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MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Project alone and cumulative assessment for the Great Orme's Head SSSI

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Image of an offshore wind farm

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Glossary

Term	Meaning
Applicant	Morgan Offshore Wind Limited.
Apportioning	A method that assigns unknown entities to known entities based on weighing factors. In this report, it refers to birds of unknown origin within the study area that are assigned to colonies based on distance to colony and colony size.
Biologically Defined Minimum Population Scale (BDMPS)	Minimum regional population size of a particular bird species at a certain time of year, defined for a range of species in Furness (2015).
Collision risk	Risk of a bird lethally colliding with a wind turbine within a wind farm.
Collision risk model	A model that calculates collision risk for a species within a wind farm based on a set of wind farm and bird species specific parameters. Collision risk models can be run deterministically or stochastically.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for a Nationally Significant Infrastructure Project (NSIP).
Morgan Array Area	The area within which the wind turbines, foundations, inter-array cables, interconnector cables, scour protection, cable protection and offshore substation platforms (OSPs) forming part of the Morgan Offshore Wind Project Generation Assets will be located.
Morgan Offshore Wind Project: Generation Assets	This is the name given to the Morgan Generation Assets project as a whole (includes all infrastructure and activities associated with the project construction, operations and maintenance, and decommissioning).
Parameter	Parameters are the input elements of a model that together affect the output of a model. In collision risk models, examples of parameters are the number of wind turbines and the length of the bird.
The Planning Inspectorate	The agency responsible for operating the planning process for applications for development consent under the Planning Act 2008.

Acronyms

Acronym	Description
AON	Apparently Occupied Nests
BDMPS	Biologically Defined Minimum Population Scale
CEA	Cumulative Effects Assessment
CRM	Collision Risk Modelling
EIA	Environmental Impact Assessment
HRA	Habitats Regulations Assessment
JNCC	Cumulative Effects Assessment
NRW	Natural Resources Wales
PVA	Population Viability Analysis
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area

Acronym	Description
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate

Units

Unit	Description
km	Kilometres
MW	Megawatt
%	Percentage

1 PROJECT ALONE AND CUMULATIVE ASSESSMENT FOR THE GREAT ORME'S HEAD SSSI

1.1 Introduction

1.1.1.1 This note has been developed on behalf of Morgan Offshore Wind Limited, hereafter referred to as 'the Applicant', in response to comments from Natural Resources Wales (NRW) (REP3-050) on Annex 4.8 to Response to Hearing Action Point 15: Great Orme Head SSSI Clarification Note (REP1-013) of the Applicant's submission at Deadline 1. This note updates the assessment presented in Annex 4.8 to Response to Hearing Action Point 15: Great Orme Head SSSI Clarification Note (REP1-013) based on specific comments on that note and also comments from NRW and other parties on other matters associated with both the application and other clarification notes submitted into the Examination.

1.1.1.2 The Applicant has previously responded to comments from NRW provided as part of their Relevant Representation (Annex 4.8 to Response to Hearing Action Point 15: Great Orme Head SSSI Clarification Note (REP1-013)). This updates relevant sections of the note to account for comments from NRW received at Deadline 3, both on Annex 4.8 to Response to Hearing Action Point 15: Great Orme Head SSSI Clarification Note (REP1-013) in REP3-050 and other clarification notes submitted into the Examination. As such, this note draws on information presented in the following clarification notes previously submitted into the Examination:

- Annex 4.5 to Response to Hearing Action Point 15: Offshore Ornithology CEA and In-combination Gap-filling of Historical Projects Note (REP1-010)
- Displacement Rates Clarification Note (REP1-011)
- Annex 4.7 to Response to Hearing Action Point 15: Apportioning Sensitivity Analysis (REP1-012)
- Review of Cumulative Effects Assessment and In-Combination Assessment: Offshore ornithology (REP3-019)
- Kittiwake apportioning clarification note (REP3-020).

1.1.1.3 How the information presented in these clarification notes, and the responses provided by Interested Parties on these notes, has been incorporated into the assessments presented in this clarification note is detailed in the relevant methodological section below.

1.2 Methodology

1.2.1 Breeding season

1.2.1.1 In Annex 4.8 to Response to Hearing Action Point 15: Great Orme Head SSSI Clarification Note (REP1-013), apportioning values for the breeding season were sourced from Volume 4, Annex 5.5: Offshore ornithology apportioning technical report (APP-057). At Deadline 1 the Applicant provided Annex 4.7 in response to Hearing Action Point 15: Apportioning Sensitivity Analysis (REP1-012) that presented updated apportioning values for the breeding season. These were calculated using the newly published Seabirds Count dataset (Burnell *et al.,* 2023). Whilst Annex 4.7 to Response to Hearing Action Point 15: Apportioning Sensitivity Analysis (REP1-012) focussed on the implications for SPA and Ramsar populations, the process applied in that note is

also applicable to the Pen y Gogarth/Great Orme's Head SSSI. This section therefore presents the same information as presented in section 1.2.1 of Annex 4.8 to Response to Hearing Action Point 15: Great Orme Head SSSI Clarification Note (REP1-013) but using the apportioning values calculated using the Seabirds Count dataset (Table 1.1). These apportioning values are then applied throughout other relevant sections in this note.

Table 1.1: Breeding season apportioning values used for features of the Pen y Gogarth/Great Orme's Head SSSI.

Feature	Population	Apportioning value
Kittiwake	2,660 breeding individuals	0.08
Guillemot	2,618 individuals (3,508 breeding adults)	0.05
Razorbill	143 individuals (192 breeding adults)	0.04

1.2.1.2 NRW, in their Relevant Representation (RR-027) indicated that they did not support the use of the apportioning approach applied for kittiwake in the breeding season, specifically in relation to the inclusion of older immature birds in the apportioning values applied. The Applicant can, however, confirm that this approach was not applied for the kittiwake feature of the Pen y Gogarth/Great Orme's Head SSSI in Volume 2, Chapter 5: Offshore ornithology (APP-023). In APP-023, it was assumed that all birds present at the Morgan Generation Assets from the Pen y Gogarth/Great Orme's Head SSSI during the breeding season were breeding adult birds with no immature birds present. This represents an over-estimate of the likely impact as it is well documented that immature kittiwake visit natal waters during the breeding season (e.g. Coulson, 2011) and will therefore be present at the Morgan Generation Assets.

1.2.1.3 At Deadline 3, the Applicant submitted the Kittiwake apportioning clarification note (REP3-020). This note addressed comments from Natural England and NRW regarding the Applicant's approach used to estimate the proportion of immature kittiwake present at the Morgan Generation Assets in the breeding season by the Applicant in HRA Stage 2 information to support an appropriate assessment Part Three: Special Protection Areas and Ramsar Site assessments (APP-098). The latter document had incorporated consideration of all immature age classes of kittiwake. However, Natural England and NRW did not agree with the approach used to estimate the proportion of older immatures and recommended that the proportion of immatures to be used should only reflect first-year kittiwake. In response, the Applicant conducted a sensitivity analysis as provided in REP3-020 that showed the application of an immature proportion representing only first year immatures would not alter the conclusions reached in HRA Stage 2 information to support an appropriate assessment Part Three: Special Protection Areas and Ramsar Site assessments (APP-098).

1.2.1.4 The proportion presented in the Kittiwake apportioning clarification note (REP3-020), excluding consideration of older immatures in the apportioning approach for kittiwake (84.11%), has therefore been used to inform the assessments presenting the Statutory Nature Conservation Body (SNCB) position for kittiwake in this note. This proportion was not applied in Annex 4.8 to Response to Hearing Action Point 15: Great Orme Head SSSI Clarification Note (REP1-013) to ensure a comparison could be made between the assessments in that note and those presented in Volume 2, Chapter 5: Offshore ornithology (APP-023). However, as the current note is providing assessments based on different assumptions to those applied in Volume 2, Chapter

5: Offshore ornithology (APP-023), consistency with the assumptions made in Volume 2, Chapter 5: Offshore ornithology (APP-023) is no longer required and therefore to provide a more ecological realistic assessment that remains precautionary the proportion of immature kittiwake as calculated in the Kittiwake apportioning clarification note (REP3-020) is applied. Assessments for the Applicant's approach use the proportion including older immatures as was applied in HRA Stage 2 information to support an appropriate assessment Part Three: Special Protection Areas and Ramsar Site assessments (APP-098).

1.2.1.5 Furness (2015) provides pre-breeding season populations for kittiwake in UK western waters. These populations include quantification of the immature component. For those colonies closest to the Morgan Generation Assets (e.g. Rathlin Island SPA), the populations presented assume that 40% of immatures associated with these colonies return to UK waters in the pre-breeding season. These birds are unlikely to move out of UK waters during the breeding season and therefore this would suggest that the application of the apportioning value calculated applying the Applicant's methodology provides a comparable representation of the proportion of immatures to that assumed in Furness (2015).

1.2.2 Non-breeding seasons

1.2.2.1 The calculation of apportioning values for non-breeding seasons (post-breeding, non-breeding and pre-breeding) has followed SNCB guidance (Natural England, 2021). For apportionment, the contribution of adult birds from an individual colony, as derived from the Seabird Monitoring Programme (SMP) Database (JNCC *et al.*, 2024), to the relevant Biologically Defined Minimum Population Scale (BDMPS) population for each species/season combination is divided by the total BDMPS population.

1.2.2.2 The individual colony populations that are incorporated into the apportioning calculations for non-breeding seasons are usually sourced from Furness (2015). Furness (2015) presents colony-specific data for SPA populations but not for smaller populations such as those found at the Pen y Gogarth/Great Orme's Head SSSI. In accordance with SNCB advice, the population used for the Pen y Gogarth/Great Orme's Head SSSI was therefore taken from the Seabird 2000 seabird census, the data from which are comparable in timeframe, survey methods and units used to the data used in Furness (2015). Furness (2015) also provides the proportion of birds from a colony expected to be present in a given BDMPS area during the season in question. As the Pen y Gogarth/Great Orme's Head SSSI is not explicitly included in Furness (2015) the proportions applied have been taken from the closest colony that is named in Furness (2015). In all cases this is the proportion used for the Rathlin Island SPA which is the closest named colony in Furness (2015) to the Pen y Gogarth/Great Orme's Head SSSI. In all cases, whilst being the closest named colony, the proportions applied to the population at the Rathlin Island SPA are the highest of all proportions applied for each species in each of the relevant seasonal BDMPS calculations[1].

1.2.2.3 The populations used for each feature at the Pen y Gogarth/Great Orme's Head SSSI, the proportion of birds in the given BDMPS area and the resulting seasonal apportioning values are presented in Table 1.2. Note that the populations for guillemot and razorbill are corrected from individuals (as provided in the SMP database and which includes incubating and brooding adults, some of their mates, failed and non-

[1] The proportions that Furness (2015) applied to the populations of the UK western non-SPA colonies are either equal to or lower than those for Rathlin Island SPA.

breeders, and immature birds) to breeding pairs using a correction factor of 0.67 (Mitchell *et al.* 2004). The kittiwake population is multiplied by two to correct breeding pairs (as provided in the SMP database) to breeding adults.

Table 1.2: Non-breeding proportions and apportioning values for each feature of the Pen y Gogarth/Great Ormes Head SSSI.

Feature	Season	Population from the SMP database	Population (breeding adults)	Proportion of adults in UK western waters in non-breeding season	BDMPS population (UK western waters)	Apportioning value
Kittiwake	Post-breeding	652 breeding pairs	1,304	0.6[2]	911,586	0.001
	Pre-breeding			0.8	691,526	0.001
Guillemot	Non-breeding	622 individuals	833	1	1,139,220	0.001
Razorbill	Post-breeding	196 individuals	263	0.98	606,914	<0.001
	Non-breeding			0.4	341,422	<0.001
	Pre-breeding			0.98	606,914	<0.001

1.2.3 Baseline mortality rates

1.2.3.1 As identified by NRW, the assessments presented in Volume 2, Chapter 5: Offshore ornithology (APP-023) used an average baseline mortality rate that represents the average baseline mortality rate across all age classes for each species. The populations for the Pen y Gogarth/Great Orme's Head SSSI against which impacts have been assessed comprises breeding adults only and therefore the assessment needs to use a baseline mortality rate for adult birds only. The Applicant is therefore following the approach recommended in NRW's Relevant Representation (RR-027), and this clarification note therefore provides an updated calculation using a baseline mortality rate for adult birds only. The baseline mortality rates used for each species have been taken from Horswill and Robinson (2015) and are consistent with those used to inform the calculation of average baseline mortality rates in Volume 2, Chapter 5: Offshore ornithology (APP-023).

1.2.3.2 The assessments presented in Volume 2, Chapter 5: Offshore ornithology (APP-023) for the Pen y Gogarth/Great Orme's Head SSSI are repeated in the following sections with adult only baseline mortality rates now applied as recommended by NRW.

1.2.4 Populations

1.2.4.1 The populations used for assessment are those incorporated into the Seabirds Count census. This approach is normally applied when considering the impact of a project on individual breeding colonies and aligns with the approach taken in HRA Stage 2 information to support an appropriate assessment Part Three: Special Protection

[2] This value is used as it reflects the proportion applied in Furness (2015) to the Rathlin Island SPA, which is the closest named colony in Furness (2015) to the Pen y Gogarth/Great Orme's Head SSSI.

Areas and Ramsar Site assessments (APP-098). The populations used represent breeding adults only and have been corrected using standard correction factors for each species as described in paragraph 1.2.2.3.

1.2.5 Updates to assessments due to other points raised by consultees

1.2.5.1 In addition to the changes to the assessment based on stakeholder comments identified in the preceding sections, the assessments have also been updated to take account of information included in other Examination submissions. This includes:

- The inclusion of impact estimates for additional projects that were included qualitatively in the Morgan Generation Assets application with quantified estimates having been calculated in REP1-010. Incorporated throughout all assessments presented in this note.
- The use of mean-peak populations, collision risk estimates and apportioning values calculated for the Morecambe Generation Assets presented in the Morecambe Offshore Windfarms: Generation Assets application (considered in REP3-019). Incorporated throughout all assessments presented in this note.
- The inclusion of March in the breeding season for kittiwake following comments from JNCC in REP3-035. Incorporated into the SNCB position assessed in this note.
- The presentation of full apportioned displacement matrices.

1.3 Project alone assessment

1.3.1 Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure

1.3.1.1 The assessments provided in Volume 2, Chapter 5: Offshore ornithology (APP-023) applied the Applicant's evidence-based displacement and mortality rates only. The assessment of disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure provided in the following sections also considers the displacement and mortality rates applied by the Secretary of State as part of their assessments for guillemot and razorbill in relation to impacts associated with the Hornsea Four and Sheringham Shoal and Dudgeon Extensions projects. Specifically, a displacement rate of 70% and mortality rate of 2% have been applied for both species of relevance with the Secretary of State's decisions on those projects representing the precedent for the upper range of displacement and mortality rates for this type of assessment.

1.3.1.2 In addition, displacement matrices presenting apportioning values for a range of displacement rates (10 to 100% in 10% increments) and mortality rates (1, 2, 5 and 10 to 100 in 10% increments) are presented for guillemot and razorbill in Appendix A:.

Operations and maintenance phase

Guillemot

Applicant's assessment using preferred rates of 50% displacement and 1% mortality

1.3.1.3 The predicted annual and seasonal impacts associated with the Morgan Generation Assets on the guillemot population of the Pen y Gogarth/Great Orme's Head SSSI

represents less than a 1% increase in the baseline mortality of the SSSI population (Table 1.3).

Table 1.3: Calculation of displacement impacts for guillemot at the Pen y Gogarth/Great Orme's Head SSSI when using 50% displacement and 1% mortality rates proposed by the Applicant.

Season	Displacement impact (no. of birds)	Apportioning value	Apportioned impact	SSSI adult population (no. of individuals) (year)	Adult baseline mortality	Increase in baseline mortality (%)
Breeding	20	0.05	0.96	3,508 (2017)	214.0	0.45
Non-breeding	19	<0.01	0.01			0.01
Annual	-	-	0.98[3]			0.46

1.3.1.4 The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be negligible for the SSSI population. This conclusion is consistent with the conclusion reached in Volume 2, Chapter 5: Offshore ornithology (APP-023).

Assessment based on Secretary of State's displacement and mortality rates (70% displacement and 2% mortality)

1.3.1.5 The predicted annual and seasonal impacts associated with the Morgan Generation Assets on the guillemot population of the Pen y Gogarth/Great Orme's Head SSSI represents more than a 1% increase in the baseline mortality of the SSSI population when applying the previously used Secretary of State's parameter assumptions. Population viability modelling has therefore been conducted with the input parameters presented in Appendix B.

Table 1.4: Calculation of displacement impacts for guillemot at the Pen y Gogarth/Great Orme's Head SSSI when using 70% displacement and 2% mortality rates previously used by the Secretary of State.

Season	Displacement impact (no. of birds)	Apportioning value	Apportioned impact	SSSI adult population (no. of individuals) (year)	Adult baseline mortality	Increase in baseline mortality (%)
Breeding	56	0.05	2.70	3,508 (2017)	214.0	1.26
Non-breeding	54	<0.01	0.04			0.02
Annual	-	-	2.74			1.28

[3] Throughout all tables in this report, numbers are presented to an appropriate number of decimal places. Underlying calculations are conducted utilising the full number and therefore totals provided in tables may not equal the constituent numbers within the same table.

1.3.1.6 The annual impact presented in Table 1.3 (and Table 1.2) is a known over-estimate due to the assumption that all birds present at the Morgan Generation Assets in the breeding season are breeding adults. This is however, not ecologically valid as it is known that a proportion of the birds present will be immature or sabbatical birds (Furness, 2015; Halley and Harris, 1993). It is however, not possible to distinguish between immature and adult guillemot during aerial surveys and therefore the assumption has been made in the calculations presented in Table 1.3 (and Table 1.2) that all birds present are breeding adults.

1.3.1.7 One potential solution is the use of the adult:immature ratio presented in Furness (2015). Furness (2015) states that for every adult there are 0.74 immatures providing an adult proportion of 0.57. This ratio represents the number of adult and immature guillemots present in a stable population. Applying this immature proportion would reduce the impact calculated in Table 1.3 to 1.6 birds/annum representing a 0.74% increase in baseline mortality.

1.3.1.8 Furness (2015) provides non-breeding season populations for guillemot in UK western waters. These populations include quantification of the immature component. For those colonies closest to the Morgan Generation Assets (e.g. Rathlin Island SPA), the populations presented assume that 90% of immatures associated with these colonies remain in UK waters in the non-breeding season. These birds are unlikely to move out of UK waters during the breeding season and therefore this would suggest that the application of the correction factor noted above is appropriate and provides a more accurate reflection of the potential impact on guillemot at the Pen y Gogarth/Great Orme's Head SSSI.

1.3.1.9 There is uncertainty in relation to the distribution of adult and immature birds within UK waters. The Morgan Generation Assets is approximately 63 km from the Pen y Gogarth/Great Orme's Head SSSI. This is beyond the mean-maximum foraging range of guillemot (55.5 km), where it is likely the large majority of breeding adult guillemot from the Pen y Gogarth/Great Orme's Head SSSI forage, but within the mean-maximum foraging range plus one standard deviation (95.2 km) where a smaller proportion of breeding adult birds from the Pen y Gogarth/Great Orme's Head SSSI are likely to forage. It is therefore considered that the ratio of breeding adult to immature birds calculated in Furness (2015) provides an accurate and suitably precautionary representation of the likely proportions of these population components at the Morgan Generation Assets.

1.3.1.10 In addition to immature birds, sabbatical birds are also likely to be present at the Morgan Generation Assets. Horswill and Robinson (2015) suggests that 7.9% of birds present are sabbatical birds with this value considered to be of good quality and good representation as part of the study. The application of this value would reduce the predicted impact to 1.5 birds/annum representing a 0.67% increase in baseline mortality.

1.3.1.11 PVA modelling has therefore been conducted for the impact scenarios identified in Table 1.5 representing the impact from the Morgan Generation Assets at different displacement and mortality rates taking account of different population components. PVA modelling for additional impact scenarios incorporating a range of displacement and mortality rates are presented in Appendix C.

Table 1.5: Predicted impact scenarios for guillemot from the Pen y Gogarth/Great Orme's Head SSSI due to displacement impacts associated with the Morgan Generation Assets.

Impact scenario	Colony proportion (%)	Adult proportion (%)	Sabbatical proportion (%)	Displacement impact (no. of birds)	Increase in baseline mortality (%)	Impact on adult survival rate
All birds are breeding adults	4.8	0	0	2.7	1.28	0.000781
Inclusion of immatures	4.8	57.47	0	1.6	0.74	0.000454
Inclusion of immature and sabbaticals	4.8	57.47	7.9	1.5	0.69	0.000419

1.3.1.12 PVA outputs for each of the scenarios identified in Table 1.5 are presented in Table 1.6.

Table 1.6: PVA outputs for the annual impact on guillemot from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets using displacement impacts calculated using a 70% displacement rate and 2% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	4,853	2.7	1.027	0.953	1.097	-	-
2030	All birds are breeding adults	4,845	2.6	1.026	0.953	1.097	0.999	0.998
2030	Inclusion of immatures	4,844	2.6	1.026	0.953	1.097	1.000	0.999
2030	Inclusion of immature and sabbaticals	4,855	2.7	1.027	0.953	1.097	1.000	0.999
2065	Baseline (unimpacted)	11,868	151.6	1.026	1.017	1.035	-	-
2065	All birds are breeding adults	11,519	144.0	1.025	1.016	1.034	0.999	0.969
2065	Inclusion of immatures	11,672	147.0	1.025	1.016	1.034	1.000	0.982

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2065	Inclusion of immature and sabbaticals	11,667	147.0	1.025	1.016	1.034	1.000	0.984

1.3.1.13 The PVA for guillemot from Pen y Gogarth/Great Orme's Head SSSI indicated that when considering an impact scenario of 70% displacement and 2% mortality and assuming all birds present at the Morgan Generation Assets were breeding adult birds, the unimpacted baseline population growth rate would be reduced by 0.001. A positive population growth rate was sustained indicating that the population is predicted to be growing and is predicted to be 144% larger than the current size after 35 years (2065).

1.3.1.14 The population of guillemot from Pen y Gogarth/Great Orme's Head SSSI has been increasing in size consistently since 2000 (average annual growth rate of 1.043 between 2000 and 2023, JNCC, 2024). This empirical annual average growth rate is higher than predicted by the PVA. Given the PVA is predicting a continuation of the increasing population, the predicted impact can be considered to be of negligible magnitude.

1.3.1.15 Following the EIA methodology defined in Volume 2, Chapter 5: Offshore ornithology (APP-023), guillemot is deemed to be of high vulnerability, medium recoverability and regional value. The sensitivity of the receptor is, therefore, considered to be medium. Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of negligible adverse significance which is not significant in EIA terms. This conclusion is consistent with the conclusions reached in Volume 2, Chapter 5: Offshore ornithology (APP-023).

Razorbill

Applicant's assessment using preferred rates of 50% displacement and 1% mortality

1.3.1.16 The predicted annual and seasonal impacts associated with the Morgan Generation Assets on the razorbill population of the Pen y Gogarth/Great Orme's Head SSSI represents less than a 1% increase in the baseline mortality of the SSSI population (Table 1.7).

Table 1.7: Calculation of displacement impacts for razorbill at the Pen y Gogarth/Great Orme's Head SSSI when using 50% displacement and 1% mortality rates proposed by the Applicant.

Season	Displacement impact (no. of birds)	Apportioning value	Apportioned impact	SSSI adult population (no. of individuals) (year)	Adult baseline mortality	Increase in baseline mortality (%)
Breeding	<1	0.04	0.01	192 (2017)	20.1	0.04

Season	Displacement impact (no. of birds)	Apportioning value	Apportioned impact	SSSI adult population (no. of individuals) (year)	Adult baseline mortality	Increase in baseline mortality (%)
Post-breeding	1	<0.01	<0.01			<0.01
Non-breeding	6	<0.01	<0.01			0.01
Pre-breeding	2	<0.01	<0.01			<0.01
Annual	-	-	0.01			0.05

1.3.1.17 The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be negligible for the SSSI population. This conclusion is consistent with the conclusion reached in Volume 2, Chapter 5: Offshore ornithology (APP-023).

Assessment based on Secretary of State's displacement and mortality rates (70% displacement and 2% mortality)

1.3.1.18 The predicted annual and seasonal impacts associated with the Morgan Generation Assets on the razorbill population of the Pen y Gogarth/Great Orme's Head SSSI represents less than a 1% increase in the baseline mortality of the SSSI population (Table 1.8).

Table 1.8: Calculation of displacement impacts for razorbill at the Pen y Gogarth/Great Orme's Head SSSI when using 70% displacement and 2% mortality rates previously used by the Secretary of State.

Season	Displacement impact (no. of birds)	Apportioning value	Apportioned impact	SSSI adult population (no. of individuals) (year)	Adult baseline mortality	Increase in baseline mortality (%)
Breeding	0	0.04	0.02			0.11
Post-breeding	4	<0.01	<0.01			0.01
Non-breeding	16	<0.01	0.01	192 (2017)	20.1	0.03
Pre-breeding	5	<0.01	<0.01			0.01
Annual	-	-	0.03			0.15

1.3.1.19 The impact is predicted to be of local spatial extent, medium term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be negligible for the SSSI population. This conclusion is consistent with the conclusion reached in Volume 2, Chapter 5: Offshore ornithology (APP-023).

1.3.2 Collision risk

Operations and maintenance phase

1.3.2.1 Table 1.9 provides the range of collision risk estimates calculated using the parameters advocated by both the Applicant (lower value; using an avoidance rate of 99.79%) and NRW (upper value; using an avoidance rate of 99.28%). Following comments from JNCC at Deadline 3, the breeding season has been extended to include March, with March therefore removed from the pre-breeding season for the SNCB position. The only other difference when compared to the assessments presented in Volume 2, Chapter 5: Offshore ornithology (APP-023) is in relation to the baseline mortality rate with Table 1.9 using the rate calculated following NRW's advice in their Relevant Representation (RR-027) (see section 1.2.3).

Table 1.9: Calculation of collision risk impacts for kittiwake at the Pen y Gogarth/Great Orme's Head SSSI.

Season	No. of collisions	Apportioning value	Apportioned impact	SSSI adult population (no. of individuals) (year)	Adult baseline mortality	Increase in baseline mortality (%)
Pre-breeding	3 to 14	<0.01	<0.01 to 0.02	1,330 (2017)	194.2	<0.01 to 0.01
Breeding	2 to 8	0.05 to 0.07	0.10 to 0.56			0.05 to 0.29
Post-breeding	4 to 18	<0.01	<0.01 to 0.02			<0.01 to 0.01
Annual	9 to 40	-	0.14 to 0.60			0.05 to 0.31

1.3.2.2 The predicted annual and seasonal impacts associated with the Morgan Generation Assets on the kittiwake population of the Pen y Gogarth/Great Orme's Head SSSI represents less than a 1% increase in the baseline mortality of the SSSI population.

1.3.2.3 The impact is predicted to be of local spatial extent, medium-term duration, continuous and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be negligible for the SSSI population. This conclusion is consistent with the conclusion reached in Volume 2, Chapter 5: Offshore ornithology (APP-023).

1.4 Cumulative assessment

1.4.1 Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure

Guillemot

1.4.1.1 Based on the mean-maximum foraging range +1SD of guillemot (Woodward *et al*., 2019) from the Pen y Gogarth/Great Orme's Head SSSI, there are a number of projects within foraging range of guillemot from the SSSI during the breeding season. In the non-breeding season, there are numerous projects within the BDMPS of relevance to the species (Furness, 2015).

1.4.1.2 Table 1.10 presents the seasonal population estimates for those projects for which quantified estimates can be obtained. These values represent the number of guillemot from the Pen y Gogarth/Great Orme's Head SSSI with apportioning in the breeding season based on the site-specific apportioning values where available or proxy apportioning values from a nearby project where unavailable and apportioning in the non-breeding season using data from Furness (2015). In addition, values calculated in Annex 4.5 to Response to Hearing Action Point 15: Offshore Ornithology CEA and In-combination Gap-filling of Historical Projects Note (REP-010) for those projects for which quantified impacts were not available from project-specific documentations have also been included in Table 1.10.

Table 1.10: Cumulative abundance for guillemot at the Pen y Gogarth/Great Orme's Head SSSI for projects considered cumulatively in relation to disturbance and displacement from projects.

Notes:

[a] Assumed to be the same as the Mona Offshore Wind Project based on distance.

[b] Assumed to be the same as the Morgan Generation Assets based on distance.

[c] Assumed to be the same as Awel y Môr based on distance.

Values highlighted in blue are those calculated in Annex 4.5 to Response to Hearing Action Point 15: Offshore Ornithology CEA and In-combination Gap-filling of Historical Projects Note (REP1-010).

Project	Seasonal apportioning values		Seasonal abundance values	
	Breeding	Non-breeding	Breeding	Non-breeding
Awel y Môr	0.365	0.001	572.7	2.1
Burbo Bank	0.156[a]	0.001	6.3	0.0
Burbo Bank Extension	0.156[a]	0.001	156.1	1.1
Erebus	No connectivity	0.001	-	20.7
Gwynt y Môr	0.365[c]	0.001	54.2	0.1
Mona Offshore Wind Project	0.156	0.001	658.3	2.7
Morecambe Offshore Wind Farm: Generation Assets	0.048[b]	0.001	306.6	6.1
Morgan Generation Assets	0.048	0.001	192.9	2.8
Ormonde	0.048[b]	0.001	43.9	0.0
Robin Rigg	No connectivity	0.001	-	0.1
Twinhub	No connectivity	0.001	-	0.2
Walney 1&2	0.048[b]	0.001	7.7	0.2
Walney 3 + 4	0.048[b]	0.001	200.5	1.4
West of Duddon Sands	0.048[b]	0.001	63.5	0.1
West of Orkney	No connectivity	0.001	-	3.2
White Cross	No connectivity	0.001	-	0.8
Annual total			**2,241.0**	

1.4.1.3 The total population of birds present across the sixteen projects apportioned to the guillemot population at the Pen y Gogarth/Great Orme's Head SSSI is 2,241.0 birds. A displacement matrix for this population is presented in Table 1.11. Blue shading is used in Table 1.11 to indicate where the 1% baseline mortality threshold of the guillemot population at the SSSI is surpassed i.e. even a relatively small mortality of two birds exceeds the 1% threshold. The purple outline indicates the range of displacement and mortality rates considered based on the Applicant's position and that applied by the Secretary of State in previous offshore wind farm consent decisions.

1.4.1.4 Applying displacement and mortality rates reflecting the Applicant's position results in an increase in baseline mortality of 5.23%. Applying displacement and mortality rates applied by the Secretary of State results in an increase in baseline mortality of 14.66%.

Table 1.11: Cumulative displacement analysis for the guillemot feature of the Pen y Gogarth/Great Orme's Head SSSI.

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	2	4	11	22	45	67	90	112	134	157	179	202	224
	20	4	9	22	45	90	134	179	224	269	314	359	403	448
	30	7	13	34	67	134	202	269	336	403	471	538	605	672
	40	9	18	45	90	179	269	359	448	538	627	717	807	896
	50	11	22	56	112	224	336	448	560	672	784	896	1008	1121
	60	13	27	67	134	269	403	538	672	807	941	1076	1210	1345
	70	16	31	78	157	314	471	627	784	941	1098	1255	1412	1569
	80	18	36	90	179	359	538	717	896	1076	1255	1434	1614	1793
	90	20	40	101	202	403	605	807	1008	1210	1412	1614	1815	2017
	100	22	45	112	224	448	672	896	1121	1345	1569	1793	2017	2241

1.4.1.5 As discussed in section 1.3.1 as part of the project alone assessment, the impact predicted in the breeding season is a known over-estimate as the presence of both immature and sabbatical birds is not accounted for. If the same proportion as discussed in paragraph 1.3.1.7 is applied (0.57) the cumulative abundance reduces to 1,287.9 birds which would represent an impact of 6 to 18 birds/annum representing an increase in baseline mortality of 3.01 to 8.43%. The removal of sabbatical birds (as discussed for the project alone assessment in paragraph 1.3.1.10) would reduce the impact to 6 to 17 birds/annum representing an increase in baseline mortality of 2.80 to 7.84%.

1.4.1.6 PVA modelling has therefore been conducted for the impact scenarios identified in Table 1.12 representing the cumulative impact at different displacement and mortality rates taking account of different population components. PVA modelling for additional impact scenarios incorporating a range of displacement and mortality rates are presented in Appendix C.

Table 1.12: Predicted impact scenarios for guillemot from the Pen y Gogarth/Great Orme's Head SSSI due to cumulative displacement impacts associated with the Morgan Generation Assets and other projects.

Scenario	Displacement and mortality rates (%)	Immature proportion applied	Sabbatical proportion applied	Displacement impact (no. of birds)	Increase in baseline mortality (%)	Impact on adult survival rate
All birds are breeding adults	50 / 1	No	No	11.2	5.24	0.003194
	70 / 2	No	No	31.4	14.66	0.008943
Inclusion of immatures	50 / 1	Yes	No	6.4	3.01	0.001836
	70 / 2	Yes	No	18.0	8.43	0.005140
Inclusion of immature and sabbaticals	50 / 1	Yes	Yes	6.0	2.80	0.001707
	70 / 2	Yes	Yes	16.8	7.84	0.004780

1.4.1.7 PVA outputs for each of the scenarios identified in Table 1.12 are presented in Table 1.13 and Table 1.14.

Table 1.13: PVA outputs for the annual impact on guillemot from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using displacement impacts calculated using a 50% displacement rate and 1% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	4,853	2.7	1.027	0.953	1.097	-	-
2030	All birds are breeding adults	4,837	2.3	1.023	0.950	1.095	0.997	0.996
2030	Inclusion of immatures	4,840	2.5	1.025	0.951	1.096	0.998	0.998
2030	Inclusion of immature and sabbaticals	4,841	2.5	1.024	1.015	1.033	0.998	0.998
2065	Baseline (unimpacted)	11,868	151.6	1.026	1.017	1.035	-	-
2065	All birds are breeding adults	10,452	121.1	1.022	1.013	1.031	0.996	0.879

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2065	Inclusion of immatures	11,081	134.8	1.024	1.015	1.033	0.998	0.933
2065	Inclusion of immature and sabbaticals	11,031	133.6	1.024	1.015	1.033	0.998	0.928

Table 1.14: PVA outputs for the annual impact on guillemot from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using displacement impacts calculated using a 70% displacement rate and 2% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	4,853	2.7	1.027	0.953	1.097	-	-
2030	All birds are breeding adults	4,804	1.8	1.018	0.943	1.087	0.991	0.990
2030	Inclusion of immatures	4,822	2.1	1.021	0.948	1.092	0.995	0.995
2030	Inclusion of immature and sabbaticals	4,822	2.1	1.021	0.948	1.092	0.995	0.995
2065	Baseline (unimpacted)	11,868	151.6	1.026	1.017	1.035	-	-
2065	All birds are breeding adults	8,286	75.1	1.016	1.007	1.025	0.990	0.697
2065	Inclusion of immatures	9,650	104.7	1.02	1.011	1.029	0.994	0.814
2065	Inclusion of immature and sabbaticals	9,650	104.7	1.020	1.011	1.029	0.994	0.814

1.4.1.8 The PVA for guillemot from the Pen y Gogarth/Great Orme's Head SSSI indicated that when considering an impact scenario of 70% displacement and 2% mortality and

assuming all birds present at the Morgan Generation Assets were breeding adult birds, the unimpacted baseline population growth rate would be reduced by 0.010. When assessing the 50% displacement and 1% mortality scenario assuming all birds present at the Morgan Generation Assets were breeding adult birds, the PVA predicted a growth rate reduction of 0.004 when compared to the baseline (counterfactual of median growth rate of 0.990). In both scenarios modelled, a positive population growth rate was sustained indicating that the population is predicted to be growing and is predicted to be 75.1% to 121.1% larger than the current size after 35 years (2065).

1.4.1.9 The mean-maximum foraging range of guillemot is 55.5 km (Woodward *et al.,* 2019). This foraging range represents the average of the longest foraging range distances exhibited by guillemot in the studies incorporated into Woodward *et al.* (2019). When the standard deviation associated with this figure is included the foraging range of guillemot increases to 95.2 km. This value is recommended by SNCBs for use in both HRA screening and as part of the calculation of apportioning values in the breeding season. As discussed in Volume 4, Annex 5.5: Offshore ornithology apportioning technical report (APP-057), the use of the mean-maximum foraging range plus one standard deviation represents a highly precautionary approach which has consequences. The mean-maximum foraging range plus one standard deviation is also applied as part of cumulative effects assessments to identify those projects that may have connectivity with a given colony in the breeding season with this again representing a highly precautionary approach that is considered to over-estimate impacts in the breeding season. Of the projects considered in the breeding season in

1.4.1.10 Table 1.15, the Morgan Generation Assets, Walney 1&2, Walney 3&4 and Ormonde are beyond the mean-maximum foraging range. It is therefore considered that the population of guillemot present at these projects in the breeding season (445.0 birds) can be excluded. This represents a 19.9% decrease in the impacts calculated for guillemot at the Pen y Gogarth/Great Orme's Head SSSI.

1.4.1.11 The population of guillemot from the Pen y Gogarth/Great Orme's Head SSSI has been increasing in size consistently since 2000 (average annual growth rate of 1.043 between 2000 and 2023, JNCC, 2024). This empirical annual average growth rate is higher than predicted by the PVA. Given the PVA is predicting a continuation of the increasing population, the predicted impact can be considered to be of negligible to low magnitude.

1.4.1.12 It should also be noted that the cumulative effects would not persist for the entire 35 year modelled period, with existing offshore wind farms likely to be decommissioned and therefore no longer presenting a collision risk to guillemot. The PVA does not account for a reduced impact as the years progress and therefore there is an innate overestimation of the potential risk.

1.4.1.13 It is important to understand that the impact scenarios calculated assuming that all birds are breeding adults cannot be considered precautionary as it is known that immature birds visit natal waters during the breeding season. As a result the "All birds" scenarios presented in Table 1.12, Table 1.13 and Table 1.14 are not ecologically valid and are therefore not representative of any impact that may occur on the guillemot population of the Pen y Gogarth/Great Orme's Head SSSI.

1.4.1.14 Following the EIA methodology defined in Volume 2, Chapter 5: Offshore ornithology (APP-023), guillemot is deemed to be of high vulnerability, medium recoverability and regional value. The sensitivity of the receptor is, therefore, considered to be medium. Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of minor adverse significance which is not significant in EIA terms.

Razorbill

1.4.1.15 Based on the mean-maximum foraging range +1SD of razorbill (Woodward *et al*., 2019) from the Pen y Gogarth/Great Orme's Head SSSI, there are a number of projects within foraging range of razorbill from the SSSI during the breeding season. In the non-breeding season, there are numerous projects within the BDMPS of relevance to the species (Furness, 2015).

1.4.1.16 Table 1.15 presents the seasonal population estimates for those projects for which quantified estimates can be obtained. These values represent the number of razorbill from the Pen y Gogarth/Great Orme's Head SSSI with apportioning in the breeding season based on the site-specific apportioning values where available or proxy apportioning values from a nearby project where unavailable and apportioning in the non-breeding season using data from Furness (2015). In addition, values calculated in Annex 4.5 to Response to Hearing Action Point 15: Offshore Ornithology CEA and In-combination Gap-filling of Historical Projects Note (REP-010) for those projects for which quantified impacts were not available from project-specific documentation have also been included in

1.4.1.17 Table 1.15.

1.4.1.18 Apportioning values for the breeding season have been taken from project-specific documentation, where available. If unavailable, an apportioning value from the nearest project for which an apportioning value is available has been applied. In the non-breeding season, apportioning values calculated using information from Furness (2015) has been applied to collision risk estimates from all projects.

Table 1.15: Cumulative abundance for razorbill at the Pen y Gogarth/Great Orme's Head SSSI for projects considered cumulatively in relation to disturbance and displacement from projects.

Notes:

[a] Assumed to be the same as the Mona Offshore Wind Project based on distance.

[b] Assumed to be the same as the Morgan Generation Assets based on distance.

[c] Assumed to be the same as Awel y Môr based on distance.

Values highlighted in blue are those calculated in Annex 4.5 to Response to Hearing Action Point 15: Offshore Ornithology CEA and In-combination Gap-filling of Historical Projects Note (REP1-010).

Project	Seasonal apportioning values				Seasonal abundance values			
	Breeding	Post-breeding	Non-breeding	Pre-breeding	Breeding	Post-breeding	Non-breeding	Pre-breeding
Awel y Môr	0.399[c]	<0.001	<0.001	<0.001	55.9	0.0	0.0	0.1
Burbo Bank	0.211[a]	<0.001	<0.001	<0.001	0.6	0.0	0.0	0.0
Burbo Bank Extension	0.211[a]	<0.001	<0.001	<0.001	13.6	0.0	0.0	0.0
Erebus	-	<0.001	<0.001	<0.001	-	0.7	0.3	0.4
Gwynt y Mor	0.399	<0.001	<0.001	<0.001	5.0	0.0	0.0	0.0
Mona Offshore Wind Project	0.211	<0.001	<0.001	<0.001	17.5	0.0	0.1	0.8

Project	Seasonal apportioning values				Seasonal abundance values			
	Breeding	Post-breeding	Non-breeding	Pre-breeding	Breeding	Post-breeding	Non-breeding	Pre-breeding
Morecambe Offshore Wind Farm: Generation Assets	0.121	<0.001	<0.001	<0.001	26.9	0.3	0.2	0.2
Morgan Generation Assets	0.044	<0.001	<0.001	<0.001	1.5	0.1	0.4	0.1
Ormonde	0.044[b]	<0.001	<0.001	<0.001	7.6	0.0	0.0	0.0
Robin Rigg	No connectivity	<0.001	<0.001	<0.001	-	0.0	0.0	0.0
Twinhub	No connectivity	<0.001	<0.001	<0.001	-	0.0	0.0	0.0
Walney 1&2	0.044[b]	<0.001	<0.001	<0.001	0.5	0.0	0.0	0.0
Walney 3 + 4	0.044[b]	<0.001	<0.001	<0.001	3.3	0.4	0.9	0.0
West of Duddon Sands	0.044[b]	<0.001	<0.001	<0.001	0.4	0.0	0.1	0.0
West of Orkney	No connectivity	<0.001	<0.001	<0.001	-	0.0	0.0	0.0
White Cross	No connectivity	<0.001	<0.001	<0.001	-	0.0	0.1	0.1
Annual total					**138.5**			

1.4.1.19 The total population of birds present across the 16 projects apportioned to the razorbill population at the Pen y Gogarth/Great Orme's Head SSSI is 138.5 birds. A displacement matrix for this population is presented in Table 1.16. Blue shading is used in Table 1.16 to indicate where the 1% baseline mortality threshold of the guillemot population at the SSSI is surpassed. The purple outline indicates the range of displacement and mortality rates considered based on the Applicant's position and that applied by the Secretary of State in previous offshore wind farm consent decisions.

1.4.1.20 Applying displacement and mortality rates reflecting the Applicant's position results in an increase in baseline mortality of 3.44%. Applying displacement and mortality rates applied by the Secretary of State results in an increase in baseline mortality of 9.64%.

Table 1.16: Cumulative displacement analysis for the razorbill feature of the Pen y Gogarth/Great Orme's Head SSSI.

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement (%)	10	0	0	1	1	3	4	6	7	8	10	11	12	14
	20	0	1	1	3	6	8	11	14	17	19	22	25	28
	30	0	1	2	4	8	12	17	21	25	29	33	37	42

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
	40	1	1	3	6	11	17	22	28	33	39	44	50	55
	50	1	1	3	7	14	21	28	35	42	48	55	62	69
	60	1	2	4	8	17	25	33	42	50	58	66	75	83
	70	1	2	5	10	19	29	39	48	58	68	78	87	97
	80	1	2	6	11	22	33	44	55	66	78	89	100	111
	90	1	2	6	12	25	37	50	62	75	87	100	112	125
	100	1	3	7	14	28	42	55	69	83	97	111	125	139

1.4.1.21 As discussed in section 1.3.1 as part of the project alone assessment for guillemot, the impact predicted for razorbill in the breeding season is a known over-estimate as the presence of both immature and sabbatical birds is not accounted for. Furness (2015) provides a value of 0.75 immatures for every breeding adult in a stable population of razorbill. If the proportion of adults based on this ratio is applied (0.57) the cumulative abundance reduces to 79 birds which would represent an impact of less than one to one birds/annum representing an increase in baseline mortality of 1.97 to 5.51%. Whilst razorbill are more migratory than guillemot, the species movements following the breeding season are not as extensive as some other seabird species (e.g. Manx shearwater) with a proportion of the UK population remaining in UK waters throughout the winter (Furness, 2015). Furness (2015) states that whilst immatures move further south than breeding adults, with younger birds potentially remaining in wintering areas during the summer, older immatures do return to breeding colonies. Therefore whilst the application of the correction factor above likely results in an under-estimate of the cumulative impact, it is considered a better indication of the likely impact than discounting immature birds entirely.

1.4.1.22 Furness (2015) provides pre-breeding season populations for razorbill in UK western waters. These populations include quantification of the immature component. For those colonies closest to the Morgan Generation Assets (e.g. Rathlin Island SPA), the populations presented assume that 90% of immatures associated with these colonies are present in UK waters in the pre-breeding season. These birds are unlikely to move out of UK waters during the breeding season and therefore this would suggest that the application of the correction factor noted above is appropriate and provides a more accurate reflection of the potential impact on razorbill at the Pen y Gogarth/Great Orme's Head SSSI.

1.4.1.23 There is uncertainty in relation to the distribution of adult and immature birds within UK waters. The Morgan Generation Assets is approximately 63 km from the Pen y Gogarth/Great Orme's Head SSSI. This is towards the edge the mean-maximum foraging range of razorbill (73.8 km), within which it is likely the large majority of breeding adult razorbill from the Pen y Gogarth/Great Orme's Head SSSI forage. It is therefore considered that the ratio of breeding adult to immature birds calculated in Furness (2015) provides a more accurate representation of the likely proportions of these population components at the Morgan Generation Assets than the assumption that all birds present are breeding adults.

1.4.1.24 In addition to immature birds, sabbatical birds are also likely to be present at the Morgan Generation Assets. Horswill and Robinson (2015) suggests that 3.0% of birds

present are sabbatical birds with this value considered to be of intermediate quality and good representation as part of the study. The removal of sabbatical birds would reduce the impact to less than one to one birds/annum representing an increase in baseline mortality of 1.91 to 5.34%.

1.4.1.25 PVA modelling has therefore been conducted for the impact scenarios identified in Table 1.17 representing the cumulative impact at different displacement and mortality rates taking account of different population components. PVA modelling for additional impact scenarios incorporating a range of displacement and mortality rates are presented in Appendix C.

Table 1.17: Predicted impact scenarios for razorbill from the Pen y Gogarth/Great Orme's Head SSSI due to cumulative displacement impacts associated with the Morgan Generation Assets and other projects.

Scenario	Displacement and mortality rates (%)	Immature proportion applied	Sabbatical proportion applied	Displacement impact (no. of birds)	Increase in baseline mortality (%)	Impact on adult survival rate
All birds are breeding adults	50 / 1	No	No	0.7	3.44	0.003614
	70 / 2	No	No	1.9	9.64	0.010120
Inclusion of immatures	50 / 1	Yes	No	0.4	1.97	0.002065
	70 / 2	Yes	No	1.1	5.51	0.005783
Inclusion of immature and sabbaticals	50 / 1	Yes	Yes	0.4	1.91	0.002003
	70 / 2	Yes	Yes	1.1	5.34	0.005609

PVA outputs for each of the scenarios identified in Table 1.17 are presented in Table 1.18 and Table 1.19.

Table 1.18: PVA outputs for the annual impact on razorbill from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using displacement impacts calculated using a 50% displacement rate and 1% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	217	2.1	1.021	0.827	1.140	-	-
2030	All birds	216	1.8	1.018	0.822	1.137	0.996	0.996
2030	Immatures	216	1.9	1.019	0.828	1.139	0.997	1.000
2030	Sabbaticals	217	1.9	1.019	0.832	1.138	0.997	1.000
2065	Baseline (unimpacted)	295	38.1	1.009	0.990	1.026	-	-

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2065	All birds	254	19.2	1.005	0.986	1.022	0.996	0.862
2065	Immatures	270	26.9	1.007	0.987	1.024	0.998	0.918
2065	Sabbaticals	270	26.6	1.007	0.998	1.024	0.998	0.923

Table 1.19: PVA outputs for the annual impact on razorbill from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using displacement impacts calculated using a 70% displacement rate and 2% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	217	2.1	1.021	0.827	1.140	-	-
2030	All birds	214	0.9	1.009	0.816	1.130	0.989	0.987
2030	Immatures	216	1.4	1.014	0.822	1.135	0.994	0.995
2030	Sabbaticals	214	10.2	1.003	0.983	1.020	0.994	0.796
2065	Baseline (unimpacted)	295	38.1	1.009	0.990	1.026	-	-
2065	All birds	193	-9.2	0.997	0.978	1.015	0.988	0.658
2065	Immatures	232	8.7	1.002	0.983	1.020	0.994	0.792
2065	Sabbaticals	233	10.2	1.003	0.983	1.020	0.994	0.796

1.4.1.26 The PVA for razorbill from the Pen y Gogarth/Great Orme's Head SSSI indicated that when considering an impact scenario of 70% displacement and 2% mortality and assuming all birds present at the Morgan Generation Assets were breeding adult birds, the unimpacted baseline population growth rate would be reduced by 0.011 leading to a growth rate of less than one. When assessing the 50% displacement and 1% mortality scenario assuming all birds present at the Morgan Generation Assets were breeding adult birds, the PVA predicted a growth rate reduction of 0.004 when compared to the baseline (counterfactual of median growth rate of 0.996). For this scenario, a positive population growth rate was sustained indicating that the population is predicted to be growing and is predicted to be 19.2% larger than the current size after 35 years (2065). When consideration is given to the presence of immature birds, the PVA outputs associated with the 70% displacement and 2% mortality rate impact scenario indicate that a positive growth rate would be maintained at the SSSI with the population predicted to be 8.7% larger than the current size after 35 years (2065).

1.4.1.27 The mean-maximum foraging range of razorbill is 73.8 km (Woodward *et al.,* 2019). This foraging range represents the average of the longest foraging range distances exhibited by razorbill in the studies incorporated into Woodward *et al.* (2019). When the standard deviation associated with this figure is included the foraging range of razorbill increases to 122.2 km. This value is recommended by SNCBs for use in both HRA screening and as part of the calculation of apportioning values in the breeding season. As discussed in Volume 4, Annex 5.5: Offshore ornithology apportioning technical report (APP-057), the use of the mean-maximum foraging range plus one standard deviation represents a highly precautionary approach. The mean-maximum foraging range plus one standard deviation is also applied as part of cumulative effects assessments to identify those projects that may have connectivity with a given colony in the breeding season with this again representing a highly precautionary approach that is considered to over-estimate impacts in the breeding season. Of the projects considered in the breeding season in Table 1.15, Walney 1&2, Walney 3&4 and Ormonde are beyond the mean-maximum foraging range. It is therefore considered that the population of razorbill present at these projects in the breeding season (11.4 birds) can be excluded. This represents a 8.23% decrease in the impacts calculated for razorbill at the Pen y Gogarth/Great Orme's Head SSSI.

1.4.1.28 The population of razorbill from the Pen y Gogarth/Great Orme's Head SSSI has been increasing in size consistently since 2000 (average annual growth rate of 1.036 between 2000 and 2023, JNCC *et al.*, 2024). This annual average growth rate is higher than predicted by the PVA, and therefore, even if the worst-case estimate of displacement and mortality scenario were to occur (70% displacement and 2% mortality and excluding the presence of immature and sabbatical birds), the population should continue to increase.

1.4.1.29 It should also be noted that the cumulative effects would not persist for the entire 35 year modelled period, with existing offshore wind farms likely to be decommissioned and therefore no longer presenting a displacement risk to razorbill. The PVA does not account for a reduced impact as the years progress and therefore there is an innate overestimation of the potential risk.

1.4.1.30 The impact scenarios calculated assuming that all birds are breeding adults cannot be considered precautionary as it is known that immature birds visit natal waters during the breeding season. As a result the "All birds" scenarios presented in Table 1.17, Table 1.18 and Table 1.19 are not ecologically valid and are therefore not representative of any impact that may occur on the razorbill population of the Pen y Gogarth/Great Orme's Head SSSI. Based on the information discussed above and that the PVA predicts a continuation of the increasing population for more realistic impact scenarios, the impact can be considered to be of negligible to low magnitude.

1.4.1.31 Following the EIA methodology defined in Volume 2, Chapter 5: Offshore ornithology (APP-023), razorbill is deemed to be of high vulnerability, medium recoverability and regional value. The sensitivity of the receptor is therefore, considered to be medium. The cumulative effect will, therefore, be of minor adverse significance which is not significant in EIA terms.

1.4.2 Collision risk

Kittiwake

1.4.2.1 Based on the mean-maximum foraging range +1SD of kittiwake (Woodward *et al*., 2019) from the Pen y Gogarth/Great Orme's Head SSSI, there are numerous projects within foraging range of kittiwake from the SSSI during the breeding season. In the

non-breeding season, there are additional projects within the BDMPS of relevance to the species (Furness, 2015).

1.4.2.2 Table 1.20 presents the collision risk estimates for those projects for which quantified estimates can be obtained. These values represent the number of collisions apportioned to the kittiwake population of the Pen y Gogarth/Great Orme's Head SSSI utilising both a 99.79% avoidance rate, reflecting the species-specific avoidance rate from Ozsanlav-Harris *et al.* (2023) and a 99.28% avoidance rate, reflecting the grouped all-gull avoidance rate from Ozsanlav-Harris *et al.* (2023). In addition, values calculated in Annex 4.5 to Response to Hearing Action Point 15: Offshore Ornithology CEA and In-combination Gap-filling of Historical Projects Note (REP-010) for those projects for which quantified impacts were not available from project-specific documentation have also been included in Table 1.20.

1.4.2.3 Apportioning values for the breeding season have been taken from project-specific documentation, where available. If unavailable, an apportioning value from the nearest project for which an apportioning value is available has been applied. In the non-breeding season, apportioning values calculated using information from Furness (2015) has been applied to collision risk estimates from all projects.

Table 1.20: Predicted annual breeding season mortality rate of kittiwake at the Pen y Gogarth/Great Orme's Head SSSI resulting from collision risk impacts from projects considered cumulatively.

Notes:

[a] Assumed to be the same as the Mona Offshore Wind Project based on distance.

[b] Assumed to be the same as the Morgan Generation Assets based on distance.

[c] Assumed to be 0 based on apportioning values for other similar colonies in project-specific documentation.

Values highlighted in blue are those calculated in Annex 4.5 to Response to Hearing Action Point 15: Offshore Ornithology CEA and In-combination Gap-filling of Historical Projects Note (REP1-010).

Project	Seasonal apportioning values			Seasonal apportioned collision values (99.28% avoidance rate)			Seasonal apportioned collision values (99.79% avoidance rate)		
	Breeding	Post-breeding	Pre-breeding	Breeding	Post-breeding	Pre-breeding	Breeding	Post-breeding	Pre-breeding
Awel y Môr	0.530	0.001	0.002	11.0	0.0	0.0	2.4	0.0	0.0
Burbo Bank	0.149[a]	0.001	0.002	0.1	0.0	0.0	0.0	0.0	0.0
Burbo Bank Extension	0.149[a]	0.001	0.002	3.0	0.0	0.0	0.9	0.0	0.0
Erebus	0[c]	0.001	0.002	0.0	0.0	0.0	0.0	0.0	0.0
Gwynt Y Mor	0.530	0.001	0.002	6.2	0.0	0.0	1.4	0.0	0.0
Mona Offshore Wind Project	0.149	0.001	0.002	0.7	0.0	0.0	0.1	0.0	0.0
Morecambe Offshore Wind Farm: Generation Assets	0.061	0.001	0.002	1.2	0.0	0.0	0.3	0.0	0.0

Project	Seasonal apportioning values			Seasonal apportioned collision values (99.28% avoidance rate)			Seasonal apportioned collision values (99.79% avoidance rate)		
	Breeding	Post-breeding	Pre-breeding	Breeding	Post-breeding	Pre-breeding	Breeding	Post-breeding	Pre-breeding
Morgan Generation Assets	0.05 to 0.07[4]	0.001	0.002	1.1	0.0	0.0	0.1	0.0	0.0
Ormonde	0.05 to 0.07[b]	0.001	0.002	0.1	0.0	0.0	0.0	0.0	0.0
Rampion	No connectivity	0.001	0.002	-	0.0	0.0	-	0.0	0.0
Rampion 2	No connectivity	0.001	0.002	-	0.0	0.0	-	0.0	0.0
Robin Rigg	0.05 to 0.07[b]	0.001	0.002	0.1	0.0	0.0	0.0	0.0	0.0
Twinhub	No connectivity	0.001	0.002	-	0.0	0.0	-	0.0	0.0
Walney 1&2	0.05 to 0.07[b]	0.001	0.002	0.3	0.0	0.0	0.1	0.0	0.0
Walney 3 + 4	0.05 to 0.07[b]	0.001	0.002	3.9	0.0	0.1	0.3	0.0	0.0
West of Duddon Sands	0.05 to 0.07[b]	0.001	0.002	0.3	0.0	0.0	0.0	0.0	0.0
West of Orkney	No connectivity	0.001	0.002	-	0.0	0.0	-	0.0	0.0
White Cross	No connectivity	0.001	0.002	0.0	0.0	0.0	0.0	0.0	0.0
Annual totals				**28.4**			**5.7**		

1.4.2.4 The total collision risk for the Morgan Generation Assets cumulatively with other projects apportioned to the kittiwake population at the Pen y Gogarth/Great Orme's Head SSSI is 5.7 to 28.4 birds/annum. This represents a 2.13% to 11.0% increase in the baseline mortality of the SSSI population.

1.4.2.5 PVA modelling has therefore been conducted for the impact scenarios identified in Table 1.21 representing the cumulative impact applying different avoidance rates.

Table 1.21: Predicted impact scenarios for kittiwake from the Pen y Gogarth/Great Orme's Head SSSI due to cumulative collision impacts associated with the Morgan Generation Assets and other projects.

[4] The breeding season apportioning value incorporating all immature age classes (0.05) has been applied to the collision risk values calculated using a 99.79% avoidance rate with the breeding season apportioning value including only first year immatures (0.07) applied to collision risk values calculated using a 99.28% avoidance rate

Avoidance rate	Annual impact (no. of collisions)	Increase in baseline mortality (%)	Impact on adult survival rate
99.28	28.4	14.63	0.021364
99.79	5.7	2.92	0.004260

1.4.2.6 PVA outputs for each of the scenarios identified in Table 1.21 are presented in Table 1.22.

Table 1.22: PVA outputs for the annual impact on kittiwake from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using two avoidance rate scenarios.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	1,375	1.2	1.012	0.812	1.164	-	-
2030	Avoidance rate 99.28%	1,350	-1.3	0.987	0.786	1.139	0.975	0.975
2030	Avoidance rate 99.79%	1,370	0.7	1.007	0.804	1.161	0.995	0.995
2065	Baseline (unimpacted)	1,516	10.4	1.003	0.982	1.022	-	-
2065	Avoidance rate 99.28%	756	-56.0	0.977	0.955	0.998	0.975	0.396
2065	Avoidance rate 99.79%	1,316	-7.7	0.998	0.977	1.018	0.995	0.835

1.4.2.7 The cumulative PVA for kittiwake at Pen y Gogarth/Great Orme's Head SSSI indicated that predicted collisions may reduce the unimpacted baseline population growth rate by 0.005 to 0.026 (i.e. 0.975 to 0.995 counterfactual of population growth rate; Table 1.22). Although this change in the growth rate is very small, there is a risk that under the cumulative impact scenario, the population could decline in size (due to a 0.977 to 0.998 growth rate). This highlights the sensitivity of the PVA tool, where even very small changes in a populations growth rate can suggest a declining population (especially for small colonies with stable populations under baseline scenarios).

1.4.2.8 The PVA models undertaken in this report utilise a density independent approach meaning that consideration of the impact on the counterfactual of population size is problematic. This metric is time dependent and therefore not as robust as the counterfactual of growth rate. In a density independent model, any slight deviation in survival or growth rate parameter values will lead to a divergence in the population sizes that increase or decrease constantly over time, with no mechanism that would

constrain infinite growth, nor allow populations to recover once impacts have been removed.

1.4.2.9 The final counterfactual growth rate should therefore be prioritised as the main assessment metric used to consider population level effects. The use of final counterfactual population size outputs as the main assessment metric is less robust as the metric is highly sensitive to both time and modelling approach, especially when using density independent models and is therefore inappropriate to use as the sole metric for evaluating population level effects.

1.4.2.10 Given that the counterfactual growth rate metric is the more robust assessment metric, the results indicate that the cumulative impact predicted for kittiwake at the Pen-y-Gogarth/Great Orme SSSI is not significant, with only a small deviation from the predicted unimpacted population growth rates for kittiwake (0.005 to 0.025) using any of the impact scenarios presented in Table 1.22.

1.4.2.11 It should also be noted that the cumulative effects would not persist for the entire 35 year modelled period, with existing offshore wind farms likely to be decommissioned and therefore no longer presenting a collision risk to kittiwake. The PVA does not account for a reduced impact as the years progress and therefore there is an innate overestimation of the potential risk.

1.4.2.12 Recent population data has shown that the population of kittiwake at the Pen y Gogarth/Great Orme's Head SSSI has increased in size between the latest colony counts (2013 to 2021; Figure 1.1; JNCC *et al.,* 2024), however, the counts within 2022 and 2023 are likely to be impacted by highly pathogenic avian influenza (HPAI), which was prevalent during the 2022 and 2023 breeding seasons (Tremlett *et al.*, 2024).

1.4.2.13 This increase in the population (between 2010 and 2021) of kittiwake from the Pen y Gogarth/Great Orme's Head SSSI (Figure 1.1) should be considered in light of the construction and subsequent operation of thirteen offshore wind farms and their associated potential impacts. Figure 1.1 provides the cumulative capacity of these offshore wind farms (measured in MW) with theoretical connectivity to the Pen y Gogarth/Great Orme's Head SSSI during the breeding and non-breeding seasons. This includes North Hoyle (operational since 2003), Barrow (operational in 2006), Burbo Bank (operational since 2007), Rhyl Flats (operational since 2009), Walney 1 (operational since 2011), Walney 2 (operational since 2012), Ormonde (operational since 2012), West of Duddon Sands (operational since 2014), Gwynt y Môr (operational since 2015), Burbo Bank Extension (operational since 2017), Rampion 1 (operational since 2018) and Walney Extension (operational since 2018). Impacts from a number of these wind farms have therefore already been accounted for within the PVA, which emphasises the precautionary nature of the cumulative effects assessment (i.e. project impacts are considered in the impact assessment, while also being accounted for within the latest colony counts and productivity rates used within the PVA input parameters (e.g. impacts on this colony from Burbo Bank Extension will have been occurring since 2017)). This also demonstrates that the increase in installed capacity of offshore wind in the Irish Sea over the last 20 years has not shown empirical effects on the Pen y Gogarth/Great Orme's Head SSSI colony (beyond natural variability).

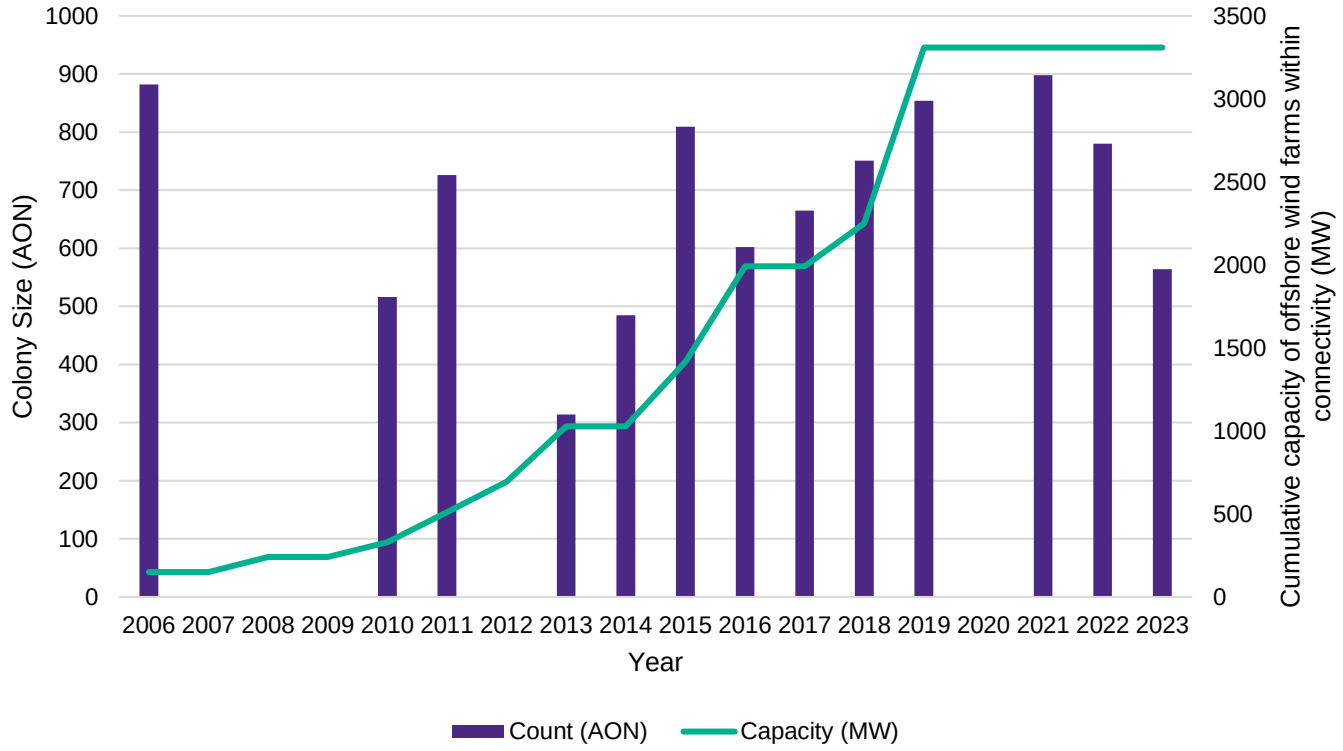

Figure 1.1: Recent (2010 to 2023) colony counts of kittiwake from Pen y Gogarth/Great Orme's Head SSSI alongside the generation capacity of the cumulative offshore wind farms (green line showing colony size between 2010 to 2023, indicating an increasing population against the increasing capacity of offshore wind farms) (AON = Apparently Occupied Nests).

1.4.2.14 There is a high degree of conservatism within the calculations presented in Table 1.20 including:

- The exclusion of older immature birds from the 99.28% avoidance rate scenario for the Morgan Generation Assets
- The exclusion of immatures from the impact totals presented for other projects considered cumulatively for both avoidance rate scenarios
- No consideration given to sabbatical birds for any projects for both avoidance rate scenarios
- The use of collision risk modelling parameters in modelling undertaken for projects considered cumulatively that will over-estimate collision risk (e.g. flight speed and avoidance rate) for the 99.28% avoidance rate scenario
- No consideration of changes to project designs between assessment and construction which will often lead to significant decreases in collision risk estimates.

1.4.2.15 This leads to predicted cumulative impacts being overestimated (or already accounted for within the PVA inputs), which will lead to an overestimation of risk through the modelled period. In addition, the small change in the predicted growth rate (i.e. <1%) even in this conservative cumulative scenario, combined with the high level of variability in PVA outputs (when considering the upper and lower confidence intervals) suggests that the actual risk of a decrease in growth rate (and therefore a population decline) due to cumulative effects of collision is low and it is likely that any effects will be within the range of natural variability. As such, the impact is predicted to be of low magnitude.

1.4.2.16 The most recent assessment for the kittiwake feature of the Pen y Gogarth/Great Orme's Head SSSI was undertaken as part of the consent application for the Awel y Môr offshore wind farm. Cumulative impacts were not considered in the assessments conducted and were not requested by NRW. The contribution of Awel y Môr to the cumulative impact on the kittiwake feature of the Pen y Gogarth/Great Orme's Head SSSI represents approximately 40% of the total impact. In contrast the Morgan Generation Assets contributes only 2 to 4% of the total cumulative impact. The assessments conducted for the Awel y Môr offshore wind farm concluded that the impact on the kittiwake feature of the Pen y Gogarth/Great Orme's Head SSSI was not significant with NRW agreeing with this conclusion.

1.4.2.17 Kittiwake is deemed to be of high vulnerability, low recoverability and international conservation value. The sensitivity of the receptor is therefore, considered to be high. The cumulative effect will, therefore, be of minor adverse significance which is not significant in EIA terms.

1.5 Conclusion

1.5.1.1 Table 1.23 provides a summary of the conclusions reached in relation to the impacts assessed in this report on the features of the Pen y Gogarth/Great Orme's Head SSSI. The conclusions reached for the Morgan Generation Assets alone are consistent with those reached in Volume 2, Chapter 5 Offshore ornithology (APP-023). Cumulative impacts were not considered for the features of the Pen y Gogarth/Great Orme's Head SSSI in Volume 2, Chapter 5 Offshore ornithology (APP-023) however, the assessments presented in this report indicate that any impacts will be minor adverse in nature which is not significant in EIA terms.

1.5.1.2 It is important to understand that these assessments are not based on purely on quantification but require consideration of a multitude of other factors to inform the assessments presented (e.g. immature birds, the limitations of PVA modelling, etc.). These factors must be considered holistically to enable the impact magnitude to be determined. If these factors are ignored the resulting impact magnitude will be over-estimated and will not be ecologically valid leading to assessments that are not representative of the potential impact on the features of the Pen y Gogarth/Great Orme's Head SSSI.

Table 1.23: Conclusions reached in relation to impact from the Morgan Generation Assets alone and cumulatively with other plans and projects on the features of the Pen y Gogarth/Great Orme's Head SSSI

Species	Impact	Assessment	Conclusion
Guillemot	Displacement	Project alone	Negligible
		Cumulative	Minor adverse
Razorbill	Displacement	Project alone	Negligible
		Cumulative	Minor adverse
Kittiwake	Collision	Project alone	Negligible
		Cumulative	Minor adverse

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Appendix A: Displacement matrices (project alone)

A.1 Guillemot

Table A. 1: Displacement matrix for guillemot at the Pen y Gogarth/Great Orme's Head SSSI in the breeding season.

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	4	8	20	40	80	120	160	201	241	281	321	361	401
	20	8	16	40	80	160	241	321	401	481	561	642	722	802
	30	12	24	60	120	241	361	481	602	722	842	962	1083	1203
	40	16	32	80	160	321	481	642	802	962	1123	1283	1444	1604
	50	20	40	100	201	401	602	802	1003	1203	1404	1604	1805	2005
	60	24	48	120	241	481	722	962	1203	1444	1684	1925	2165	2406
	70	28	56	140	281	561	842	1123	1404	1684	1965	2246	2526	2807
	80	32	64	160	321	642	962	1283	1604	1925	2246	2566	2887	3208
	90	36	72	180	361	722	1083	1444	1805	2165	2526	2887	3248	3609
	100	40	80	201	401	802	1203	1604	2005	2406	2807	3208	3609	4010

Table A. 2: Displacement matrix for guillemot at the Pen y Gogarth/Great Orme's Head SSSI in the non-breeding season.

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	4	8	19	38	76	115	153	191	229	268	306	344	382
	20	8	15	38	76	153	229	306	382	459	535	612	688	765
	30	11	23	57	115	229	344	459	574	688	803	918	1032	1147
	40	15	31	76	153	306	459	612	765	918	1071	1224	1377	1529
	50	19	38	96	191	382	574	765	956	1147	1338	1529	1721	1912
	60	23	46	115	229	459	688	918	1147	1377	1606	1835	2065	2294
	70	27	54	134	268	535	803	1071	1338	1606	1874	2141	2409	2677
	80	31	61	153	306	612	918	1224	1529	1835	2141	2447	2753	3059
	90	34	69	172	344	688	1032	1377	1721	2065	2409	2753	3097	3441
	100	38	76	191	382	765	1147	1529	1912	2294	2677	3059	3441	3824

A.2 Razorbill

Table A. 3: Displacement matrix for razorbill at the Pen y Gogarth/Great Orme's Head SSSI in the breeding season.

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	0	0	0	1	1	1	2	2	2	3	3	3
	20	0	0	0	1	1	2	3	3	4	5	6	6	7
	30	0	0	1	1	2	3	4	5	6	7	8	9	10
	40	0	0	1	1	3	4	6	7	8	10	11	13	14
	50	0	0	1	2	3	5	7	9	10	12	14	16	17
	60	0	0	1	2	4	6	8	10	13	15	17	19	21
	70	0	0	1	2	5	7	10	12	15	17	19	22	24
	80	0	1	1	3	6	8	11	14	17	19	22	25	28
	90	0	1	2	3	6	9	13	16	19	22	25	28	31
	100	0	1	2	3	7	10	14	17	21	24	28	31	35

Table A. 4: Displacement matrix for razorbill at the Pen y Gogarth/Great Orme's Head SSSI in the post-breeding season.

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	1	3	5	8	10	13	15	18	20	23	25
	20	1	1	3	5	10	15	20	25	30	35	41	46	51
	30	1	2	4	8	15	23	30	38	46	53	61	68	76
	40	1	2	5	10	20	30	41	51	61	71	81	91	101
	50	1	3	6	13	25	38	51	63	76	89	101	114	127
	60	2	3	8	15	30	46	61	76	91	106	122	137	152
	70	2	4	9	18	35	53	71	89	106	124	142	160	177
	80	2	4	10	20	41	61	81	101	122	142	162	183	203
	90	2	5	11	23	46	68	91	114	137	160	183	205	228
	100	3	5	13	25	51	76	101	127	152	177	203	228	254

Table A. 5: Displacement matrix for razorbill at the Pen y Gogarth/Great Orme's Head SSSI in the non-breeding season.

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	1	2	6	12	23	35	47	59	70	82	94	105	117
	20	2	5	12	23	47	70	94	117	140	164	187	211	234
	30	4	7	18	35	70	105	140	176	211	246	281	316	351
	40	5	9	23	47	94	140	187	234	281	328	374	421	468
	50	6	12	29	59	117	176	234	293	351	410	468	527	585
	60	7	14	35	70	140	211	281	351	421	491	562	632	702
	70	8	16	41	82	164	246	328	410	491	573	655	737	819
	80	9	19	47	94	187	281	374	468	562	655	749	842	936
	90	11	21	53	105	211	316	421	527	632	737	842	948	1053
	100	12	23	59	117	234	351	468	585	702	819	936	1053	1170

Table A. 6: Displacement matrix for razorbill at the Pen y Gogarth/Great Orme's Head SSSI in the pre-breeding season.

		Mortality rate (%)												
		1	2	5	10	20	30	40	50	60	70	80	90	100
Displacement rate (%)	10	0	1	2	3	7	10	13	16	20	23	26	30	33
	20	1	1	3	7	13	20	26	33	39	46	52	59	66
	30	1	2	5	10	20	30	39	49	59	69	79	89	98
	40	1	3	7	13	26	39	52	66	79	92	105	118	131
	50	2	3	8	16	33	49	66	82	98	115	131	148	164
	60	2	4	10	20	39	59	79	98	118	138	157	177	197
	70	2	5	11	23	46	69	92	115	138	161	184	207	229
	80	3	5	13	26	52	79	105	131	157	184	210	236	262
	90	3	6	15	30	59	89	118	148	177	207	236	266	295
	100	3	7	16	33	66	98	131	164	197	229	262	295	328

Appendix B: Population Viability Analysis

B.1 Guillemot (project alone and cumulative)

Set up

The log file was created on: 2024-11-19 17:10:27 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

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

Basic information

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

Baseline demographic rates

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

Population 1

Initial population values: Initial population 3508 in 2017

Productivity rate per pair: mean: 0.583 , sd: 0.075

Adult survival rate: mean: 0.94 , sd: 0.025

Immatures survival rates:

Age class 0 to 1 - mean: 0.56 , sd: 0.058 , DD: NA

Age class 1 to 2 - mean: 0.792 , sd: 0.152 , DD: NA

Age class 2 to 3 - mean: 0.917 , sd: 0.098 , DD: NA

Age class 3 to 4 - mean: 0.938 , sd: 0.107 , DD: NA

Age class 4 to 5 - mean: 0.94 , sd: 0.025 , DD: NA

Age class 5 to 6 - mean: 0.94 , sd: 0.025 , DD: NA

Impacts

Number of impact scenarios: 4.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: Yes

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

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

Scenario Name: GU_GO_allbirds_501

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.003194 , se: NA

Scenario Name: GU_GO_allbirds_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.008943 , se: NA

Scenario Name: GU_GO_allbirds_301

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001916 , se: NA

Scenario Name: GU_GO_allbirds_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.044716 , se: NA

Scenario Name: GU_GO_Furness_501

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001836 , se: NA

Scenario Name: GU_GO_Furness_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.00514 , se: NA

Scenario Name: GU_GO_Furness_301

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001101 , se: NA

Scenario Name: GU_GO_Furness_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.025699 , se: NA

Scenario Name: GU_GO_Sabs_501

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001707 , se: NA

Scenario Name: GU_GO_Sabs_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.00478 , se: NA

Scenario Name: GU_GO_Sabs_301

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001024 , se: NA

Scenario Name: GU_GO_Sabs_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0239 , se: NA

Scenario Name: GU_GO__PA_allbirds_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000781 , se: NA

Scenario Name: GU_GO__PA_imms_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000454 , se: NA

Scenario Name: GU_GO__PA_sabs_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.000419 , se: NA

Scenario Name: GU_GO__PA_allbirds_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.003904 , se: NA

Scenario Name: GU_GO__PA_imms_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002268 , se: NA

Scenario Name: GU_GO__PA_sabs_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002093 , se: NA

Output:

First year to include in outputs: 2030
Final year to include in outputs: 2065
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

B.2 Kittiwake (project alone)

Set up

The log file was created on: 2024-11-19 13:37:37 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

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

Basic information

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

Baseline demographic rates

Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 1330 in 2017

Productivity rate per pair: mean: 0.619 , sd: 0.121

Adult survival rate: mean: 0.854 , sd: 0.077

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 0.001 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts

Number of impact scenarios: 2.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: Yes

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

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

Impact on Demographic Rates

Scenario Name: KI_GO_allbirds_SNCB

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.021364 , se: NA

Scenario Name: KI_GO_allbirds_App

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.00426 , se: NA

Output:

First year to include in outputs: 2030
Final year to include in outputs: 2065
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

B.4 Razorbill (project alone)

Set up

The log file was created on: 2024-11-19 13:58:29 using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

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

Basic information

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

Baseline demographic rates

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

Population 1

Initial population values: Initial population 192 in 2017

Productivity rate per pair: mean: 0.532 , sd: 0.084

Adult survival rate: mean: 0.895 , sd: 0.067

Immatures survival rates:

Age class 0 to 1 - mean: 0.794 , sd: 0.001 , DD: NA

Age class 1 to 2 - mean: 0.794 , sd: 0.001 , DD: NA

Age class 2 to 3 - mean: 0.895 , sd: 0.067 , DD: NA

Age class 3 to 4 - mean: 0.895 , sd: 0.067 , DD: NA

Age class 4 to 5 - mean: 0.895 , sd: 0.067 , DD: NA

Impacts

Number of impact scenarios: 4.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: Yes

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

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

Impact on Demographic Rates

Scenario Name: RA_GO_allbirds_501

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.003614 , se: NA

Scenario Name: RA_GO_allbirds_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.01012 , se: NA

Scenario Name: RA_GO_allbirds_301

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002169 , se: NA

Scenario Name: RA_GO_allbirds_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.0506 , se: NA

Scenario Name: RA_GO_Furness_501

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002065 , se: NA

Scenario Name: RA_GO_Furness_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005783 , se: NA

Scenario Name: RA_GO_Furness_301

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001239 , se: NA

Scenario Name: RA_GO_Furness_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.028914 , se: NA

Scenario Name: RA_GO_Sabs_501

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.002003 , se: NA

Scenario Name: RA_GO_Sabs_702

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.005609 , se: NA

Scenario Name: RA_GO_Sabs_301

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.001202 , se: NA

Scenario Name: RA_GO_Sabs_7010

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.028047 , se: NA

Output:

First year to include in outputs: 2030
Final year to include in outputs: 2065
How should outputs be produced, in terms of ages?: breeding.adults
Target population size to use in calculating impact metrics: NA
Quasi-extinction threshold to use in calculating impact metrics: NA

Appendix C: Additional PVA outputs

C.1 Guillemot (project alone)

Table C. 1 : PVA outputs for the annual impact on guillemot from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets using displacement impacts calculated using a 70% displacement rate and 10% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	4,853	2.7	1.027	0.953	1.097	-	-
2030	All birds are breeding adults	4,831	2.3	1.023	0.949	1.094	0.996	0.996
2030	Inclusion of immatures	4,839	2.4	1.024	0.951	1.096	0.998	0.998
2030	Inclusion of immature and sabbaticals	4,841	2.5	1.025	0.951	1.097	0.998	0.998
2065	Baseline (unimpacted)	11,868	151.6	1.026	1.017	1.035	-	-
2065	All birds are breeding adults	10,142	114.9	1.021	1.013	1.030	0.996	0.855
2065	Inclusion of immatures	10,839	129.7	1.023	1.014	1.032	0.997	0.913
2065	Inclusion of immature and sabbaticals	10,883	131.1	1.024	1.015	1.032	0.998	0.919

C.2 Guillemot (cumulative)

Table C. 2 : PVA outputs for the annual impact on guillemot from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using displacement impacts calculated using a 30% displacement rate and 1% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	4,853	2.7	1.027	0.953	1.097	-	-
2030	All birds are breeding adults	4,840	2.4	1.024	0.951	1.096	0.998	0.998
2030	Inclusion of immatures	4,847	2.5	1.025	0.952	1.097	0.999	0.999
2030	Inclusion of immature and sabbaticals	4,844	2.6	1.026	0.953	1.098	0.999	0.999
2065	Baseline (unimpacted)	11,868	151.6	1.026	1.017	1.035	-	-
2065	All birds are breeding adults	10,979	132.8	1.024	1.015	1.033	0.998	0.926
2065	Inclusion of immatures	11,368	140.6	1.025	1.016	1.033	0.999	0.957
2065	Inclusion of immature and sabbaticals	11,395	141.4	1.025	1.016	1.034	0.999	0.961

Table C. 3 : PVA outputs for the annual impact on guillemot from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using displacement impacts calculated using a 70% displacement rate and 10% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	4,853	2.7	1.027	0.953	1.097	-	-
2030	All birds are breeding adults	4,623	-2.1	0.979	0.905	1.047	0.953	0.952
2030	Inclusion of immatures	4,715	-0.1	0.999	0.926	1.07	0.973	0.973
2030	Inclusion of immature and sabbaticals	4,728	0.1	1.001	0.928	1.071	0.975	0.975
2065	Baseline (unimpacted)	11,868	151.6	1.026	1.017	1.035	-	-
2065	All birds are breeding adults	1,880	-60.1	0.975	0.966	0.984	0.950	0.159
2065	Inclusion of immatures	4,167	-11.7	0.997	0.987	1.005	0.971	0.351
2065	Inclusion of immature and sabbaticals	4,490	-5.0	0.999	0.990	1.007	0.973	0.378

C.3 Razorbill (cumulative)

Table C. 4 : PVA outputs for the annual impact on razorbill from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using displacement impacts calculated using a 30% displacement rate and 1% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	217	2.1	1.021	0.827	1.140	-	-
2030	All birds are breeding adults	216	1.9	1.019	0.832	1.141	0.997	1.000
2030	Inclusion of immatures	217	2.1	1.021	0.833	1.141	0.999	1.000
2030	Inclusion of immature and sabbaticals	217	2.1	1.021	0.831	1.142	0.999	1.000
2065	Baseline (unimpacted)	295	38.1	1.009	0.990	1.026	-	-
2065	All birds are breeding adults	270	26.4	1.007	0.988	1.024	0.998	0.918
2065	Inclusion of immatures	280	31.8	1.008	0.989	1.025	0.999	0.956
2065	Inclusion of immature and sabbaticals	282	32.1	1.008	0.988	1.024	0.999	0.954

Table C. 5 : PVA outputs for the annual impact on razorbill from Pen y Gogarth/Great Orme's Head SSSI from the Morgan Generation Assets cumulatively with other projects using displacement impacts calculated using a 70% displacement rate and 10% mortality rate.

Year	Impact scenario	Simulated population size	Median population change (%)	Median growth rate	Lower confidence limit of simulated growth rate	Upper confidence limit of simulated growth rate	Median CGR	Median CPS
2030	Baseline (unimpacted)	217	2.1	1.021	0.827	1.140	-	-
2030	All birds are breeding adults	205	-3.6	0.964	0.772	1.083	0.944	0.944
2030	Inclusion of immatures	210	-1.1	0.989	0.799	1.111	0.968	0.967
2030	Inclusion of immature and sabbaticals	209	-1.1	0.989	0.799	1.110	0.968	0.967
2065	Baseline (unimpacted)	295	38.1	1.009	0.990	1.026	-	-
2065	All birds are breeding adults	34	-83.9	0.950	0.925	0.970	0.942	0.115
2065	Inclusion of immatures	87	-58.9	0.976	0.954	0.993	0.967	0.297
2065	Inclusion of immature and sabbaticals	91	-57.3	0.977	0.955	0.995	0.968	0.309