0.993	13546
Stevenson	10%	25	0.368	0.590	0.781	0.848	0.898	0.937	0.965	0.984	0.992	13642
MacColl and Stevenson	50%	340	0.387	0.620	0.800	0.865	0.913	0.947	0.971	0.987	0.995	13341
MacColl and Stevenson	10%	68	0.371	0.594	0.784	0.851	0.900	0.939	0.966	0.984	0.993	13600
Stevenson and Telford	50%	213	0.379	0.608	0.793	0.858	0.907	0.943	0.969	0.986	0.994	13461
Stevenson and Telford	10%	43	0.369	0.592	0.782	0.849	0.899	0.938	0.965	0.984	0.993	13624
Telford and MacColl	50%	304	0.385	0.617	0.798	0.863	0.911	0.946	0.971	0.986	0.994	13375
Telford and MacColl	10%	61	0.370	0.594	0.783	0.850	0.900	0.938	0.965	0.984	0.993	13607
BOWL	50%	56	0.370	0.593	0.783	0.850	0.900	0.938	0.965	0.984	0.993	13611
BOWL	10%	11	0.367	0.589	0.780	0.848	0.897	0.936	0.964	0.984	0.992	13655
BOWL and MORL	50%	485	0.396	0.634	0.809	0.871	0.919	0.952	0.974	0.988	0.995	13205
BOWL and MORL	10%	97	0.372	0.597	0.786	0.852	0.902	0.940	0.966	0.984	0.993	13572

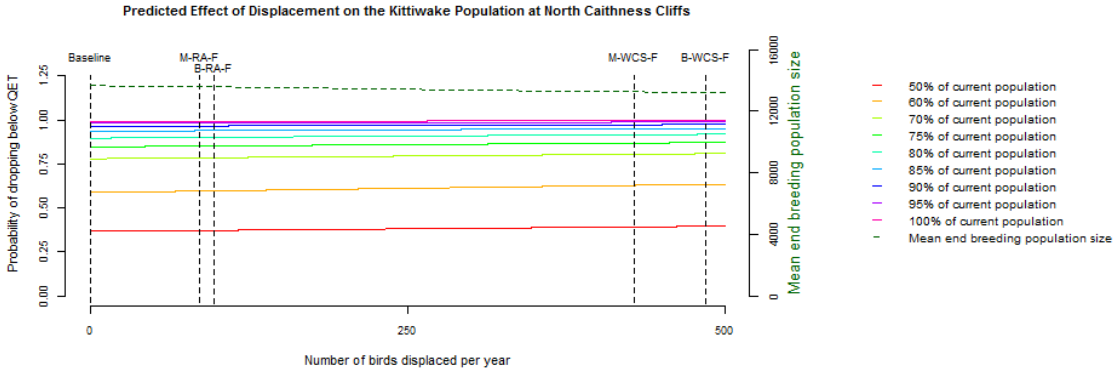


Figure G.15. Probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

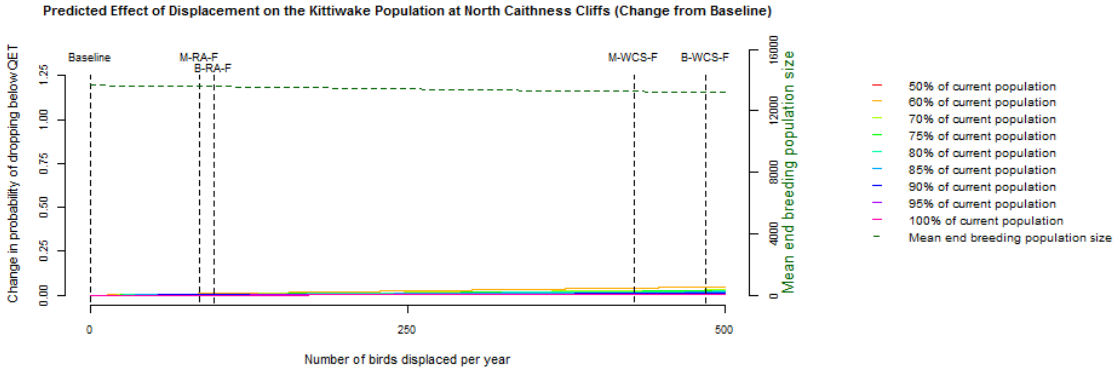


Figure G.16. Change in probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table G.8. Modelled probabilities of dropping below current population size for the kittiwake population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.583	0.764	0.880	0.917	0.945	0.965	0.979	0.991	0.997	11707
Whole site	50%	429	0.612	0.788	0.902	0.936	0.959	0.976	0.988	0.995	0.998	11302
Whole site	10%	86	0.589	0.769	0.884	0.921	0.948	0.967	0.981	0.992	0.997	11624
Sum of MacColl, Telford & Stevenson	50%	429	0.612	0.788	0.902	0.936	0.959	0.976	0.988	0.995	0.998	11302
Sum of MacColl, Telford & Stevenson	10%	86	0.589	0.769	0.884	0.921	0.948	0.967	0.981	0.992	0.997	11624
MacColl	50%	216	0.597	0.777	0.891	0.927	0.953	0.971	0.984	0.993	0.997	11501
MacColl	10%	43	0.586	0.767	0.882	0.919	0.947	0.966	0.980	0.992	0.997	11665
Telford	50%	89	0.589	0.769	0.884	0.921	0.948	0.968	0.981	0.992	0.997	11622
Telford	10%	18	0.584	0.765	0.881	0.918	0.946	0.965	0.980	0.991	0.997	11690
Stevenson	50%	125	0.591	0.771	0.886	0.923	0.950	0.969	0.982	0.992	0.997	11588
Stevenson	10%	25	0.585	0.766	0.881	0.918	0.946	0.966	0.980	0.991	0.997	11683
MacColl and Stevenson	50%	340	0.606	0.783	0.897	0.932	0.957	0.974	0.987	0.994	0.997	11384
MacColl and Stevenson	10%	68	0.587	0.768	0.883	0.920	0.947	0.967	0.981	0.992	0.997	11641
Stevenson and Telford	50%	213	0.597	0.776	0.891	0.927	0.953	0.971	0.984	0.993	0.997	11503
Stevenson and Telford	10%	43	0.586	0.767	0.882	0.919	0.946	0.966	0.980	0.992	0.997	11666
Telford and MacColl	50%	304	0.603	0.781	0.896	0.931	0.956	0.973	0.986	0.994	0.997	11418
Telford and MacColl	10%	61	0.587	0.768	0.883	0.920	0.947	0.967	0.981	0.992	0.997	11648
BOWL	50%	56	0.587	0.768	0.883	0.920	0.947	0.967	0.981	0.992	0.997	11653
BOWL	10%	11	0.584	0.765	0.880	0.917	0.945	0.965	0.979	0.991	0.997	11696
BOWL and MORL	50%	485	0.615	0.791	0.904	0.938	0.961	0.978	0.989	0.995	0.998	11250
BOWL and MORL	10%	97	0.589	0.770	0.885	0.922	0.949	0.968	0.982	0.992	0.997	11614

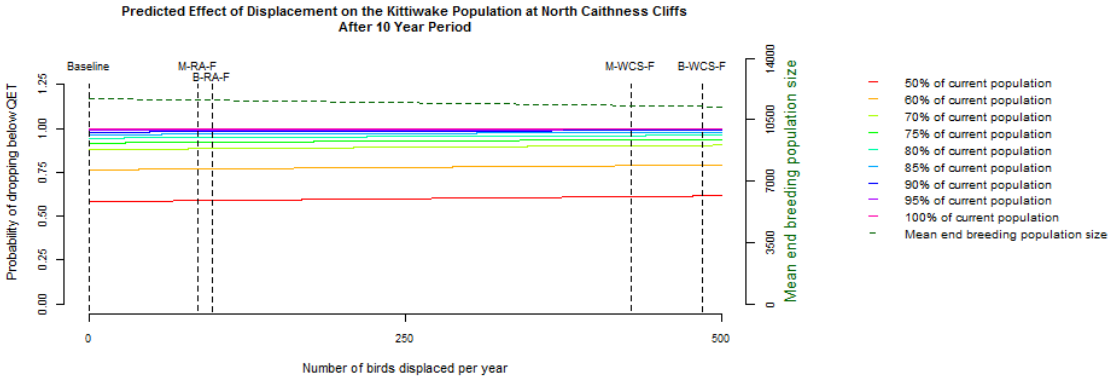


Figure G.17. Probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

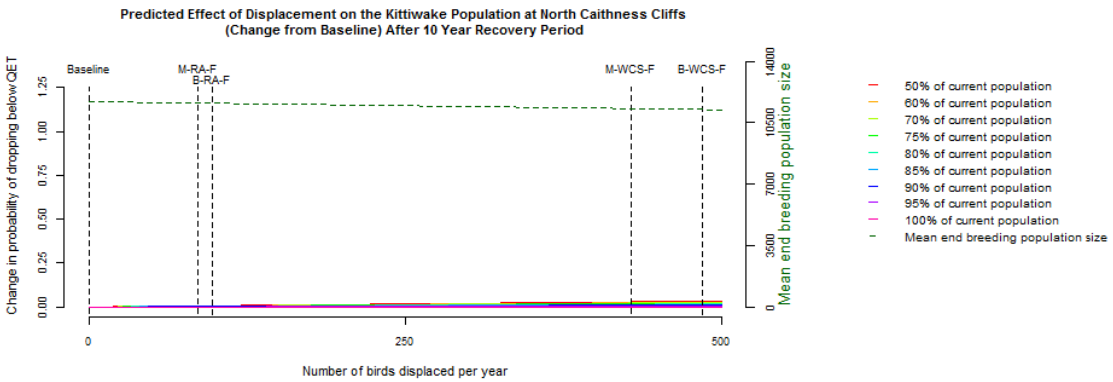


Figure G.18. Change in probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table G.9. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the kittiwake population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.020	0.068	0.146	0.199	0.256	0.313	0.372	0.429	0.482	13666
Whole site	50%	429	0.023	0.077	0.168	0.222	0.283	0.345	0.407	0.465	0.525	13257
Whole site	10%	86	0.021	0.070	0.150	0.204	0.261	0.319	0.379	0.436	0.491	13583
Sum of MacColl, Telford & Stevenson	50%	429	0.023	0.077	0.168	0.222	0.283	0.345	0.407	0.465	0.525	13257
Sum of MacColl, Telford & Stevenson	10%	86	0.021	0.070	0.150	0.204	0.261	0.319	0.379	0.436	0.491	13583
MacColl	50%	216	0.022	0.072	0.157	0.210	0.269	0.329	0.389	0.447	0.504	13459
MacColl	10%	43	0.021	0.069	0.148	0.201	0.259	0.316	0.376	0.433	0.487	13624
Telford	50%	89	0.021	0.070	0.150	0.204	0.262	0.319	0.379	0.437	0.491	13580
Telford	10%	18	0.020	0.068	0.147	0.200	0.257	0.314	0.374	0.431	0.484	13648
Stevenson	50%	125	0.021	0.071	0.152	0.206	0.264	0.322	0.382	0.440	0.495	13546
Stevenson	10%	25	0.020	0.069	0.147	0.200	0.258	0.315	0.374	0.431	0.485	13642
MacColl and Stevenson	50%	340	0.023	0.075	0.163	0.217	0.277	0.338	0.399	0.458	0.516	13341
MacColl and Stevenson	10%	68	0.021	0.069	0.149	0.203	0.260	0.318	0.378	0.435	0.489	13600
Stevenson and Telford	50%	213	0.022	0.072	0.156	0.210	0.269	0.329	0.389	0.447	0.504	13461
Stevenson and Telford	10%	43	0.021	0.069	0.148	0.201	0.259	0.316	0.376	0.433	0.487	13624
Telford and MacColl	50%	304	0.022	0.074	0.161	0.215	0.275	0.335	0.397	0.455	0.513	13375
Telford and MacColl	10%	61	0.021	0.069	0.149	0.202	0.260	0.317	0.377	0.434	0.488	13607
BOWL	50%	56	0.021	0.069	0.148	0.202	0.260	0.317	0.377	0.434	0.488	13611
BOWL	10%	11	0.020	0.068	0.146	0.200	0.257	0.314	0.373	0.430	0.484	13655
BOWL and MORL	50%	485	0.024	0.078	0.171	0.225	0.287	0.349	0.411	0.470	0.531	13205
BOWL and MORL	10%	97	0.021	0.070	0.150	0.204	0.262	0.320	0.380	0.437	0.492	13572

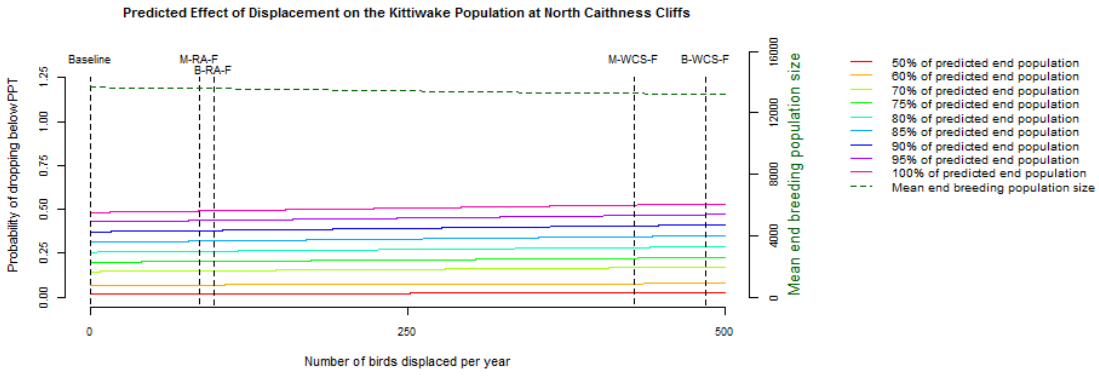


Figure G.19. Probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

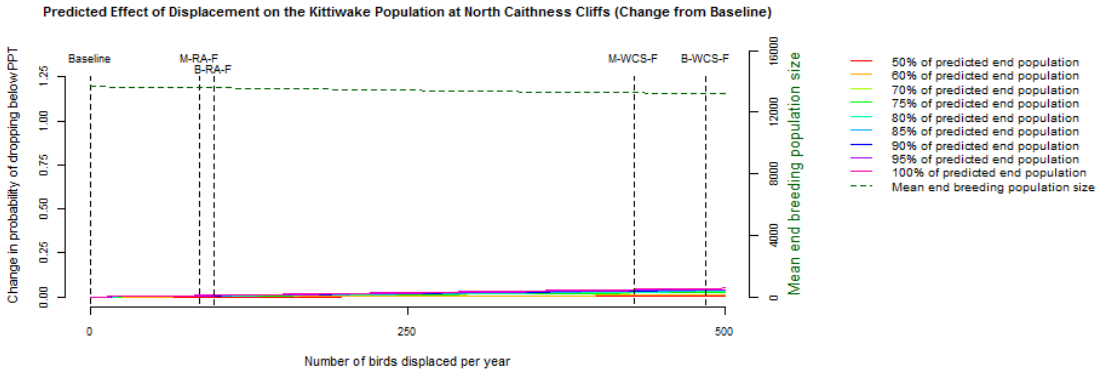


Figure G.20. Change in probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table G.10. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the kittiwake population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0.106	0.206	0.321	0.382	0.448	0.508	0.561	0.611	0.659	11707
Whole site	50%	429	0.114	0.219	0.351	0.415	0.477	0.535	0.587	0.640	0.689	11302
Whole site	10%	86	0.108	0.208	0.327	0.388	0.454	0.513	0.566	0.617	0.665	11624
Sum of MacColl, Telford & Stevenson	50%	429	0.114	0.219	0.351	0.415	0.477	0.535	0.587	0.640	0.689	11302
Sum of MacColl, Telford & Stevenson	10%	86	0.108	0.208	0.327	0.388	0.454	0.513	0.566	0.617	0.665	11624
MacColl	50%	216	0.110	0.212	0.336	0.398	0.462	0.522	0.574	0.626	0.674	11501
MacColl	10%	43	0.107	0.207	0.324	0.385	0.451	0.511	0.564	0.614	0.662	11665
Telford	50%	89	0.108	0.208	0.327	0.388	0.454	0.514	0.566	0.617	0.665	11622
Telford	10%	18	0.106	0.206	0.323	0.383	0.449	0.509	0.562	0.613	0.660	11690
Stevenson	50%	125	0.108	0.209	0.330	0.391	0.456	0.516	0.568	0.620	0.668	11588
Stevenson	10%	25	0.107	0.206	0.323	0.384	0.450	0.510	0.562	0.613	0.661	11683
MacColl and Stevenson	50%	340	0.112	0.216	0.344	0.408	0.471	0.530	0.581	0.634	0.683	11384
MacColl and Stevenson	10%	68	0.107	0.208	0.326	0.387	0.452	0.512	0.565	0.616	0.664	11641
Stevenson and Telford	50%	213	0.110	0.212	0.336	0.398	0.462	0.521	0.574	0.626	0.674	11503
Stevenson and Telford	10%	43	0.107	0.207	0.324	0.385	0.451	0.511	0.564	0.614	0.662	11666
Telford and MacColl	50%	304	0.111	0.215	0.342	0.405	0.468	0.527	0.579	0.632	0.681	11418
Telford and MacColl	10%	61	0.107	0.207	0.326	0.386	0.452	0.512	0.565	0.615	0.663	11648
BOWL	50%	56	0.107	0.207	0.325	0.386	0.452	0.512	0.564	0.615	0.663	11653
BOWL	10%	11	0.106	0.206	0.322	0.383	0.449	0.509	0.562	0.612	0.660	11696
BOWL and MORL	50%	485	0.115	0.220	0.354	0.419	0.481	0.539	0.590	0.643	0.693	11250
BOWL and MORL	10%	97	0.108	0.209	0.328	0.389	0.454	0.514	0.567	0.618	0.666	11614

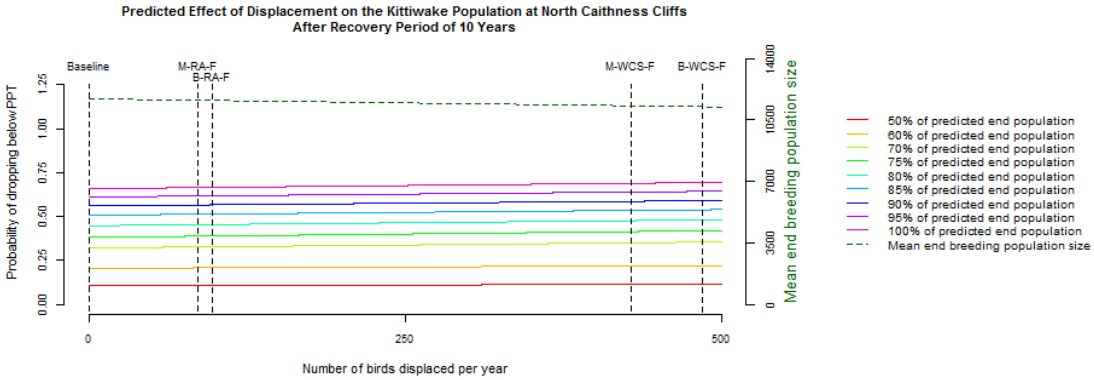


Figure G.21. Probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

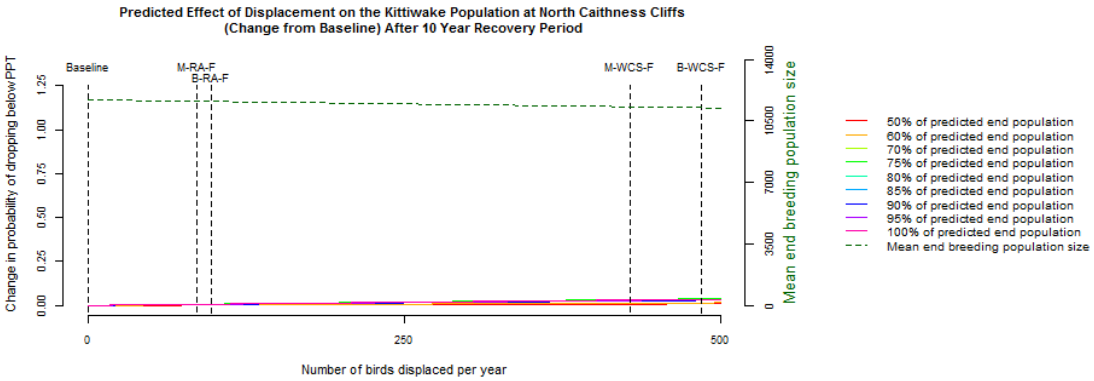


Figure G.22. Change in probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Collision

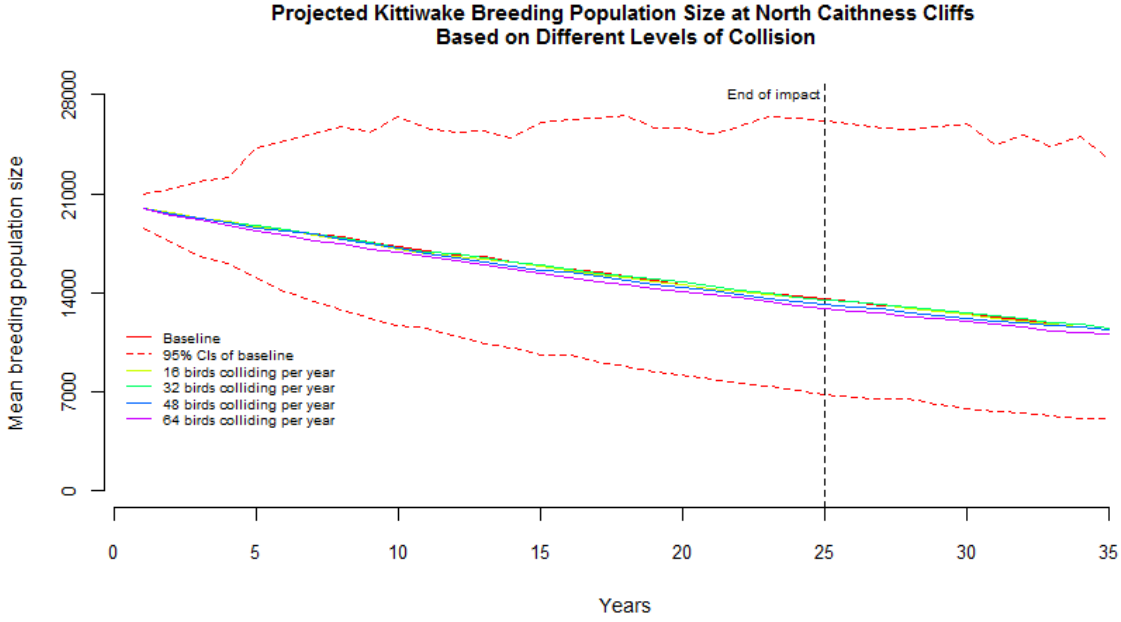


Figure G.23. Population projections for the kittiwake population at North Caithness Cliffs at different levels of collision.

Table G.11. Modelled probabilities of dropping below current population size for the kittiwake population at North Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.352	0.585	0.768	0.836	0.891	0.938	0.965	0.981	0.991	13795
Whole site	95.0%	72	0.421	0.655	0.820	0.878	0.921	0.956	0.976	0.988	0.994	12890
Whole site	98.0%	29	0.379	0.614	0.790	0.854	0.904	0.946	0.970	0.984	0.992	13425
Whole site	98.5%	22	0.372	0.607	0.784	0.849	0.901	0.944	0.969	0.984	0.992	13517
Whole site	99.0%	14	0.366	0.600	0.779	0.845	0.898	0.942	0.968	0.983	0.992	13609
Whole site	99.5%	7	0.359	0.593	0.774	0.840	0.895	0.940	0.966	0.982	0.992	13702
Sum of MacColl, Telford & Stevenson	95.0%	87	0.435	0.668	0.829	0.885	0.926	0.959	0.978	0.989	0.994	12711
Sum of MacColl, Telford & Stevenson	98.0%	35	0.385	0.619	0.794	0.857	0.907	0.947	0.971	0.985	0.993	13351
Sum of MacColl, Telford & Stevenson	98.5%	26	0.377	0.611	0.788	0.852	0.903	0.945	0.969	0.984	0.992	13460
Sum of MacColl, Telford & Stevenson	99.0%	17	0.368	0.603	0.781	0.847	0.899	0.943	0.968	0.983	0.992	13571
Sum of MacColl, Telford & Stevenson	99.5%	9	0.360	0.594	0.775	0.841	0.895	0.940	0.967	0.982	0.992	13682
MacColl	95.0%	44	0.393	0.628	0.800	0.862	0.910	0.950	0.972	0.986	0.993	13239
MacColl	98.0%	18	0.369	0.603	0.781	0.847	0.899	0.943	0.968	0.983	0.992	13570
MacColl	98.5%	13	0.364	0.598	0.778	0.844	0.897	0.942	0.967	0.983	0.992	13626
MacColl	99.0%	9	0.360	0.594	0.775	0.841	0.896	0.940	0.967	0.982	0.992	13682
MacColl	99.5%	4	0.356	0.590	0.771	0.839	0.894	0.939	0.966	0.982	0.991	13738
Stevenson	95.0%	25	0.376	0.610	0.787	0.852	0.903	0.945	0.969	0.984	0.992	13471
Stevenson	98.0%	10	0.362	0.595	0.776	0.842	0.896	0.941	0.967	0.982	0.992	13664
Stevenson	98.5%	8	0.359	0.593	0.774	0.841	0.895	0.940	0.966	0.982	0.992	13697
Stevenson	99.0%	5	0.357	0.590	0.772	0.839	0.894	0.939	0.966	0.982	0.991	13729
Stevenson	99.5%	3	0.355	0.588	0.770	0.837	0.893	0.938	0.965	0.982	0.991	13762
Telford	95.0%	18	0.369	0.603	0.782	0.847	0.900	0.943	0.968	0.983	0.992	13564
Telford	98.0%	7	0.359	0.593	0.774	0.840	0.895	0.940	0.966	0.982	0.992	13702
Telford	98.5%	5	0.357	0.591	0.772	0.839	0.894	0.939	0.966	0.982	0.991	13725
Telford	99.0%	4	0.356	0.589	0.771	0.838	0.893	0.939	0.966	0.982	0.991	13748
Telford	99.5%	2	0.354	0.587	0.769	0.837	0.892	0.938	0.965	0.982	0.991	13772
MacColl and Stevenson	95.0%	69	0.417	0.652	0.818	0.876	0.920	0.955	0.976	0.988	0.994	12928
MacColl and Stevenson	98.0%	28	0.378	0.613	0.789	0.853	0.904	0.945	0.970	0.984	0.992	13441
MacColl and Stevenson	98.5%	21	0.371	0.606	0.784	0.849	0.901	0.944	0.969	0.984	0.992	13529
MacColl and Stevenson	99.0%	14	0.365	0.599	0.779	0.845	0.898	0.942	0.967	0.983	0.992	13617
MacColl and Stevenson	99.5%	7	0.359	0.592	0.773	0.840	0.895	0.940	0.966	0.982	0.991	13706
Telford and MacColl	95.0%	62	0.410	0.645	0.813	0.872	0.917	0.954	0.975	0.987	0.994	13017
Telford and MacColl	98.0%	25	0.375	0.610	0.787	0.851	0.903	0.945	0.969	0.984	0.992	13478
Telford and MacColl	98.5%	19	0.369	0.604	0.782	0.847	0.900	0.943	0.968	0.983	0.992	13557
Telford and MacColl	99.0%	12	0.364	0.598	0.778	0.844	0.897	0.941	0.967	0.983	0.992	13636
Telford and MacColl	99.5%	6	0.358	0.591	0.773	0.840	0.894	0.940	0.966	0.982	0.991	13715
Stevenson and Telford	95.0%	43	0.393	0.628	0.800	0.862	0.910	0.949	0.972	0.986	0.993	13245
Stevenson and Telford	98.0%	17	0.368	0.602	0.781	0.847	0.899	0.943	0.968	0.983	0.992	13572
Stevenson and Telford	98.5%	13	0.364	0.598	0.778	0.844	0.897	0.941	0.967	0.983	0.992	13628
Stevenson and Telford	99.0%	9	0.360	0.594	0.775	0.841	0.895	0.940	0.967	0.982	0.992	13683
Stevenson and Telford	99.5%	4	0.356	0.590	0.771	0.839	0.893	0.939	0.966	0.982	0.991	13739
BOWL	95.0%	79	0.427	0.661	0.824	0.881	0.924	0.957	0.977	0.988	0.994	12808
BOWL	98.0%	32	0.382	0.617	0.792	0.856	0.906	0.947	0.970	0.985	0.993	13386
BOWL	98.5%	24	0.375	0.609	0.786	0.851	0.902	0.944	0.969	0.984	0.992	13487
BOWL	99.0%	16	0.367	0.601	0.780	0.846	0.899	0.942	0.968	0.983	0.992	13589
BOWL	99.5%	8	0.360	0.593	0.774	0.841	0.895	0.940	0.966	0.982	0.992	13692
BOWL and MORL	95.0%	151	0.499	0.724	0.865	0.912	0.945	0.970	0.984	0.992	0.996	11967
BOWL and MORL	98.0%	60	0.409	0.644	0.812	0.871	0.917	0.953	0.974	0.987	0.994	13032
BOWL and MORL	98.5%	45	0.395	0.630	0.802	0.863	0.911	0.950	0.972	0.986	0.993	13219
BOWL and MORL	99.0%	30	0.380	0.615	0.791	0.855	0.905	0.946	0.970	0.984	0.992	13408
BOWL and MORL	99.5%	15	0.366	0.600	0.780	0.845	0.898	0.942	0.968	0.983	0.992	13600

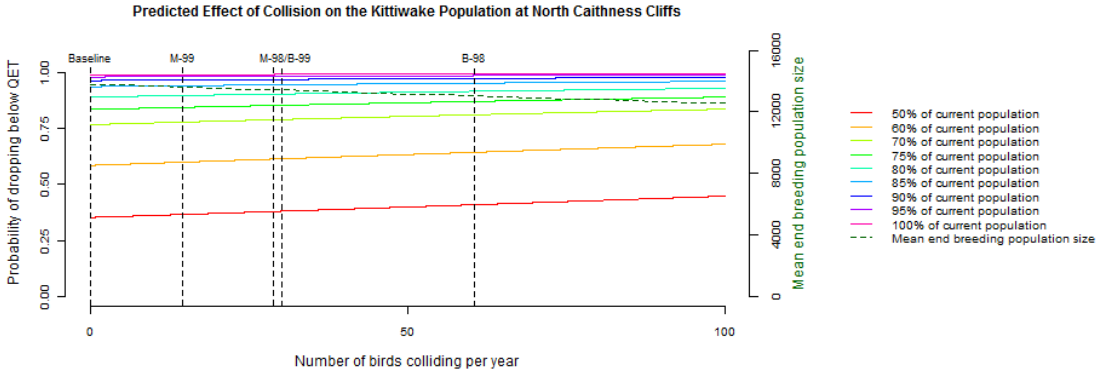


Figure G.24. Probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

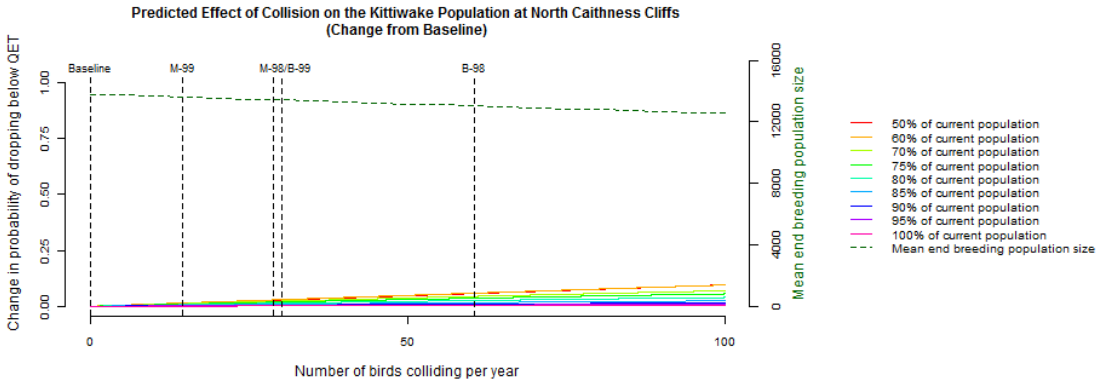


Figure G.25. Change in probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (up to end of impact).

Table G.12. Modelled probabilities of dropping below current population size for the kittiwake population at North Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (QET = quasi-extinction threshold, representing different proportions of the current population size).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.575	0.758	0.868	0.916	0.947	0.968	0.980	0.991	0.996	11772
Whole site	95.0%	72	0.643	0.811	0.907	0.942	0.964	0.979	0.988	0.995	0.997	11006
Whole site	98.0%	29	0.603	0.780	0.885	0.928	0.954	0.973	0.984	0.993	0.997	11459
Whole site	98.5%	22	0.596	0.775	0.881	0.925	0.953	0.972	0.983	0.992	0.997	11537
Whole site	99.0%	14	0.589	0.769	0.877	0.922	0.951	0.971	0.982	0.992	0.996	11615
Whole site	99.5%	7	0.582	0.764	0.873	0.919	0.949	0.970	0.981	0.992	0.996	11693
Sum of MacColl, Telford & Stevenson	95.0%	87	0.656	0.821	0.914	0.946	0.966	0.981	0.989	0.995	0.998	10855
Sum of MacColl, Telford & Stevenson	98.0%	35	0.608	0.785	0.888	0.930	0.956	0.974	0.984	0.993	0.997	11396
Sum of MacColl, Telford & Stevenson	98.5%	26	0.600	0.778	0.884	0.927	0.954	0.973	0.983	0.993	0.997	11489
Sum of MacColl, Telford & Stevenson	99.0%	17	0.592	0.772	0.879	0.923	0.952	0.971	0.982	0.992	0.996	11583
Sum of MacColl, Telford & Stevenson	99.5%	9	0.583	0.765	0.874	0.920	0.949	0.970	0.981	0.992	0.996	11677
MacColl	95.0%	44	0.617	0.791	0.893	0.933	0.958	0.975	0.985	0.993	0.997	11302
MacColl	98.0%	18	0.592	0.772	0.879	0.923	0.952	0.971	0.982	0.992	0.996	11582
MacColl	98.5%	13	0.588	0.768	0.876	0.922	0.951	0.971	0.982	0.992	0.996	11629
MacColl	99.0%	9	0.583	0.765	0.874	0.920	0.949	0.970	0.981	0.992	0.996	11676
MacColl	99.5%	4	0.579	0.761	0.871	0.918	0.948	0.969	0.980	0.992	0.996	11724
Stevenson	95.0%	25	0.599	0.778	0.883	0.926	0.954	0.973	0.983	0.993	0.997	11498
Stevenson	98.0%	10	0.585	0.766	0.874	0.920	0.950	0.970	0.981	0.992	0.996	11662
Stevenson	98.5%	8	0.582	0.764	0.873	0.919	0.949	0.970	0.981	0.992	0.996	11689
Stevenson	99.0%	5	0.580	0.762	0.871	0.918	0.948	0.969	0.981	0.992	0.996	11717
Stevenson	99.5%	3	0.577	0.760	0.870	0.917	0.948	0.969	0.980	0.991	0.996	11744
Telford	95.0%	18	0.592	0.772	0.879	0.924	0.952	0.971	0.982	0.992	0.996	11576
Telford	98.0%	7	0.582	0.764	0.873	0.919	0.949	0.970	0.981	0.992	0.996	11693
Telford	98.5%	5	0.580	0.762	0.872	0.919	0.948	0.969	0.981	0.992	0.996	11713
Telford	99.0%	4	0.578	0.761	0.870	0.918	0.948	0.969	0.980	0.991	0.996	11733
Telford	99.5%	2	0.577	0.759	0.869	0.917	0.948	0.969	0.980	0.991	0.996	11752
MacColl and Stevenson	95.0%	69	0.640	0.809	0.906	0.941	0.963	0.978	0.988	0.994	0.997	11038
MacColl and Stevenson	98.0%	28	0.601	0.779	0.884	0.927	0.954	0.973	0.983	0.993	0.997	11473
MacColl and Stevenson	98.5%	21	0.595	0.774	0.881	0.925	0.952	0.972	0.983	0.992	0.997	11547
MacColl and Stevenson	99.0%	14	0.588	0.769	0.877	0.922	0.951	0.971	0.982	0.992	0.996	11621
MacColl and Stevenson	99.5%	7	0.582	0.763	0.872	0.919	0.949	0.970	0.981	0.992	0.996	11696
Telford and MacColl	95.0%	62	0.633	0.804	0.902	0.938	0.962	0.978	0.987	0.994	0.997	11114
Telford and MacColl	98.0%	25	0.599	0.777	0.883	0.926	0.953	0.972	0.983	0.993	0.997	11504
Telford and MacColl	98.5%	19	0.593	0.772	0.879	0.924	0.952	0.972	0.982	0.992	0.996	11570
Telford and MacColl	99.0%	12	0.587	0.768	0.876	0.921	0.950	0.971	0.982	0.992	0.996	11637
Telford and MacColl	99.5%	6	0.581	0.763	0.872	0.919	0.949	0.970	0.981	0.992	0.996	11704
Stevenson and Telford	95.0%	43	0.616	0.791	0.893	0.933	0.958	0.975	0.985	0.993	0.997	11307
Stevenson and Telford	98.0%	17	0.592	0.772	0.879	0.923	0.952	0.971	0.982	0.992	0.996	11584
Stevenson and Telford	98.5%	13	0.587	0.768	0.876	0.922	0.950	0.971	0.982	0.992	0.996	11630
Stevenson and Telford	99.0%	9	0.583	0.765	0.874	0.920	0.949	0.970	0.981	0.992	0.996	11677
Stevenson and Telford	99.5%	4	0.579	0.761	0.871	0.918	0.948	0.969	0.980	0.992	0.996	11725
BOWL	95.0%	79	0.649	0.816	0.910	0.944	0.965	0.980	0.988	0.995	0.997	10937
BOWL	98.0%	32	0.606	0.783	0.887	0.929	0.955	0.974	0.984	0.993	0.997	11426
BOWL	98.5%	24	0.598	0.777	0.882	0.926	0.953	0.972	0.983	0.993	0.997	11512
BOWL	99.0%	16	0.590	0.771	0.878	0.923	0.951	0.971	0.982	0.992	0.996	11598
BOWL	99.5%	8	0.583	0.764	0.873	0.920	0.949	0.970	0.981	0.992	0.996	11685
BOWL and MORL	95.0%	151	0.711	0.858	0.937	0.961	0.976	0.986	0.993	0.997	0.998	10225
BOWL and MORL	98.0%	60	0.632	0.803	0.901	0.938	0.961	0.977	0.987	0.994	0.997	11127
BOWL and MORL	98.5%	45	0.618	0.792	0.894	0.933	0.958	0.975	0.985	0.993	0.997	11285
BOWL and MORL	99.0%	30	0.604	0.781	0.886	0.928	0.955	0.973	0.984	0.993	0.997	11445
BOWL and MORL	99.5%	15	0.589	0.770	0.877	0.922	0.951	0.971	0.982	0.992	0.996	11607

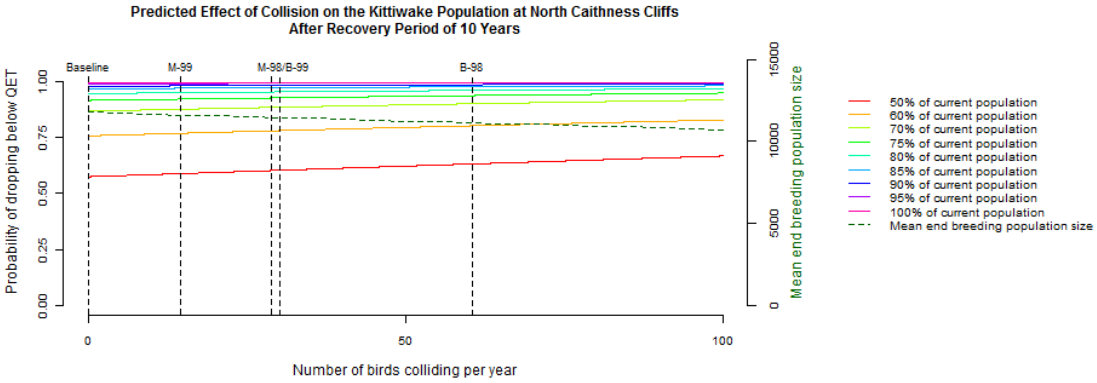


Figure G.26. Probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

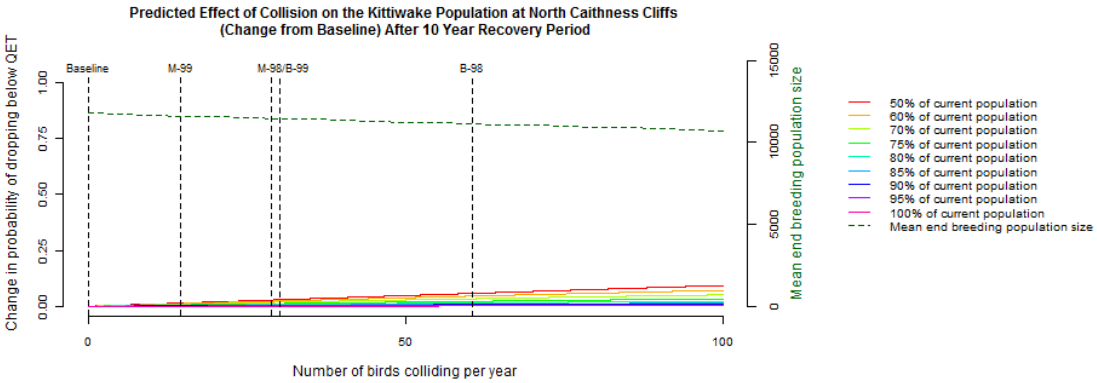


Figure G.27. Change in probability of the kittiwake population at North Caithness Cliffs dropping below quasi-extinction thresholds (after 10 year recovery period).

Table G.13. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the kittiwake population at North Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.022	0.069	0.152	0.196	0.248	0.299	0.361	0.424	0.484	13795
Whole site	95.0%	72	0.033	0.096	0.196	0.250	0.309	0.368	0.432	0.497	0.556	12890
Whole site	98.0%	29	0.026	0.079	0.168	0.217	0.271	0.326	0.389	0.453	0.513	13425
Whole site	98.5%	22	0.025	0.077	0.164	0.211	0.265	0.319	0.382	0.446	0.505	13517
Whole site	99.0%	14	0.024	0.074	0.160	0.206	0.259	0.312	0.375	0.439	0.498	13609
Whole site	99.5%	7	0.023	0.072	0.156	0.201	0.254	0.306	0.368	0.431	0.491	13702
Sum of MacColl, Telford & Stevenson	95.0%	87	0.036	0.102	0.207	0.262	0.322	0.382	0.447	0.512	0.571	12711
Sum of MacColl, Telford & Stevenson	98.0%	35	0.027	0.081	0.172	0.221	0.276	0.331	0.395	0.459	0.519	13351
Sum of MacColl, Telford & Stevenson	98.5%	26	0.026	0.078	0.167	0.215	0.269	0.323	0.386	0.450	0.510	13460
Sum of MacColl, Telford & Stevenson	99.0%	17	0.025	0.075	0.162	0.208	0.262	0.315	0.377	0.442	0.501	13571
Sum of MacColl, Telford & Stevenson	99.5%	9	0.024	0.072	0.156	0.202	0.255	0.307	0.369	0.433	0.492	13682
MacColl	95.0%	44	0.028	0.084	0.178	0.228	0.284	0.340	0.403	0.468	0.528	13239
MacColl	98.0%	18	0.025	0.075	0.162	0.208	0.262	0.315	0.378	0.442	0.501	13570
MacColl	98.5%	13	0.024	0.074	0.159	0.205	0.258	0.311	0.373	0.437	0.497	13626
MacColl	99.0%	9	0.024	0.072	0.157	0.202	0.255	0.307	0.369	0.433	0.492	13682
MacColl	99.5%	4	0.023	0.071	0.154	0.199	0.251	0.303	0.365	0.429	0.488	13738
Stevenson	95.0%	25	0.026	0.078	0.166	0.214	0.268	0.322	0.385	0.450	0.509	13471
Stevenson	98.0%	10	0.024	0.073	0.157	0.203	0.256	0.308	0.370	0.434	0.494	13664
Stevenson	98.5%	8	0.023	0.072	0.156	0.201	0.254	0.306	0.368	0.432	0.491	13697
Stevenson	99.0%	5	0.023	0.071	0.154	0.200	0.252	0.304	0.365	0.429	0.489	13729
Stevenson	99.5%	3	0.023	0.070	0.153	0.198	0.250	0.302	0.363	0.427	0.486	13762
Telford	95.0%	18	0.025	0.075	0.162	0.209	0.262	0.316	0.378	0.442	0.502	13564
Telford	98.0%	7	0.023	0.072	0.156	0.201	0.254	0.306	0.368	0.431	0.491	13702
Telford	98.5%	5	0.023	0.071	0.155	0.200	0.252	0.304	0.366	0.430	0.489	13725
Telford	99.0%	4	0.023	0.071	0.154	0.199	0.251	0.303	0.364	0.428	0.487	13748
Telford	99.5%	2	0.023	0.070	0.153	0.197	0.249	0.301	0.362	0.426	0.485	13772
MacColl and Stevenson	95.0%	69	0.033	0.094	0.194	0.248	0.306	0.365	0.429	0.494	0.553	12928
MacColl and Stevenson	98.0%	28	0.026	0.079	0.168	0.216	0.270	0.325	0.387	0.452	0.511	13441
MacColl and Stevenson	98.5%	21	0.025	0.076	0.163	0.211	0.264	0.318	0.381	0.445	0.504	13529
MacColl and Stevenson	99.0%	14	0.024	0.074	0.159	0.206	0.259	0.312	0.374	0.438	0.497	13617
MacColl and Stevenson	99.5%	7	0.023	0.072	0.155	0.201	0.253	0.306	0.367	0.431	0.491	13706
Telford and MacColl	95.0%	62	0.031	0.091	0.189	0.242	0.299	0.357	0.422	0.487	0.546	13017
Telford and MacColl	98.0%	25	0.026	0.078	0.166	0.214	0.268	0.322	0.385	0.449	0.508	13478
Telford and MacColl	98.5%	19	0.025	0.075	0.162	0.209	0.263	0.316	0.379	0.443	0.502	13557
Telford and MacColl	99.0%	12	0.024	0.073	0.159	0.205	0.258	0.311	0.373	0.437	0.496	13636
Telford and MacColl	99.5%	6	0.023	0.071	0.155	0.200	0.253	0.305	0.367	0.430	0.490	13715
Stevenson and Telford	95.0%	43	0.028	0.084	0.177	0.227	0.283	0.339	0.403	0.468	0.527	13245
Stevenson and Telford	98.0%	17	0.025	0.075	0.161	0.208	0.262	0.315	0.377	0.442	0.501	13572
Stevenson and Telford	98.5%	13	0.024	0.074	0.159	0.205	0.258	0.311	0.373	0.437	0.497	13628
Stevenson and Telford	99.0%	9	0.024	0.072	0.156	0.202	0.255	0.307	0.369	0.433	0.492	13683
Stevenson and Telford	99.5%	4	0.023	0.071	0.154	0.199	0.251	0.303	0.365	0.429	0.488	13739
BOWL	95.0%	79	0.034	0.099	0.201	0.256	0.315	0.374	0.439	0.504	0.563	12808
BOWL	98.0%	32	0.027	0.080	0.170	0.219	0.274	0.329	0.392	0.456	0.516	13386
BOWL	98.5%	24	0.026	0.077	0.165	0.213	0.267	0.321	0.384	0.448	0.508	13487
BOWL	99.0%	16	0.024	0.075	0.161	0.207	0.261	0.314	0.376	0.440	0.500	13589
BOWL	99.5%	8	0.023	0.072	0.156	0.202	0.254	0.307	0.368	0.432	0.492	13692
BOWL and MORL	95.0%	151	0.050	0.134	0.256	0.320	0.384	0.449	0.514	0.577	0.633	11967
BOWL and MORL	98.0%	60	0.031	0.091	0.188	0.241	0.298	0.356	0.420	0.485	0.544	13032
BOWL and MORL	98.5%	45	0.029	0.085	0.179	0.229	0.285	0.341	0.405	0.470	0.529	13219
BOWL and MORL	99.0%	30	0.026	0.080	0.169	0.218	0.272	0.327	0.390	0.455	0.514	13408
BOWL and MORL	99.5%	15	0.024	0.074	0.160	0.207	0.260	0.313	0.375	0.439	0.499	13600

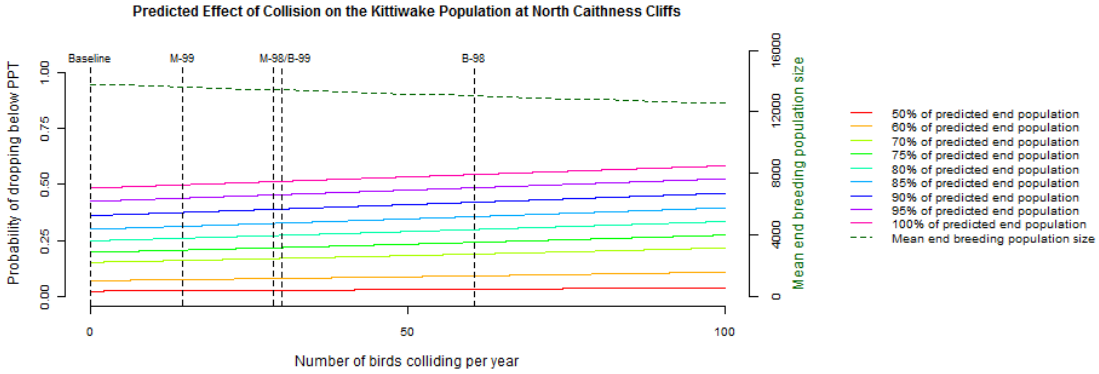


Figure G.28. Probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

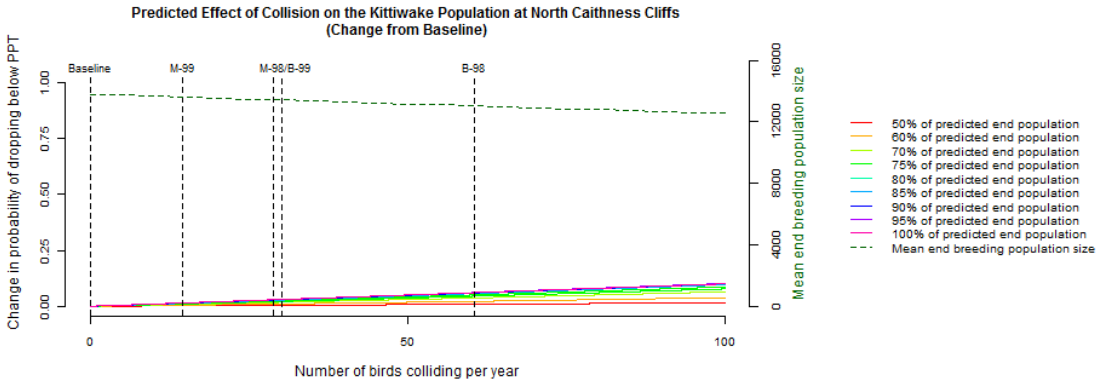


Figure G.29. Change in probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table G.14. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the kittiwake population at North Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.101	0.208	0.320	0.380	0.437	0.498	0.549	0.601	0.654	11772
Whole site	95.0%	72	0.130	0.254	0.378	0.442	0.502	0.563	0.613	0.663	0.711	11006
Whole site	98.0%	29	0.112	0.226	0.343	0.404	0.463	0.524	0.575	0.627	0.678	11459
Whole site	98.5%	22	0.109	0.221	0.337	0.398	0.457	0.517	0.568	0.620	0.672	11537
Whole site	99.0%	14	0.106	0.217	0.332	0.392	0.450	0.511	0.562	0.614	0.666	11615
Whole site	99.5%	7	0.103	0.213	0.326	0.386	0.444	0.504	0.555	0.608	0.660	11693
Sum of MacColl, Telford & Stevenson	95.0%	87	0.137	0.264	0.391	0.455	0.516	0.576	0.626	0.675	0.722	10855
Sum of MacColl, Telford & Stevenson	98.0%	35	0.114	0.229	0.348	0.409	0.468	0.529	0.580	0.632	0.683	11396
Sum of MacColl, Telford & Stevenson	98.5%	26	0.111	0.224	0.341	0.402	0.461	0.521	0.572	0.624	0.676	11489
Sum of MacColl, Telford & Stevenson	99.0%	17	0.107	0.219	0.334	0.394	0.453	0.514	0.565	0.617	0.669	11583
Sum of MacColl, Telford & Stevenson	99.5%	9	0.104	0.213	0.327	0.387	0.445	0.506	0.557	0.609	0.662	11677
MacColl	95.0%	44	0.118	0.235	0.355	0.417	0.477	0.537	0.588	0.639	0.690	11302
MacColl	98.0%	18	0.107	0.219	0.334	0.395	0.453	0.514	0.565	0.617	0.669	11582
MacColl	98.5%	13	0.106	0.216	0.331	0.391	0.449	0.510	0.561	0.613	0.665	11629
MacColl	99.0%	9	0.104	0.213	0.327	0.387	0.445	0.506	0.557	0.609	0.662	11676
MacColl	99.5%	4	0.102	0.211	0.324	0.383	0.441	0.502	0.553	0.605	0.658	11724
Stevenson	95.0%	25	0.110	0.223	0.340	0.401	0.460	0.521	0.572	0.624	0.675	11498
Stevenson	98.0%	10	0.104	0.214	0.328	0.388	0.446	0.507	0.558	0.610	0.663	11662
Stevenson	98.5%	8	0.104	0.213	0.326	0.386	0.444	0.505	0.556	0.608	0.661	11689
Stevenson	99.0%	5	0.103	0.211	0.324	0.384	0.442	0.502	0.554	0.606	0.659	11717
Stevenson	99.5%	3	0.102	0.210	0.322	0.382	0.440	0.500	0.551	0.604	0.656	11744
Telford	95.0%	18	0.107	0.219	0.334	0.395	0.453	0.514	0.565	0.617	0.669	11576
Telford	98.0%	7	0.103	0.213	0.326	0.386	0.444	0.504	0.555	0.608	0.660	11693
Telford	98.5%	5	0.103	0.211	0.324	0.384	0.442	0.503	0.554	0.606	0.659	11713
Telford	99.0%	4	0.102	0.210	0.323	0.383	0.440	0.501	0.552	0.605	0.657	11733
Telford	99.5%	2	0.101	0.209	0.322	0.381	0.439	0.499	0.551	0.603	0.656	11752
MacColl and Stevenson	95.0%	69	0.128	0.252	0.376	0.439	0.499	0.560	0.610	0.661	0.709	11038
MacColl and Stevenson	98.0%	28	0.111	0.225	0.342	0.403	0.462	0.523	0.574	0.626	0.677	11473
MacColl and Stevenson	98.5%	21	0.108	0.221	0.337	0.397	0.456	0.516	0.568	0.620	0.671	11547
MacColl and Stevenson	99.0%	14	0.106	0.216	0.331	0.391	0.450	0.510	0.561	0.614	0.666	11621
MacColl and Stevenson	99.5%	7	0.103	0.212	0.326	0.386	0.443	0.504	0.555	0.607	0.660	11696
Telford and MacColl	95.0%	62	0.125	0.247	0.370	0.433	0.493	0.553	0.604	0.655	0.704	11114
Telford and MacColl	98.0%	25	0.110	0.223	0.340	0.401	0.459	0.520	0.571	0.623	0.675	11504
Telford and MacColl	98.5%	19	0.108	0.219	0.335	0.395	0.454	0.515	0.566	0.618	0.670	11570
Telford and MacColl	99.0%	12	0.105	0.216	0.330	0.390	0.448	0.509	0.560	0.612	0.665	11637
Telford and MacColl	99.5%	6	0.103	0.212	0.325	0.385	0.443	0.503	0.555	0.607	0.659	11704
Stevenson and Telford	95.0%	43	0.117	0.235	0.355	0.417	0.476	0.537	0.588	0.639	0.689	11307
Stevenson and Telford	98.0%	17	0.107	0.219	0.334	0.394	0.453	0.513	0.565	0.617	0.669	11584
Stevenson and Telford	98.5%	13	0.106	0.216	0.330	0.391	0.449	0.510	0.561	0.613	0.665	11630
Stevenson and Telford	99.0%	9	0.104	0.213	0.327	0.387	0.445	0.506	0.557	0.609	0.662	11677
Stevenson and Telford	99.5%	4	0.102	0.211	0.324	0.383	0.441	0.502	0.553	0.605	0.658	11725
BOWL	95.0%	79	0.133	0.258	0.384	0.448	0.508	0.569	0.619	0.669	0.717	10937
BOWL	98.0%	32	0.113	0.228	0.346	0.407	0.466	0.527	0.578	0.629	0.680	11426
BOWL	98.5%	24	0.110	0.223	0.339	0.400	0.459	0.519	0.571	0.622	0.674	11512
BOWL	99.0%	16	0.107	0.218	0.333	0.393	0.452	0.512	0.563	0.615	0.667	11598
BOWL	99.5%	8	0.104	0.213	0.327	0.386	0.444	0.505	0.556	0.608	0.661	11685
BOWL and MORL	95.0%	151	0.170	0.310	0.446	0.512	0.573	0.631	0.679	0.725	0.767	10225
BOWL and MORL	98.0%	60	0.125	0.246	0.369	0.432	0.492	0.552	0.603	0.654	0.703	11127
BOWL and MORL	98.5%	45	0.118	0.236	0.356	0.418	0.478	0.539	0.590	0.641	0.691	11285
BOWL and MORL	99.0%	30	0.112	0.227	0.344	0.405	0.464	0.525	0.576	0.628	0.679	11445
BOWL and MORL	99.5%	15	0.106	0.217	0.332	0.392	0.451	0.511	0.563	0.615	0.667	11607

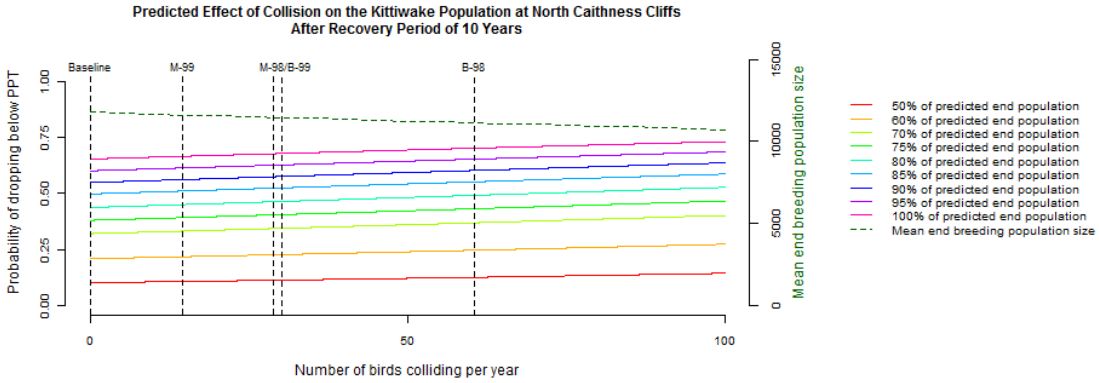


Figure G.30. Probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

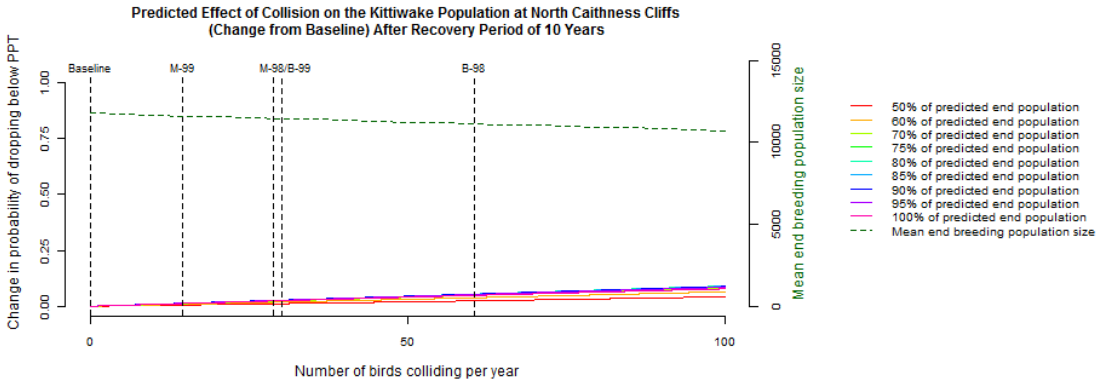


Figure G.31. Change in probability of the kittiwake population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix H – PVA Outputs: Herring Gull – East Caithness Cliffs

Collision

Table H.1. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the herring gull population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.087	0.155	0.242	0.285	0.329	0.372	0.411	0.453	0.496	17585
Whole site	95.0%	30	0.111	0.194	0.292	0.341	0.389	0.437	0.479	0.524	0.566	16240
Whole site	98.0%	12	0.096	0.170	0.261	0.307	0.352	0.397	0.438	0.481	0.524	17034
Whole site	98.5%	9	0.093	0.166	0.257	0.301	0.346	0.391	0.431	0.474	0.517	17170
Whole site	99.0%	6	0.091	0.162	0.252	0.296	0.340	0.384	0.424	0.467	0.510	17307
Whole site	99.5%	3	0.089	0.159	0.247	0.290	0.334	0.378	0.417	0.460	0.503	17445
Sum of MacColl, Telford & Stevenson	95.0%	36	0.117	0.202	0.303	0.352	0.402	0.450	0.492	0.537	0.580	15989
Sum of MacColl, Telford & Stevenson	98.0%	14	0.098	0.173	0.265	0.311	0.357	0.402	0.443	0.487	0.530	16928
Sum of MacColl, Telford & Stevenson	98.5%	11	0.095	0.168	0.259	0.304	0.350	0.395	0.435	0.478	0.521	17090
Sum of MacColl, Telford & Stevenson	99.0%	7	0.092	0.164	0.254	0.298	0.343	0.387	0.427	0.470	0.513	17253
Sum of MacColl, Telford & Stevenson	99.5%	4	0.089	0.160	0.248	0.291	0.336	0.379	0.419	0.462	0.504	17418
MacColl	95.0%	11	0.095	0.168	0.260	0.305	0.350	0.395	0.435	0.479	0.522	17080
MacColl	98.0%	4	0.090	0.160	0.249	0.293	0.337	0.381	0.421	0.463	0.506	17381
MacColl	98.5%	3	0.089	0.159	0.247	0.291	0.335	0.379	0.418	0.461	0.504	17432
MacColl	99.0%	2	0.088	0.158	0.245	0.289	0.333	0.376	0.416	0.458	0.501	17483
MacColl	99.5%	1	0.087	0.157	0.244	0.287	0.331	0.374	0.413	0.456	0.498	17534
Stevenson	95.0%	13	0.097	0.171	0.263	0.309	0.355	0.400	0.440	0.484	0.527	16984
Stevenson	98.0%	5	0.091	0.161	0.250	0.294	0.339	0.383	0.422	0.465	0.508	17342
Stevenson	98.5%	4	0.090	0.160	0.248	0.292	0.336	0.380	0.419	0.462	0.505	17402
Stevenson	99.0%	3	0.089	0.158	0.246	0.290	0.334	0.377	0.417	0.459	0.502	17463
Stevenson	99.5%	1	0.088	0.157	0.244	0.287	0.331	0.375	0.414	0.456	0.499	17524
Telford	95.0%	12	0.096	0.169	0.261	0.306	0.352	0.397	0.437	0.481	0.524	17044
Telford	98.0%	5	0.090	0.161	0.250	0.293	0.338	0.382	0.421	0.464	0.507	17366
Telford	98.5%	4	0.089	0.159	0.248	0.291	0.335	0.379	0.419	0.461	0.504	17421
Telford	99.0%	2	0.088	0.158	0.246	0.289	0.333	0.377	0.416	0.459	0.501	17475
Telford	99.5%	1	0.088	0.157	0.244	0.287	0.331	0.374	0.413	0.456	0.499	17530
MacColl and Stevenson	95.0%	24	0.106	0.185	0.282	0.329	0.377	0.424	0.465	0.510	0.553	16496
MacColl and Stevenson	98.0%	10	0.094	0.167	0.258	0.302	0.348	0.392	0.432	0.476	0.519	17141
MacColl and Stevenson	98.5%	7	0.092	0.164	0.254	0.298	0.343	0.387	0.427	0.470	0.513	17251
MacColl and Stevenson	99.0%	5	0.090	0.161	0.250	0.294	0.338	0.382	0.421	0.464	0.507	17361
MacColl and Stevenson	99.5%	2	0.088	0.158	0.246	0.289	0.333	0.377	0.416	0.459	0.502	17473
Telford and MacColl	95.0%	23	0.105	0.184	0.280	0.327	0.374	0.421	0.462	0.507	0.549	16555
Telford and MacColl	98.0%	9	0.094	0.166	0.257	0.301	0.346	0.391	0.431	0.474	0.517	17165
Telford and MacColl	98.5%	7	0.092	0.163	0.253	0.297	0.342	0.386	0.426	0.469	0.512	17269
Telford and MacColl	99.0%	5	0.090	0.161	0.249	0.293	0.337	0.381	0.421	0.464	0.507	17374
Telford and MacColl	99.5%	2	0.088	0.158	0.246	0.289	0.333	0.377	0.416	0.459	0.501	17479
Stevenson and Telford	95.0%	25	0.107	0.187	0.283	0.331	0.379	0.425	0.467	0.512	0.554	16461
Stevenson and Telford	98.0%	10	0.094	0.167	0.258	0.303	0.348	0.393	0.433	0.476	0.519	17126
Stevenson and Telford	98.5%	7	0.092	0.164	0.254	0.298	0.343	0.388	0.427	0.471	0.514	17240
Stevenson and Telford	99.0%	5	0.090	0.161	0.250	0.294	0.338	0.382	0.422	0.465	0.508	17354
Stevenson and Telford	99.5%	2	0.089	0.158	0.246	0.289	0.333	0.377	0.416	0.459	0.502	17469
BOWL	95.0%	124	0.230	0.357	0.483	0.540	0.594	0.645	0.688	0.728	0.761	12638
BOWL	98.0%	50	0.131	0.223	0.330	0.381	0.432	0.482	0.526	0.571	0.613	15392
BOWL	98.5%	37	0.118	0.204	0.305	0.355	0.404	0.453	0.495	0.540	0.583	15934
BOWL	99.0%	25	0.107	0.187	0.284	0.331	0.379	0.426	0.468	0.512	0.555	16452
BOWL	99.5%	12	0.096	0.170	0.262	0.307	0.352	0.397	0.438	0.481	0.524	17032
BOWL and MORL	95.0%	154	0.283	0.420	0.547	0.604	0.656	0.704	0.744	0.780	0.809	11672
BOWL and MORL	98.0%	62	0.144	0.241	0.352	0.405	0.457	0.508	0.552	0.597	0.638	14926
BOWL and MORL	98.5%	46	0.127	0.217	0.322	0.373	0.424	0.473	0.517	0.562	0.604	15550
BOWL and MORL	99.0%	31	0.112	0.195	0.294	0.343	0.391	0.439	0.481	0.526	0.568	16201
BOWL and MORL	99.5%	15	0.099	0.174	0.267	0.313	0.359	0.405	0.446	0.489	0.532	16879

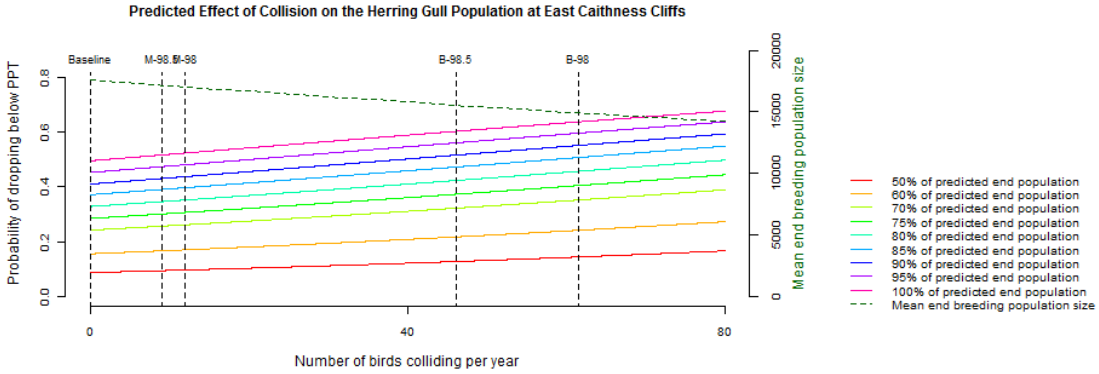


Figure H.1. Probability of the herring gull population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

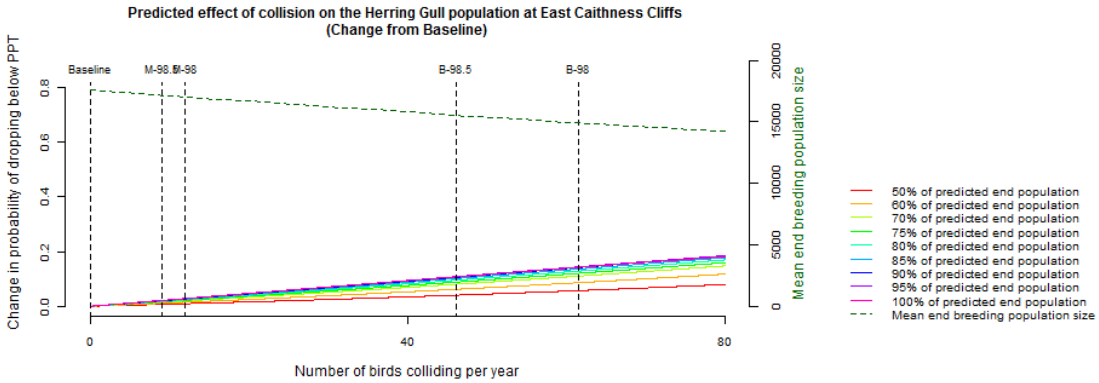


Figure H.2. Change in probability of the herring gull population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table H.2. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the herring gull population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.043	0.075	0.124	0.149	0.172	0.199	0.227	0.253	0.278	25987
Whole site	95.0%	30	0.055	0.094	0.151	0.180	0.207	0.237	0.269	0.298	0.326	23990
Whole site	98.0%	12	0.047	0.082	0.134	0.161	0.185	0.213	0.243	0.270	0.297	25169
Whole site	98.5%	9	0.046	0.081	0.131	0.158	0.182	0.210	0.239	0.266	0.292	25371
Whole site	99.0%	6	0.045	0.079	0.129	0.155	0.179	0.206	0.235	0.262	0.287	25575
Whole site	99.5%	3	0.044	0.077	0.126	0.152	0.175	0.202	0.231	0.257	0.283	25780
Sum of MacColl, Telford & Stevenson	95.0%	36	0.057	0.098	0.157	0.187	0.214	0.245	0.278	0.307	0.336	23618
Sum of MacColl, Telford & Stevenson	98.0%	14	0.048	0.084	0.136	0.163	0.188	0.216	0.246	0.274	0.300	25012
Sum of MacColl, Telford & Stevenson	98.5%	11	0.047	0.082	0.133	0.160	0.184	0.212	0.242	0.269	0.295	25253
Sum of MacColl, Telford & Stevenson	99.0%	7	0.045	0.080	0.130	0.156	0.180	0.207	0.237	0.263	0.289	25495
Sum of MacColl, Telford & Stevenson	99.5%	4	0.044	0.077	0.127	0.153	0.176	0.203	0.232	0.258	0.284	25740
MacColl	95.0%	11	0.047	0.082	0.133	0.160	0.184	0.212	0.242	0.269	0.295	25238
MacColl	98.0%	4	0.044	0.078	0.128	0.154	0.177	0.204	0.233	0.259	0.285	25685
MacColl	98.5%	3	0.044	0.077	0.127	0.152	0.176	0.203	0.231	0.258	0.283	25760
MacColl	99.0%	2	0.044	0.077	0.126	0.151	0.174	0.201	0.230	0.256	0.281	25836
MacColl	99.5%	1	0.043	0.076	0.125	0.150	0.173	0.200	0.229	0.255	0.280	25912
Stevenson	95.0%	13	0.048	0.083	0.135	0.162	0.187	0.215	0.245	0.272	0.298	25095
Stevenson	98.0%	5	0.045	0.078	0.128	0.154	0.178	0.205	0.234	0.261	0.286	25627
Stevenson	98.5%	4	0.044	0.078	0.127	0.153	0.176	0.203	0.232	0.259	0.284	25716
Stevenson	99.0%	3	0.044	0.077	0.126	0.152	0.175	0.202	0.231	0.257	0.282	25806
Stevenson	99.5%	1	0.043	0.076	0.125	0.151	0.174	0.200	0.229	0.255	0.280	25897
Telford	95.0%	12	0.047	0.082	0.134	0.161	0.185	0.213	0.243	0.270	0.296	25184
Telford	98.0%	5	0.045	0.078	0.128	0.154	0.177	0.204	0.233	0.260	0.285	25663
Telford	98.5%	4	0.044	0.077	0.127	0.153	0.176	0.203	0.232	0.258	0.283	25744
Telford	99.0%	2	0.044	0.077	0.126	0.152	0.175	0.201	0.230	0.256	0.282	25825
Telford	99.5%	1	0.043	0.076	0.125	0.150	0.173	0.200	0.229	0.255	0.280	25906
MacColl and Stevenson	95.0%	24	0.052	0.090	0.145	0.174	0.199	0.229	0.260	0.289	0.316	24371
MacColl and Stevenson	98.0%	10	0.046	0.081	0.132	0.159	0.183	0.210	0.240	0.267	0.293	25328
MacColl and Stevenson	98.5%	7	0.045	0.080	0.130	0.156	0.180	0.207	0.237	0.263	0.289	25492
MacColl and Stevenson	99.0%	5	0.045	0.078	0.128	0.154	0.177	0.204	0.233	0.260	0.285	25656
MacColl and Stevenson	99.5%	2	0.044	0.077	0.126	0.152	0.175	0.201	0.230	0.256	0.282	25821
Telford and MacColl	95.0%	23	0.051	0.089	0.144	0.172	0.198	0.227	0.258	0.287	0.314	24458
Telford and MacColl	98.0%	9	0.046	0.081	0.132	0.158	0.182	0.210	0.239	0.266	0.292	25365
Telford and MacColl	98.5%	7	0.045	0.079	0.130	0.156	0.180	0.207	0.236	0.263	0.289	25519
Telford and MacColl	99.0%	5	0.044	0.078	0.128	0.154	0.177	0.204	0.233	0.260	0.285	25674
Telford and MacColl	99.5%	2	0.044	0.077	0.126	0.151	0.175	0.201	0.230	0.256	0.281	25830
Stevenson and Telford	95.0%	25	0.052	0.091	0.146	0.174	0.200	0.230	0.261	0.290	0.317	24319
Stevenson and Telford	98.0%	10	0.046	0.081	0.132	0.159	0.183	0.211	0.240	0.267	0.293	25307
Stevenson and Telford	98.5%	7	0.046	0.080	0.130	0.157	0.180	0.208	0.237	0.264	0.290	25475
Stevenson and Telford	99.0%	5	0.045	0.078	0.128	0.154	0.178	0.205	0.234	0.260	0.286	25645
Stevenson and Telford	99.5%	2	0.044	0.077	0.126	0.152	0.175	0.202	0.230	0.257	0.282	25816
BOWL	95.0%	124	0.114	0.183	0.267	0.307	0.346	0.387	0.427	0.464	0.497	18647
BOWL	98.0%	50	0.064	0.109	0.171	0.203	0.233	0.265	0.300	0.331	0.360	22732
BOWL	98.5%	37	0.058	0.099	0.158	0.188	0.216	0.247	0.280	0.309	0.338	23537
BOWL	99.0%	25	0.052	0.091	0.146	0.175	0.201	0.230	0.262	0.290	0.318	24305
BOWL	99.5%	12	0.047	0.083	0.134	0.161	0.185	0.213	0.243	0.271	0.297	25166
BOWL and MORL	95.0%	154	0.142	0.223	0.314	0.357	0.399	0.442	0.483	0.520	0.553	17214
BOWL and MORL	98.0%	62	0.070	0.119	0.184	0.218	0.248	0.283	0.318	0.350	0.381	22040
BOWL and MORL	98.5%	46	0.062	0.106	0.167	0.199	0.227	0.260	0.294	0.324	0.353	22967
BOWL and MORL	99.0%	31	0.055	0.095	0.152	0.181	0.208	0.238	0.270	0.299	0.327	23932
BOWL and MORL	99.5%	15	0.049	0.085	0.137	0.165	0.189	0.218	0.248	0.276	0.302	24939

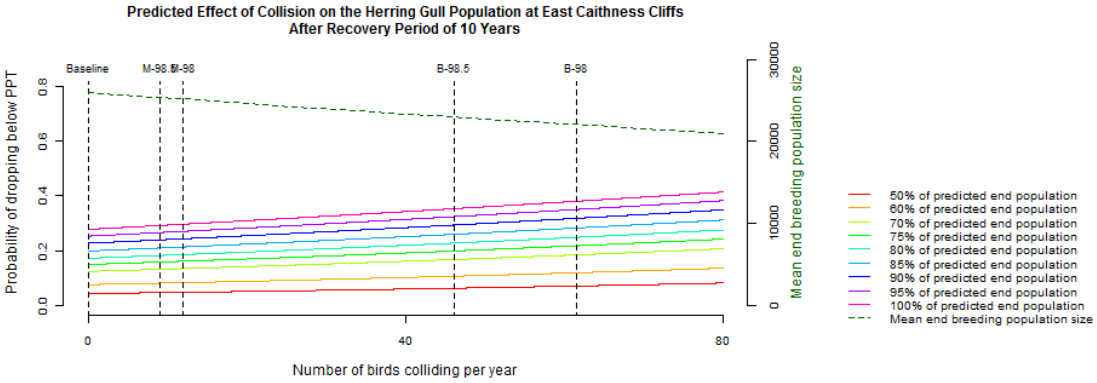


Figure H.3. Probability of the herring gull population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

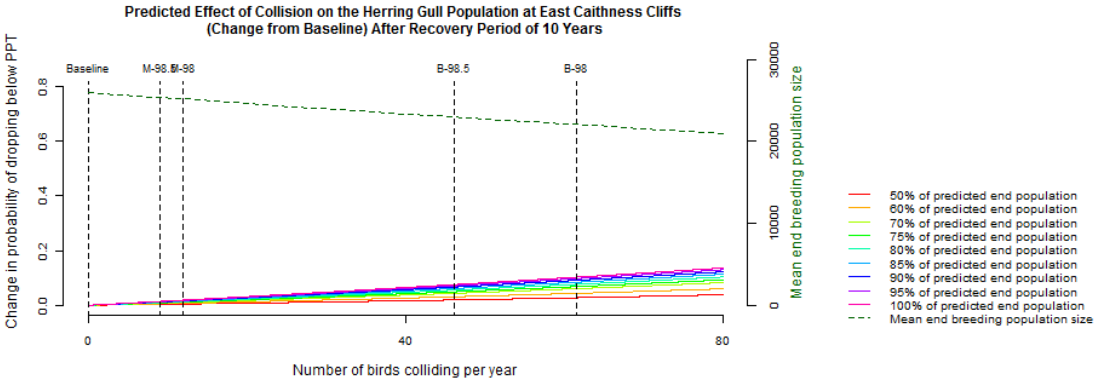


Figure H.4. Change in probability of the herring gull population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix I – PVA Outputs: Great Black-backed Gull – East Caithness Cliffs

Collision

Table I.1. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the great black backed population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.006	0.010	0.064	0.108	0.172	0.258	0.361	0.557	0.681	4783
Whole site	95.0%	62	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	279
Whole site	98.0%	25	0.960	0.995	0.996	0.998	0.999	1.000	1.000	1.000	1.000	1534
Whole site	98.5%	19	0.749	0.947	0.972	0.985	0.992	0.996	0.998	0.999	0.999	2039
Whole site	99.0%	12	0.270	0.600	0.815	0.889	0.935	0.965	0.981	0.991	0.993	2709
Whole site	99.5%	6	0.044	0.112	0.355	0.496	0.634	0.757	0.844	0.905	0.927	3600
Sum of MacColl, Telford & Stevenson	95.0%	72	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	176
Sum of MacColl, Telford & Stevenson	98.0%	29	0.989	0.999	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1276
Sum of MacColl, Telford & Stevenson	98.5%	22	0.892	0.984	0.990	0.994	0.997	0.999	0.999	1.000	1.000	1775
Sum of MacColl, Telford & Stevenson	99.0%	14	0.421	0.770	0.897	0.940	0.966	0.983	0.991	0.996	0.997	2470
Sum of MacColl, Telford & Stevenson	99.5%	7	0.060	0.158	0.436	0.580	0.710	0.816	0.887	0.934	0.950	3438
MacColl	95.0%	35	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	987
MacColl	98.0%	14	0.370	0.722	0.875	0.927	0.959	0.978	0.989	0.995	0.996	2544
MacColl	98.5%	10	0.155	0.396	0.688	0.799	0.877	0.931	0.961	0.980	0.985	2979
MacColl	99.0%	7	0.055	0.142	0.410	0.554	0.687	0.799	0.875	0.926	0.943	3488
MacColl	99.5%	3	0.018	0.040	0.179	0.279	0.403	0.540	0.665	0.761	0.813	4085
Stevenson	95.0%	26	0.969	0.997	0.997	0.999	0.999	1.000	1.000	1.000	1.000	1478
Stevenson	98.0%	10	0.152	0.388	0.682	0.794	0.874	0.929	0.960	0.979	0.984	2990
Stevenson	98.5%	8	0.070	0.185	0.476	0.619	0.742	0.841	0.903	0.945	0.958	3363
Stevenson	99.0%	5	0.031	0.075	0.278	0.406	0.545	0.680	0.786	0.861	0.893	3782
Stevenson	99.5%	3	0.013	0.028	0.140	0.224	0.333	0.462	0.590	0.692	0.756	4253
Telford	95.0%	12	0.245	0.562	0.795	0.875	0.927	0.961	0.978	0.990	0.992	2758
Telford	98.0%	5	0.028	0.067	0.257	0.380	0.518	0.655	0.765	0.845	0.881	3838
Telford	98.5%	4	0.019	0.043	0.187	0.290	0.416	0.554	0.678	0.772	0.823	4055
Telford	99.0%	2	0.013	0.027	0.134	0.214	0.321	0.448	0.576	0.678	0.744	4285
Telford	99.5%	1	0.008	0.017	0.093	0.154	0.239	0.347	0.467	0.567	0.646	4527
MacColl and Stevenson	95.0%	60	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	305
MacColl and Stevenson	98.0%	24	0.949	0.994	0.995	0.998	0.999	0.999	1.000	1.000	1.000	1590
MacColl and Stevenson	98.5%	18	0.710	0.934	0.967	0.982	0.990	0.995	0.998	0.999	0.999	2094
MacColl and Stevenson	99.0%	12	0.245	0.562	0.795	0.875	0.927	0.961	0.978	0.990	0.992	2758
MacColl and Stevenson	99.5%	6	0.041	0.104	0.341	0.479	0.618	0.744	0.835	0.898	0.922	3632
Telford and MacColl	95.0%	47	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	569
Telford and MacColl	98.0%	19	0.747	0.947	0.972	0.985	0.992	0.996	0.998	0.999	0.999	2041
Telford and MacColl	98.5%	14	0.382	0.735	0.881	0.931	0.961	0.980	0.989	0.995	0.996	2525
Telford and MacColl	99.0%	9	0.115	0.302	0.608	0.736	0.833	0.903	0.944	0.970	0.977	3125
Telford and MacColl	99.5%	5	0.026	0.063	0.247	0.368	0.504	0.642	0.755	0.837	0.874	3866
Stevenson and Telford	95.0%	38	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	852
Stevenson and Telford	98.0%	15	0.474	0.812	0.915	0.951	0.973	0.986	0.993	0.997	0.998	2399
Stevenson and Telford	98.5%	11	0.203	0.490	0.753	0.846	0.908	0.950	0.972	0.986	0.989	2851
Stevenson and Telford	99.0%	8	0.067	0.176	0.463	0.606	0.732	0.833	0.898	0.941	0.955	3387
Stevenson and Telford	99.5%	4	0.020	0.045	0.196	0.302	0.429	0.568	0.690	0.783	0.832	4025
BOWL	95.0%	179	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
BOWL	98.0%	72	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	179
BOWL	98.5%	54	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	408
BOWL	99.0%	36	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	926
BOWL	99.5%	18	0.702	0.931	0.966	0.981	0.990	0.995	0.997	0.999	0.999	2105
BOWL and MORL	95.0%	241	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0
BOWL and MORL	98.0%	97	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	59
BOWL and MORL	98.5%	72	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	176
BOWL and MORL	99.0%	48	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	529
BOWL and MORL	99.5%	24	0.948	0.994	0.995	0.998	0.999	0.999	1.000	1.000	1.000	1591

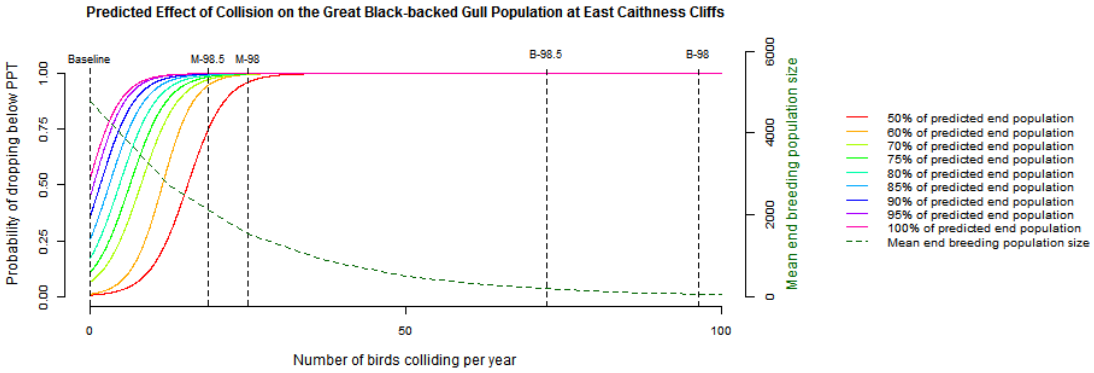


Figure I.1. Probability of the great black-backed gull population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

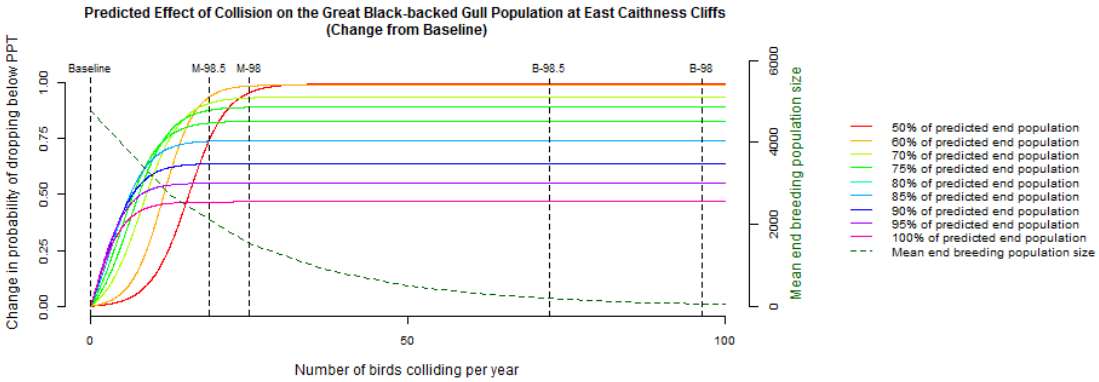


Figure I.2. Change in probability of the great black-backed gull population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table I.2. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the great black backed population at East Caithness Cliffs with increasing collision rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Avoidance rate	Collisions per year	Probability of dropping below percentage of predicted end population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	13271
Whole site	95.0%	62	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	769
Whole site	98.0%	25	0.011	0.046	0.131	0.201	0.274	0.382	0.469	0.556	0.631	4248
Whole site	98.5%	19	0.001	0.007	0.023	0.037	0.051	0.077	0.103	0.146	0.190	5647
Whole site	99.0%	12	0.000	0.001	0.004	0.006	0.008	0.011	0.015	0.023	0.031	7508
Whole site	99.5%	6	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.003	0.004	9982
Sum of MacColl, Telford & Stevenson	95.0%	72	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	485
Sum of MacColl, Telford & Stevenson	98.0%	29	0.040	0.143	0.333	0.458	0.570	0.695	0.769	0.820	0.861	3531
Sum of MacColl, Telford & Stevenson	98.5%	22	0.004	0.018	0.055	0.088	0.122	0.181	0.236	0.311	0.382	4916
Sum of MacColl, Telford & Stevenson	99.0%	14	0.000	0.002	0.007	0.011	0.014	0.021	0.028	0.043	0.058	6845
Sum of MacColl, Telford & Stevenson	99.5%	7	0.000	0.000	0.001	0.001	0.002	0.002	0.003	0.004	0.006	9531
MacColl	95.0%	35	0.213	0.481	0.726	0.821	0.884	0.933	0.955	0.965	0.974	2729
MacColl	98.0%	14	0.000	0.002	0.006	0.009	0.012	0.017	0.023	0.035	0.048	7049
MacColl	98.5%	10	0.000	0.001	0.002	0.003	0.004	0.006	0.007	0.012	0.016	8257
MacColl	99.0%	7	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.004	0.006	9672
MacColl	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	11329
Stevenson	95.0%	26	0.014	0.059	0.161	0.244	0.327	0.447	0.536	0.619	0.689	4090
Stevenson	98.0%	10	0.000	0.001	0.002	0.003	0.004	0.006	0.007	0.012	0.016	8288
Stevenson	98.5%	8	0.000	0.000	0.001	0.001	0.002	0.002	0.003	0.005	0.007	9323
Stevenson	99.0%	5	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.003	10487
Stevenson	99.5%	3	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	11797
Telford	95.0%	12	0.000	0.001	0.003	0.005	0.007	0.010	0.013	0.020	0.028	7644
Telford	98.0%	5	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.003	10643
Telford	98.5%	4	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	11246
Telford	99.0%	2	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	11884
Telford	99.5%	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	12558
MacColl and Stevenson	95.0%	60	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	841
MacColl and Stevenson	98.0%	24	0.008	0.037	0.107	0.166	0.228	0.325	0.406	0.493	0.571	4403
MacColl and Stevenson	98.5%	18	0.001	0.006	0.020	0.032	0.043	0.064	0.086	0.124	0.163	5801
MacColl and Stevenson	99.0%	12	0.000	0.001	0.003	0.005	0.007	0.010	0.013	0.020	0.028	7644
MacColl and Stevenson	99.5%	6	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.003	0.004	10072
Telford and MacColl	95.0%	47	0.937	0.973	0.990	0.994	0.997	0.999	0.999	0.999	0.999	1572
Telford and MacColl	98.0%	19	0.001	0.007	0.023	0.037	0.051	0.076	0.102	0.145	0.189	5654
Telford and MacColl	98.5%	14	0.000	0.002	0.006	0.009	0.012	0.018	0.024	0.037	0.050	6998
Telford and MacColl	99.0%	9	0.000	0.000	0.001	0.002	0.003	0.004	0.005	0.009	0.012	8662
Telford and MacColl	99.5%	5	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.003	10721
Stevenson and Telford	95.0%	38	0.440	0.712	0.873	0.923	0.954	0.975	0.984	0.987	0.990	2356
Stevenson and Telford	98.0%	15	0.000	0.002	0.008	0.013	0.018	0.026	0.034	0.052	0.070	6647
Stevenson and Telford	98.5%	11	0.000	0.001	0.003	0.004	0.005	0.008	0.010	0.016	0.022	7901
Stevenson and Telford	99.0%	8	0.000	0.000	0.001	0.001	0.002	0.002	0.003	0.005	0.007	9392
Stevenson and Telford	99.5%	4	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	11164
BOWL	95.0%	179	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4
BOWL	98.0%	72	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	494
BOWL	98.5%	54	0.994	0.997	0.999	0.999	1.000	1.000	1.000	1.000	1.000	1125
BOWL	99.0%	36	0.300	0.586	0.800	0.874	0.922	0.956	0.971	0.977	0.983	2562
BOWL	99.5%	18	0.001	0.006	0.019	0.031	0.042	0.062	0.083	0.121	0.158	5830
BOWL and MORL	95.0%	241	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0
BOWL and MORL	98.0%	97	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	161
BOWL and MORL	98.5%	72	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	486
BOWL and MORL	99.0%	48	0.962	0.983	0.993	0.996	0.998	0.999	0.999	1.000	1.000	1463
BOWL and MORL	99.5%	24	0.008	0.037	0.106	0.165	0.227	0.324	0.405	0.492	0.570	4406

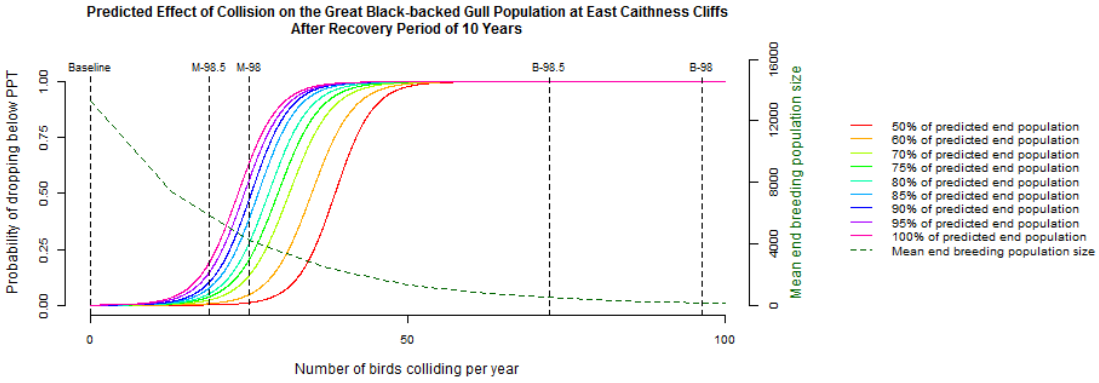


Figure I.3. Probability of the great black-backed gull population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

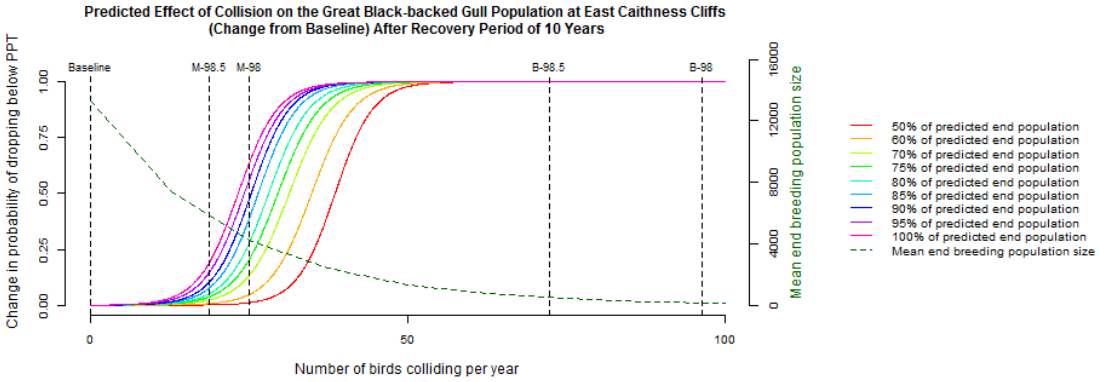


Figure I.4. Change in probability of the great black-backed gull population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix J – PVA Outputs: Guillemot – East Caithness Cliffs

Displacement

Table J.1. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the guillemot population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	0.001	0.007	0.026	0.079	0.181	0.335	0.512	647506
Whole site	100%	3443	<0.001	<0.001	0.003	0.016	0.054	0.140	0.291	0.483	0.670	625411
Whole site	50%	1721	<0.001	<0.001	0.002	0.010	0.038	0.106	0.232	0.407	0.594	636363
Sum of MacColl, Telford & Stevenson	100%	3443	<0.001	<0.001	0.003	0.016	0.054	0.140	0.291	0.483	0.670	625411
Sum of MacColl, Telford & Stevenson	50%	1721	<0.001	<0.001	0.002	0.010	0.038	0.106	0.232	0.407	0.594	636363
MacColl	100%	1495	<0.001	<0.001	0.002	0.010	0.036	0.102	0.224	0.397	0.583	637818
MacColl	50%	747	<0.001	<0.001	0.001	0.008	0.031	0.090	0.202	0.366	0.548	642644
Telford	100%	1104	<0.001	<0.001	0.002	0.009	0.033	0.095	0.212	0.381	0.565	640334
Telford	50%	552	<0.001	<0.001	0.001	0.008	0.030	0.087	0.196	0.358	0.539	643910
Stevenson	100%	843	<0.001	<0.001	0.001	0.008	0.031	0.091	0.205	0.370	0.553	642022
Stevenson	50%	422	<0.001	<0.001	0.001	0.008	0.029	0.085	0.193	0.352	0.533	644758
MacColl and Stevenson	100%	2338	<0.001	<0.001	0.002	0.012	0.043	0.117	0.252	0.434	0.622	632416
MacColl and Stevenson	50%	1169	<0.001	<0.001	0.002	0.009	0.034	0.096	0.214	0.383	0.568	639917
Stevenson and Telford	100%	1948	<0.001	<0.001	0.002	0.011	0.040	0.110	0.239	0.417	0.604	634911
Stevenson and Telford	50%	974	<0.001	<0.001	0.001	0.009	0.032	0.093	0.209	0.375	0.559	641178
Telford and MacColl	100%	2599	<0.001	<0.001	0.003	0.013	0.046	0.122	0.261	0.445	0.633	630754
Telford and MacColl	50%	1300	<0.001	<0.001	0.002	0.009	0.035	0.098	0.218	0.389	0.574	639075
BOWL	100%	1415	<0.001	<0.001	0.002	0.010	0.035	0.100	0.222	0.394	0.579	638334
BOWL	50%	707	<0.001	<0.001	0.001	0.008	0.031	0.089	0.201	0.364	0.546	642904
BOWL and MORL	100%	4857	<0.001	<0.001	0.005	0.022	0.073	0.175	0.346	0.546	0.727	616552
BOWL and MORL	50%	2429	<0.001	<0.001	0.002	0.012	0.044	0.119	0.255	0.438	0.626	631840

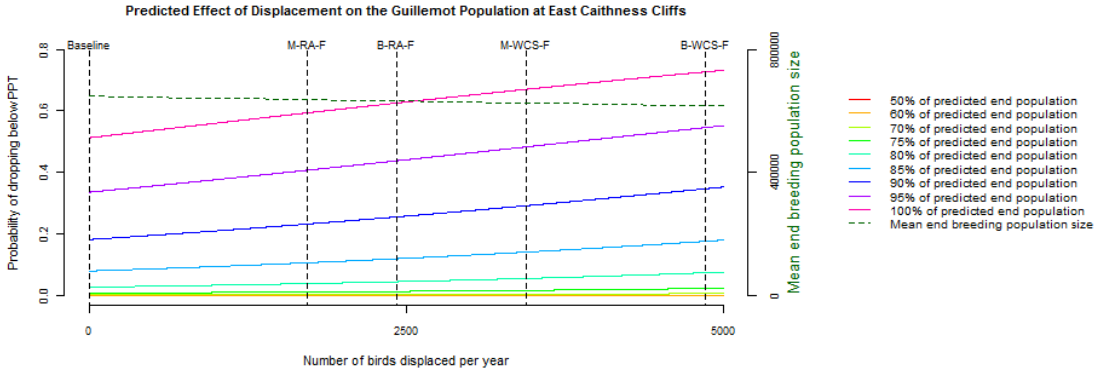


Figure J.1. Probability of the guillemot population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

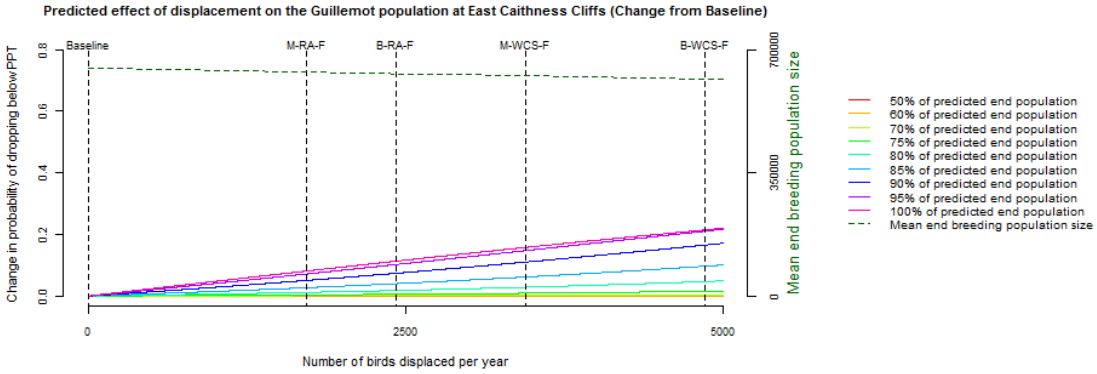


Figure J.2. Change in probability of the guillemot population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table J.2. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the guillemot population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1135192.263
Whole site	100%	3443	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1092153.752
Whole site	50%	1721	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1113465.082
Sum of MacColl, Telford & Stevenson	100%	3443	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1092153.752
Sum of MacColl, Telford & Stevenson	50%	1721	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1113465.082
MacColl	100%	1495	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1116299.99
MacColl	50%	747	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1125706.494
Telford	100%	1104	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1121203.785
Telford	50%	552	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1128176.344
Stevenson	100%	843	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1124494.022
Stevenson	50%	422	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1129830.48
MacColl and Stevenson	100%	2338	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1105779.792
MacColl and Stevenson	50%	1169	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1120389.515
Stevenson and Telford	100%	1948	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1110637.374
Stevenson and Telford	50%	974	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1122847.698
Telford and MacColl	100%	2599	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1102544.313
Telford and MacColl	50%	1300	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1118749.201
BOWL	100%	1415	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1117305.183
BOWL	50%	707	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1126213.212
BOWL and MORL	100%	4857	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1074944.825
BOWL and MORL	50%	2429	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1104657.887

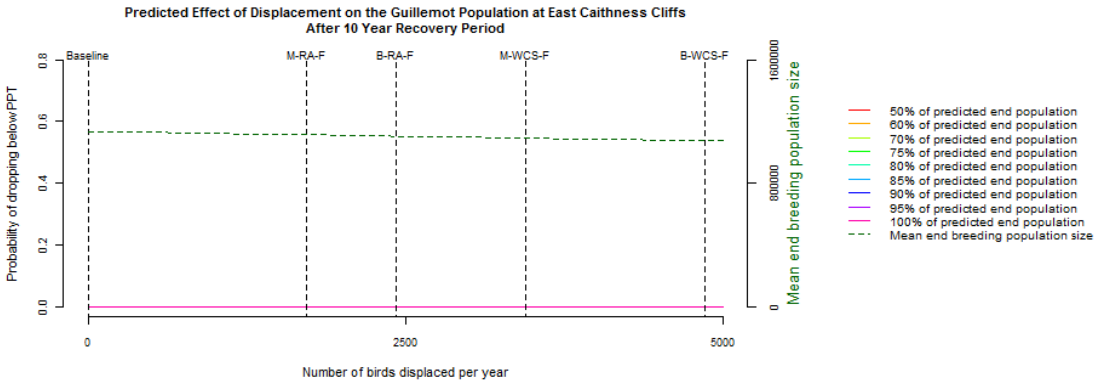


Figure J.3. Probability of the guillemot population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

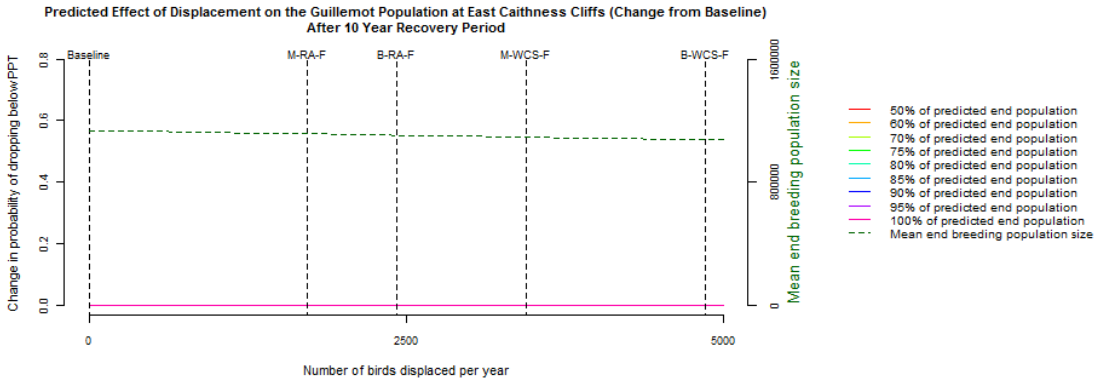


Figure J.4. Change in probability of the guillemot population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix K – PVA Outputs: Guillemot – North Caithness Cliffs

Displacement

Table K.1. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the guillemot population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	0.001	0.004	0.023	0.072	0.166	0.316	0.490	574757
Whole site	100%	2869	<0.001	<0.001	0.002	0.011	0.047	0.126	0.257	0.442	0.629	558132
Whole site	50%	1434	<0.001	<0.001	0.001	0.007	0.033	0.096	0.208	0.377	0.561	566383
Sum of MacColl, Telford & Stevenson	100%	2869	<0.001	<0.001	0.002	0.011	0.047	0.126	0.257	0.442	0.629	558132
Sum of MacColl, Telford & Stevenson	50%	1434	<0.001	<0.001	0.001	0.007	0.033	0.096	0.208	0.377	0.561	566383
MacColl	100%	1246	<0.001	<0.001	0.001	0.006	0.031	0.092	0.202	0.369	0.552	567478
MacColl	50%	623	<0.001	<0.001	0.001	0.005	0.027	0.081	0.183	0.342	0.521	571106
Telford	100%	920	<0.001	<0.001	0.001	0.006	0.029	0.086	0.192	0.355	0.536	569370
Telford	50%	460	<0.001	<0.001	0.001	0.005	0.026	0.079	0.179	0.335	0.513	572057
Stevenson	100%	703	<0.001	<0.001	0.001	0.006	0.027	0.083	0.186	0.345	0.525	570639
Stevenson	50%	351	<0.001	<0.001	0.001	0.005	0.025	0.077	0.176	0.331	0.508	572694
MacColl and Stevenson	100%	1948	<0.001	<0.001	0.001	0.008	0.037	0.106	0.225	0.400	0.586	563412
MacColl and Stevenson	50%	974	<0.001	<0.001	0.001	0.006	0.029	0.087	0.194	0.357	0.538	569056
Stevenson and Telford	100%	1623	<0.001	<0.001	0.001	0.007	0.034	0.099	0.214	0.385	0.570	565291
Stevenson and Telford	50%	812	<0.001	<0.001	0.001	0.006	0.028	0.085	0.189	0.350	0.530	570004
Telford and MacColl	100%	2166	<0.001	<0.001	0.002	0.009	0.039	0.110	0.232	0.410	0.596	562160
Telford and MacColl	50%	1083	<0.001	<0.001	0.001	0.006	0.030	0.089	0.197	0.362	0.544	568424
BOWL	100%	1179	<0.001	<0.001	0.001	0.006	0.031	0.091	0.200	0.366	0.548	567866
BOWL	50%	589	<0.001	<0.001	0.001	0.005	0.026	0.081	0.183	0.341	0.519	571301
BOWL and MORL	100%	4048	<0.001	<0.001	0.003	0.015	0.062	0.158	0.303	0.497	0.682	551440
BOWL and MORL	50%	2024	<0.001	<0.001	0.001	0.008	0.038	0.107	0.227	0.403	0.589	562978

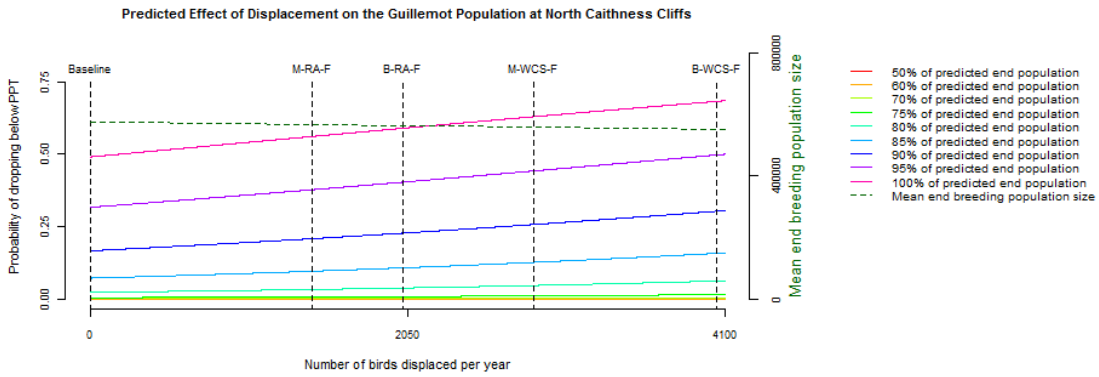


Figure K.1. Probability of the guillemot population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

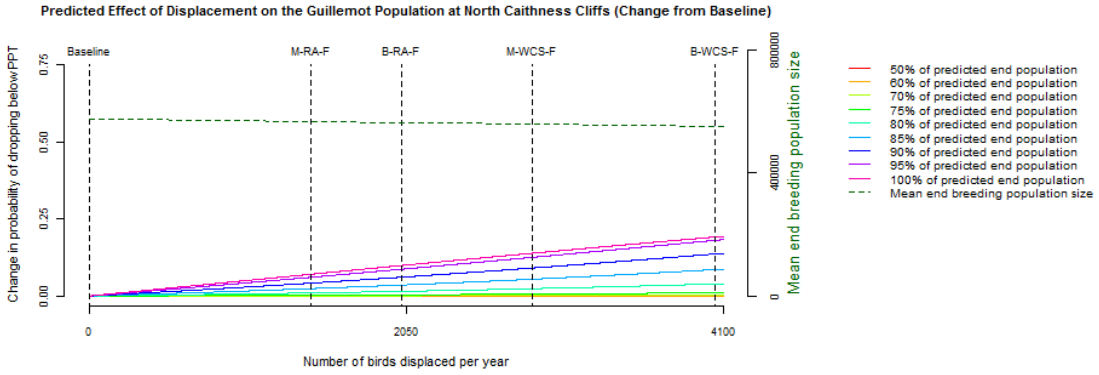


Figure K.2. Change in probability of the guillemot population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table K.2. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the guillemot population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1010112
Whole site	100%	2869	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	974663
Whole site	50%	1434	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	992229
Sum of MacColl, Telford & Stevenson	100%	2869	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	974663
Sum of MacColl, Telford & Stevenson	50%	1434	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	992229
MacColl	100%	1246	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	994564
MacColl	50%	623	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1002308
Telford	100%	920	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	998602
Telford	50%	460	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1004340
Stevenson	100%	703	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1001310
Stevenson	50%	351	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1005701
MacColl and Stevenson	100%	1948	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	985897
MacColl and Stevenson	50%	974	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	997931
Stevenson and Telford	100%	1623	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	989900
Stevenson and Telford	50%	812	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	999955
Telford and MacColl	100%	2166	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	983231
Telford and MacColl	50%	1083	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	996581
BOWL	100%	1179	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	995392
BOWL	50%	589	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1002725
BOWL and MORL	100%	4048	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	960459
BOWL and MORL	50%	2024	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	984973

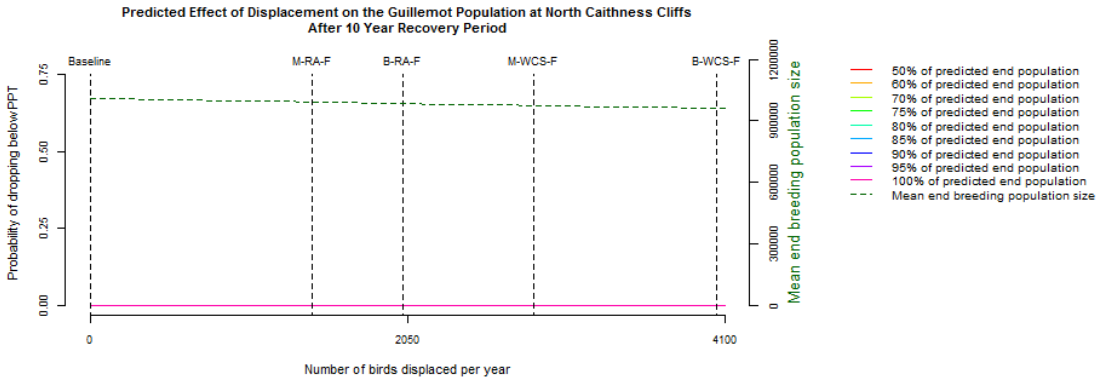


Figure K.3. Probability of the guillemot population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

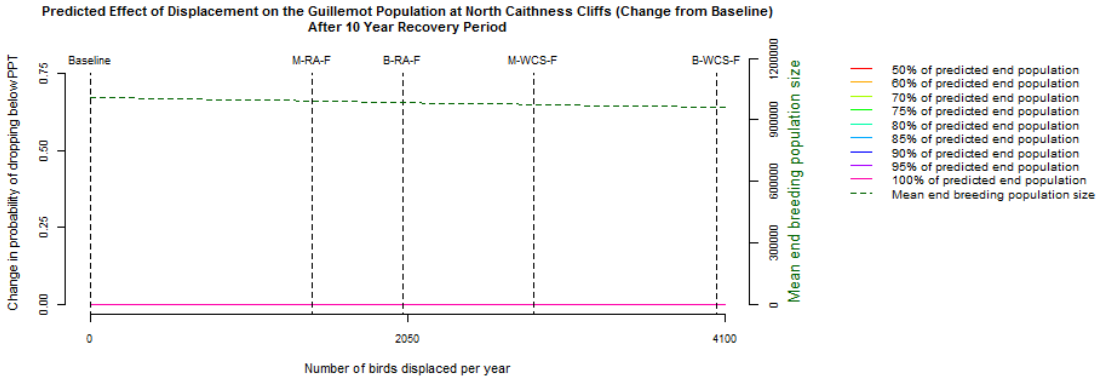


Figure K.4. Change in probability of the guillemot population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix L – PVA Outputs: Razorbill – East Caithness Cliffs

Displacement

Table L.1. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the razorbill population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	NA	0	<0.001	<0.001	0.001	0.006	0.023	0.066	0.158	0.292	0.471	123548
Whole site	100%	990	<0.001	0.001	0.039	0.130	0.301	0.523	0.724	0.864	0.939	106036
Whole site	50%	495	<0.001	<0.001	0.006	0.029	0.091	0.217	0.412	0.618	0.788	114458
Sum of MacColl, Telford & Stevenson	100%	990	<0.001	0.001	0.039	0.130	0.301	0.523	0.724	0.864	0.939	106036
Sum of MacColl, Telford & Stevenson	50%	495	<0.001	<0.001	0.006	0.029	0.091	0.217	0.412	0.618	0.788	114458
MacColl	100%	461	<0.001	<0.001	0.005	0.026	0.083	0.201	0.391	0.596	0.771	115058
MacColl	50%	230	<0.001	<0.001	0.002	0.013	0.044	0.117	0.257	0.438	0.634	119228
Telford	100%	266	<0.001	<0.001	0.002	0.014	0.048	0.128	0.276	0.462	0.657	118580
Telford	50%	133	<0.001	<0.001	0.001	0.009	0.033	0.092	0.211	0.373	0.566	121039
Stevenson	100%	263	<0.001	<0.001	0.002	0.014	0.048	0.127	0.274	0.460	0.655	118630
Stevenson	50%	132	<0.001	<0.001	0.001	0.009	0.033	0.092	0.210	0.372	0.565	121064
MacColl and Stevenson	100%	724	<0.001	<0.001	0.014	0.060	0.164	0.344	0.564	0.753	0.878	110478
MacColl and Stevenson	50%	362	<0.001	<0.001	0.004	0.019	0.063	0.161	0.330	0.528	0.717	116831
Stevenson and Telford	100%	529	<0.001	<0.001	0.007	0.033	0.099	0.233	0.434	0.640	0.804	113860
Stevenson and Telford	50%	264	<0.001	<0.001	0.002	0.014	0.048	0.127	0.275	0.461	0.656	118605
Telford and MacColl	100%	727	<0.001	<0.001	0.014	0.060	0.165	0.345	0.566	0.754	0.879	110432
Telford and MacColl	50%	363	<0.001	<0.001	0.004	0.019	0.063	0.161	0.331	0.529	0.718	116806
BOWL	100%	287	<0.001	<0.001	0.003	0.015	0.051	0.135	0.287	0.477	0.671	118191
BOWL	50%	144	<0.001	<0.001	0.002	0.010	0.034	0.095	0.216	0.380	0.574	120840
BOWL and MORL	100%	1277	<0.001	0.004	0.109	0.274	0.501	0.708	0.850	0.934	0.973	101438
BOWL and MORL	50%	638	<0.001	<0.001	0.010	0.046	0.132	0.292	0.507	0.706	0.849	111949

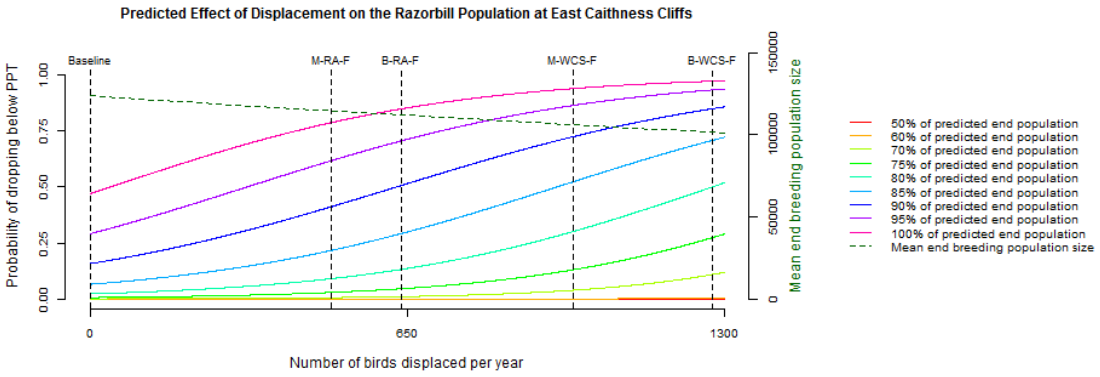


Figure L.1. Probability of the razorbill population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

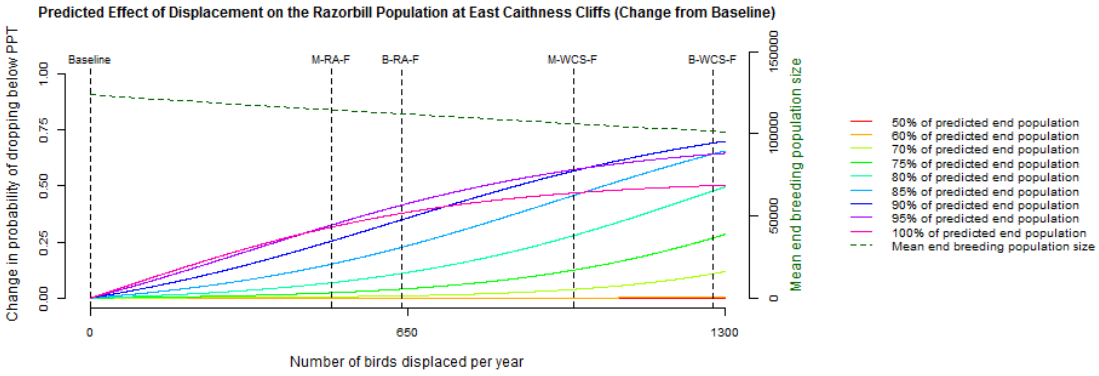


Figure L.2. Change in probability of the razorbill population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table L.2. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the razorbill population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	268278
Whole site	100%	990	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	226534
Whole site	50%	495	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	246524
Sum of MacColl, Telford & Stevenson	100%	990	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	226534
Sum of MacColl, Telford & Stevenson	50%	495	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	246524
MacColl	100%	461	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	247956
MacColl	50%	230	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	257917
Telford	100%	266	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	256368
Telford	50%	133	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	262256
Stevenson	100%	263	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	256487
Stevenson	50%	132	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	262316
MacColl and Stevenson	100%	724	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	237058
MacColl and Stevenson	50%	362	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	252185
Stevenson and Telford	100%	529	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	245100
Stevenson and Telford	50%	264	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	256428
Telford and MacColl	100%	727	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	236948
Telford and MacColl	50%	363	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	252127
BOWL	100%	287	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	255437
BOWL	50%	144	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	261779
BOWL and MORL	100%	1277	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	215691
BOWL and MORL	50%	638	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	240552

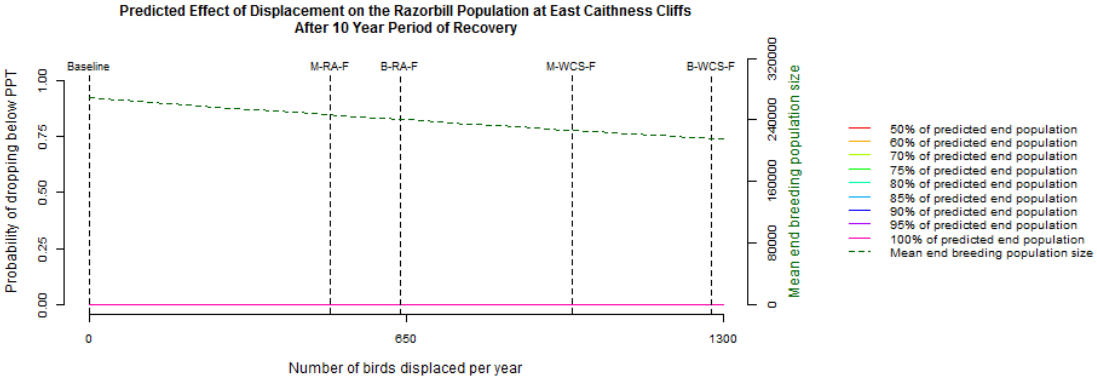


Figure L.3. Probability of the razorbill population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

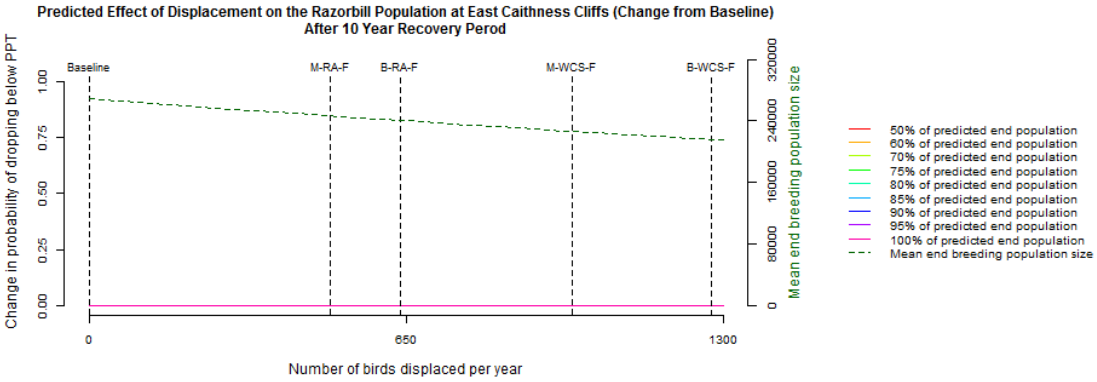


Figure L.4. Change in probability of the razobill population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix M – PVA Outputs: Razorbill – North Caithness Cliffs

Displacement

Table M.1. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the razorbill population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0	0	0.002	0.006	0.02	0.062	0.145	0.279	0.449	17349
Whole site	50%	528	0.592	0.969	0.997	0.999	1	1	1	1	1	9032
Whole site	10%	264	0.002	0.048	0.445	0.718	0.885	0.948	0.978	0.992	0.997	12518
Sum of MacColl, Telford & Stevenson	50%	528	0.592	0.969	0.997	0.999	1	1	1	1	1	9032
Sum of MacColl, Telford & Stevenson	10%	264	0.002	0.048	0.445	0.718	0.885	0.948	0.978	0.992	0.997	12518
MacColl	50%	246	0.001	0.031	0.348	0.628	0.836	0.925	0.969	0.988	0.996	12801
MacColl	10%	123	0	0.002	0.032	0.094	0.243	0.476	0.696	0.849	0.935	14902
Telford	50%	142	0	0.003	0.048	0.137	0.329	0.575	0.773	0.894	0.957	14560
Telford	10%	71	0	0	0.01	0.031	0.09	0.23	0.432	0.644	0.811	15893
Stevenson	50%	140	0	0.002	0.046	0.133	0.322	0.567	0.768	0.891	0.956	14586
Stevenson	10%	70	0	0	0.01	0.03	0.089	0.228	0.428	0.64	0.808	15908
MacColl and Stevenson	50%	386	0.039	0.496	0.928	0.976	0.992	0.996	0.998	0.999	1	10763
MacColl and Stevenson	10%	193	0	0.009	0.138	0.337	0.609	0.801	0.91	0.963	0.987	13664
Stevenson and Telford	50%	282	0.003	0.072	0.548	0.793	0.92	0.964	0.985	0.994	0.998	12241
Stevenson and Telford	10%	141	0	0.002	0.047	0.135	0.325	0.571	0.77	0.893	0.957	14573
Telford and MacColl	50%	388	0.04	0.505	0.93	0.977	0.992	0.996	0.998	0.999	1	10743
Telford and MacColl	10%	194	0	0.009	0.14	0.341	0.613	0.804	0.911	0.963	0.987	13652
BOWL	50%	153	0	0.003	0.061	0.17	0.387	0.633	0.812	0.915	0.967	14357
BOWL	10%	77	0	0.001	0.011	0.035	0.101	0.252	0.462	0.672	0.83	15782
BOWL and MORL	50%	681	0.986	0.999	1	1	1	1	1	1	1	7475
BOWL and MORL	10%	340	0.013	0.244	0.821	0.935	0.977	0.989	0.996	0.998	1	11388

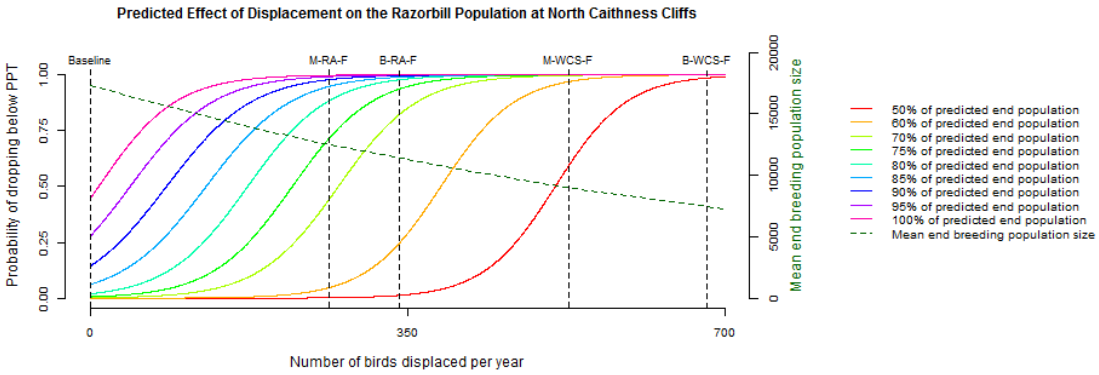


Figure M.1. Probability of the razorbill population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

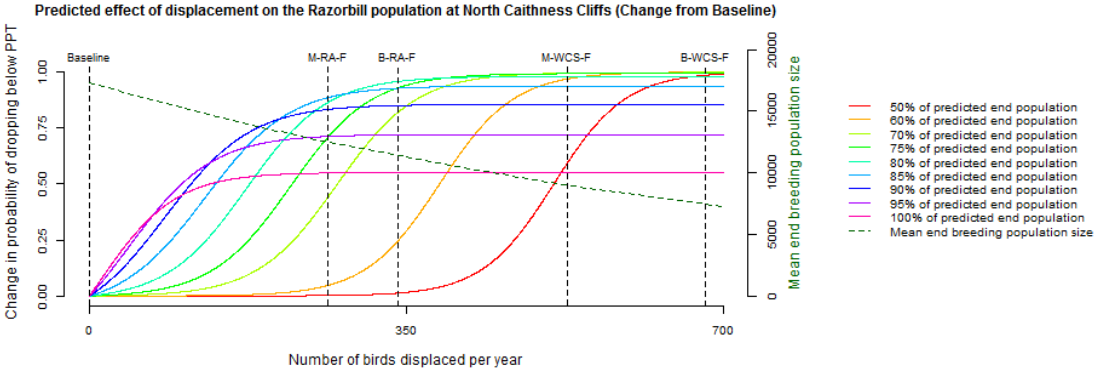


Figure M.2. Change in probability of the razorbill population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table M.2. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the razorbill population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	37757
Whole site	100%	528	<0.001	<0.001	0.001	0.004	0.011	0.030	0.065	0.132	0.243	18352
Whole site	50%	264	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002	26323
Sum of MacColl, Telford & Stevenson	100%	528	<0.001	<0.001	0.001	0.004	0.011	0.030	0.065	0.132	0.243	18352
Sum of MacColl, Telford & Stevenson	50%	264	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002	26323
MacColl	100%	246	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	26981
MacColl	50%	123	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	31918
Telford	100%	142	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	31108
Telford	50%	71	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	34271
Stevenson	100%	140	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	31169
Stevenson	50%	70	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	34305
MacColl and Stevenson	100%	386	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.004	0.008	0.019	22274
MacColl and Stevenson	50%	193	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	29000
Stevenson and Telford	100%	282	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.003	25681
Stevenson and Telford	50%	141	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	31139
Telford and MacColl	100%	388	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.004	0.009	0.020	22230
Telford and MacColl	50%	194	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	28971
BOWL	100%	153	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	30629
BOWL	50%	77	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	34007
BOWL and MORL	100%	681	<0.001	0.002	0.045	0.125	0.251	0.432	0.625	0.774	0.868	14887
BOWL and MORL	50%	340	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.003	0.008	23708

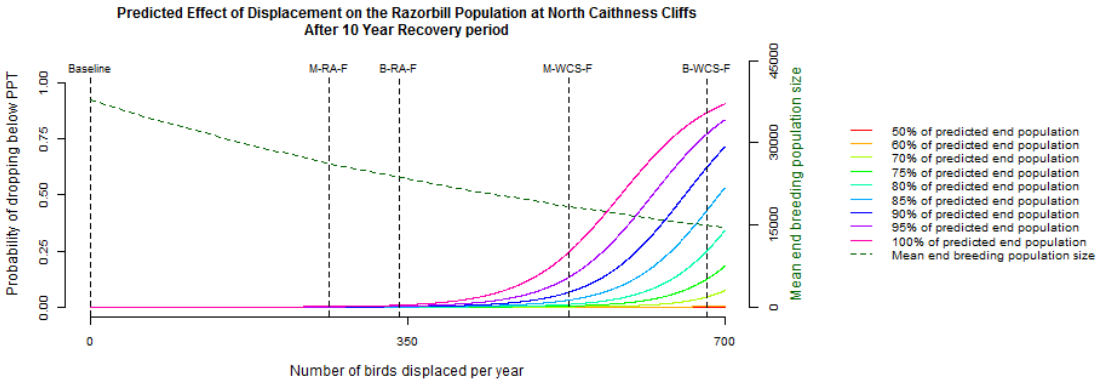


Figure M.3. Probability of the razorbill population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

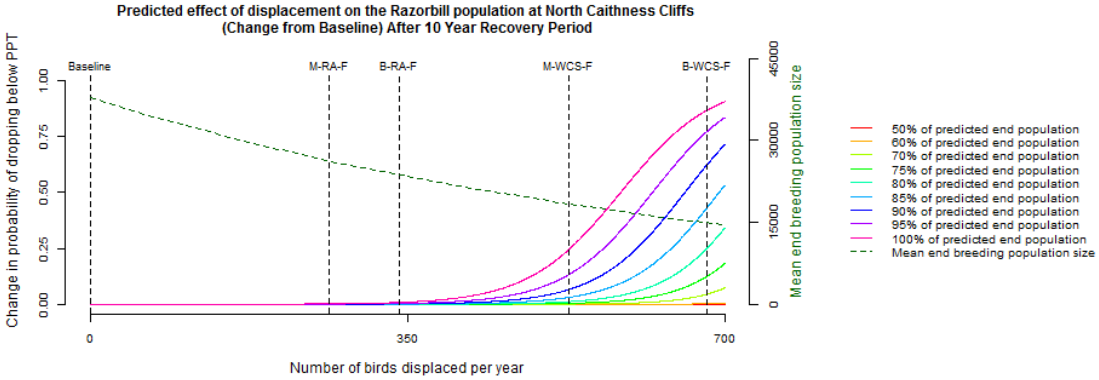


Figure M.4. Change in probability of the razorbill population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix N – PVA Outputs: Puffin – East Caithness Cliffs

Displacement

Table N.1. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the puffin population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	0	0	0.004	0.014	0.039	0.093	0.186	0.323	0.495	4207
Whole site	100%	159	0.937	0.995	0.999	1	1	1	1	1	1	1683
Whole site	50%	79	0.011	0.18	0.692	0.867	0.941	0.974	0.988	0.994	0.997	2668
Sum of MacColl, Telford & Stevenson	100%	159	0.937	0.995	0.999	1	1	1	1	1	1	1683
Sum of MacColl, Telford & Stevenson	50%	79	0.011	0.18	0.692	0.867	0.941	0.974	0.988	0.994	0.997	2668
MacColl	100%	138	0.691	0.97	0.996	0.998	0.999	1	1	1	1	1899
MacColl	50%	69	0.004	0.086	0.5	0.75	0.882	0.946	0.974	0.987	0.994	2827
Telford	100%	165	0.962	0.997	1	1	1	1	1	1	1	1626
Telford	50%	82	0.014	0.22	0.742	0.892	0.952	0.979	0.99	0.995	0.998	2623
Stevenson	100%	95	0.044	0.46	0.892	0.958	0.982	0.992	0.996	0.998	0.999	2433
Stevenson	50%	47	0.001	0.014	0.143	0.351	0.586	0.773	0.882	0.939	0.97	3209
MacColl and Stevenson	100%	232	1	1	1	1	1	1	1	1	1	1105
MacColl and Stevenson	50%	116	0.235	0.835	0.979	0.991	0.996	0.998	0.999	1	1	2156
Stevenson and Telford	100%	259	1	1	1	1	1	1	1	1	1	946
Stevenson and Telford	50%	130	0.521	0.943	0.993	0.997	0.999	0.999	1	1	1	1989
Telford and MacColl	100%	302	1	1	1	1	1	1	1	1	1	738
Telford and MacColl	50%	151	0.879	0.99	0.999	0.999	1	1	1	1	1	1762
BOWL	100%	38	<0.001	0.007	0.074	0.212	0.418	0.635	0.793	0.888	0.942	3380
BOWL	50%	19	<0.001	0.001	0.017	0.058	0.146	0.297	0.483	0.66	0.8	3771
BOWL and MORL	100%	197	0.998	1	1	1	1	1	1	1	1	1352
BOWL and MORL	50%	98	0.057	0.523	0.914	0.966	0.985	0.993	0.997	0.998	0.999	2392

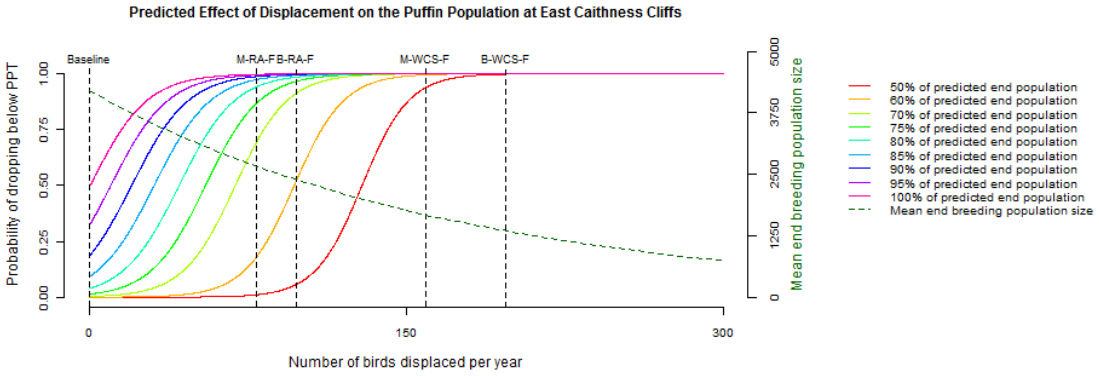


Figure N.1. Probability of the puffin population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

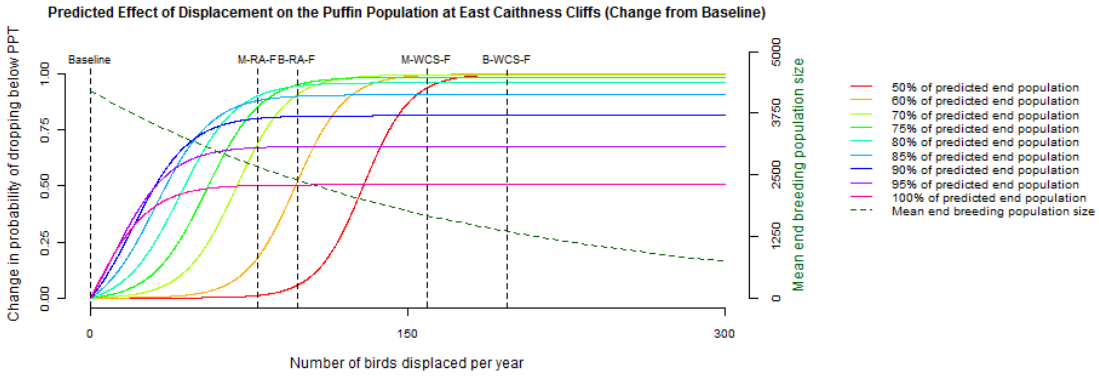


Figure N.2. Change in probability of the puffin population at East Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table N.2. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the puffin population at East Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	9209
Whole site	100%	159	<0.001	0.002	0.017	0.052	0.118	0.233	0.398	0.578	0.719	3241
Whole site	50%	79	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.003	0.006	5481
Sum of MacColl, Telford & Stevenson	100%	159	<0.001	0.002	0.017	0.052	0.118	0.233	0.398	0.578	0.719	3241
Sum of MacColl, Telford & Stevenson	50%	79	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.003	0.006	5481
MacColl	100%	138	<0.001	<0.001	0.003	0.010	0.022	0.050	0.107	0.208	0.346	3720
MacColl	50%	69	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.003	5853
Telford	100%	165	<0.001	0.003	0.029	0.083	0.182	0.334	0.519	0.687	0.800	3116
Telford	50%	82	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.003	0.008	5374
Stevenson	100%	95	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.004	0.009	0.021	4934
Stevenson	50%	47	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	6763
MacColl and Stevenson	100%	232	0.099	0.593	0.917	0.958	0.984	0.993	0.996	0.998	0.998	2007
MacColl and Stevenson	50%	116	<0.001	<0.001	<0.001	0.002	0.004	0.008	0.020	0.044	0.093	4299
Stevenson and Telford	100%	259	0.599	0.945	0.992	0.995	0.998	0.999	1.000	1.000	1.000	1681
Stevenson and Telford	50%	130	<0.001	<0.001	0.001	0.005	0.012	0.026	0.059	0.123	0.225	3921
Telford and MacColl	100%	302	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1267
Telford and MacColl	50%	151	<0.001	0.001	0.009	0.028	0.064	0.135	0.257	0.422	0.584	3416
BOWL	100%	38	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	7175
BOWL	50%	19	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	8128
BOWL and MORL	100%	197	0.004	0.057	0.335	0.560	0.767	0.880	0.936	0.965	0.978	2525
BOWL and MORL	50%	98	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.005	0.011	0.026	4838

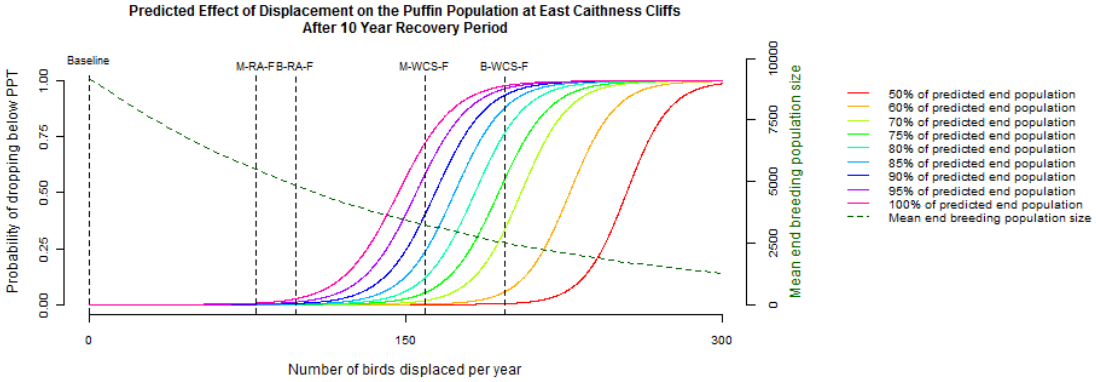


Figure N.3. Probability of the puffin population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

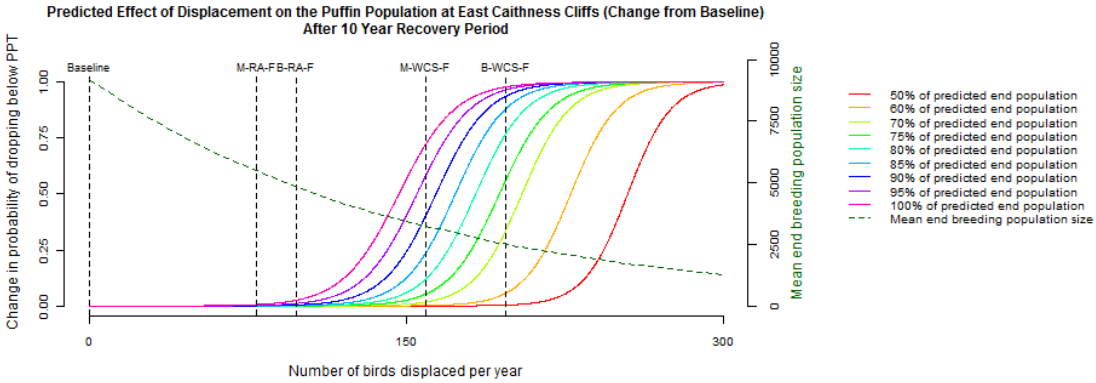


Figure N.4. Change in probability of the puffin population at East Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Appendix O – PVA Outputs: Puffin –North Caithness Cliffs

Displacement

Table O.1. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the puffin population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	0.005	0.014	0.035	0.082	0.162	0.299	0.455	96443
Whole site	100%	1587	0.002	0.052	0.353	0.595	0.795	0.905	0.959	0.983	0.993	73475
Whole site	50%	794	<0.001	0.004	0.048	0.125	0.273	0.481	0.680	0.832	0.916	84172
Sum of MacColl, Telford & Stevenson	100%	1587	0.002	0.052	0.353	0.595	0.795	0.905	0.959	0.983	0.993	73475
Sum of MacColl, Telford & Stevenson	50%	794	<0.001	0.004	0.048	0.125	0.273	0.481	0.680	0.832	0.916	84172
MacColl	100%	468	<0.001	0.001	0.018	0.052	0.126	0.262	0.442	0.644	0.792	89009
MacColl	50%	234	<0.001	0.001	0.009	0.027	0.067	0.151	0.282	0.467	0.641	92652
Telford	100%	559	<0.001	0.002	0.024	0.067	0.158	0.317	0.511	0.705	0.836	87632
Telford	50%	280	<0.001	0.001	0.010	0.031	0.076	0.169	0.310	0.503	0.674	91924
Stevenson	100%	322	<0.001	0.001	0.012	0.035	0.086	0.187	0.338	0.535	0.703	91265
Stevenson	50%	161	<0.001	0.001	0.007	0.022	0.055	0.126	0.239	0.412	0.585	93818
MacColl and Stevenson	100%	790	<0.001	0.004	0.047	0.124	0.271	0.478	0.677	0.830	0.915	84230
MacColl and Stevenson	50%	395	<0.001	0.001	0.015	0.042	0.104	0.222	0.389	0.590	0.750	90130
Stevenson and Telford	100%	881	<0.001	0.005	0.061	0.156	0.327	0.545	0.734	0.866	0.936	82926
Stevenson and Telford	50%	440	<0.001	0.001	0.017	0.048	0.117	0.246	0.422	0.623	0.777	89437
Telford and MacColl	100%	1028	<0.001	0.009	0.092	0.222	0.428	0.648	0.811	0.910	0.959	80863
Telford and MacColl	50%	514	<0.001	0.002	0.021	0.059	0.141	0.289	0.477	0.675	0.815	88310
BOWL	100%	763	<0.001	0.004	0.043	0.116	0.255	0.458	0.659	0.818	0.908	84621
BOWL	50%	382	<0.001	0.001	0.014	0.041	0.101	0.216	0.380	0.581	0.742	90331
BOWL and MORL	100%	2350	0.040	0.396	0.845	0.933	0.973	0.989	0.996	0.998	0.999	64468
BOWL and MORL	50%	1176	<0.001	0.014	0.136	0.305	0.536	0.740	0.870	0.941	0.974	78838

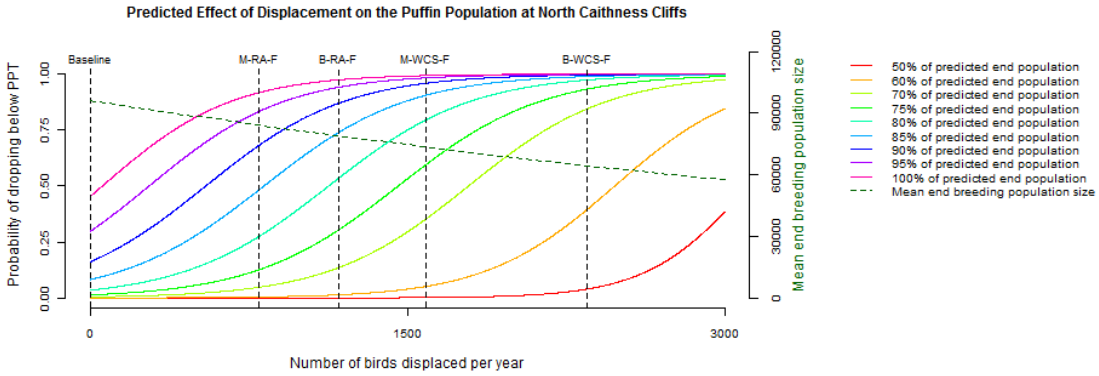


Figure O.1. Probability of the puffin population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

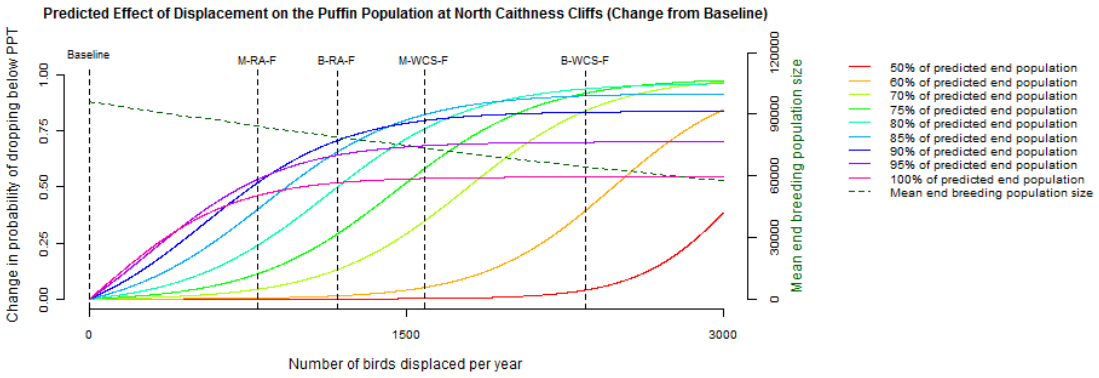


Figure O.2. Change in probability of the puffin population at North Caithness Cliffs dropping below population percentage thresholds (up to end of impact).

Table O.2. Modelled probabilities of dropping below baseline predicted population size (after 25 years) for the puffin population at North Caithness Cliffs with increasing displacement rates (probabilities are based on the 25 year expected life span of the development plus a 10 year recovery period). (PPT = population percentage threshold, representing different proportions of the baseline predicted population size after 25 years).

Site	Displacement rate	Number displaced	Probability of dropping below percentage of current population size									Predicted end population size
			50%	60%	70%	75%	80%	85%	90%	95%	100%	
Baseline	Zero	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	207811
Whole site	100%	1587	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	152441
Whole site	50%	794	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	177968
Sum of MacColl, Telford & Stevenson	100%	1587	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	152441
Sum of MacColl, Telford & Stevenson	50%	794	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	177968
MacColl	100%	468	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	189664
MacColl	50%	234	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	198531
Telford	100%	559	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	186324
Telford	50%	280	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	196756
Stevenson	100%	322	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	195149
Stevenson	50%	161	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	201381
MacColl and Stevenson	100%	790	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	178108
MacColl and Stevenson	50%	395	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	192387
Stevenson and Telford	100%	881	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	174971
Stevenson and Telford	50%	440	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	190704
Telford and MacColl	100%	1028	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	170021
Telford and MacColl	50%	514	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	187969
BOWL	100%	763	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	179049
BOWL	50%	382	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	192876
BOWL and MORL	100%	2350	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.007	0.015	131342
BOWL and MORL	50%	1176	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	165178

Figure O.3. Probability of the puffin population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

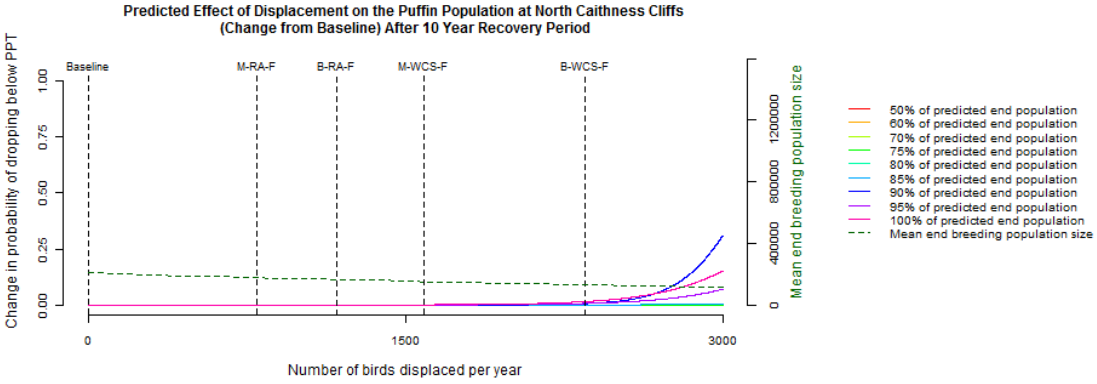


Figure O.4. Change in probability of the puffin population at North Caithness Cliffs dropping below population percentage thresholds (after 10 year recovery period).

Moray Offshore Renewables
EDPR UK
40 Princes Street
Edinburgh
EH2 2BY

Email: info@morayoffshorerenewables.co.uk

moray offshore renewables ltd